

SESSION ONE

HANSON, STEIN, SUNDERAM, and ZWICK
on Business Credit Programs in the Pandemic Era

ARNON, RICCO, and SMETTERS
on Epidemiological and Economic Effects of Lockdown

SESSION TWO

FERNÁNDEZ-VILLVERDE and JONES
on Macroeconomic Outcomes and COVID-19: A Progress Report

GALLANT, KROFT, LANGE, and NOTOWIDIGDO
on Temporary Unemployment and Labor Market Dynamics during the COVID-19 Recession

SESSION THREE

AUERBACH, GALE, LUTZ, and SHEINER
on Effects of COVID-19 on Federal, State, and Local Government Budgets

ILZETZKI, REINHART, and ROGOFF
on Will the Secular Decline in Exchange Rate and Inflation Volatility Survive COVID-19?

SESSION FOUR

HUBBARD and STRAIN
on Has the Paycheck Protection Program Succeeded?

GREENWOOD, IVERSON, and THESMAR
on Sizing Up Corporate Restructuring in the COVID-19 Crisis

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COVID-19 AND THE ECONOMY PART TWO

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Monetary Issues and Epidemiology

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Epidemiology across Countries and Labor Markets

SESSION THREE

Fiscal Policy and International Implications

SESSION FOUR

Business Dynamics and Policy

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JANICE EBERLY

JAMES H. STOCK

Editors

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Guest Editors

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The year 2020 marks the 50th anniversary of the *Brookings Papers on Economic Activity* (*BPEA*). Since its founding in 1970, *BPEA* has published high-quality independent research on timely economic challenges using state-of-the-art empirical methods and conceptual approaches. Currently led by coeditors Janice Eberly and James Stock, *BPEA* is widely recognized as a premier economics journal with a long-standing reputation for rigorous analysis and real-world application and relevance.

As the COVID-19 pandemic ravaged the world in 2020, policymakers faced unprecedented challenges in developing adequate responses to alleviate its adverse impact on the global economy. Under this exceptional circumstance, *BPEA* immediately convened two conferences uniquely devoted to exploring the pandemic's impact on economic activity, financial markets, and individual lives. The papers included in this volume, which were presented in September 2020 at the second of these two conferences, represent the best thinking of economists early in the pandemic. They also highlight the ability of research teams to come together in difficult times to inform public policymaking moving forward.

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SESSION ONE
Monetary Issues and Epidemiology

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Business Credit Programs in the Pandemic Era

ABSTRACT We develop a pair of models that speak to the goals and design of the sort of business lending and corporate bond purchase programs that have been introduced by governments in response to the ongoing COVID-19 pandemic. An overarching theme is that, in contrast to the classic lender-of-last-resort thinking that underpinned much of the response to the 2007–2009 global financial crisis, an effective policy response to the pandemic will require the government to accept the prospect of significant losses on credit extended to private sector firms.

Governments around the world have responded to the COVID-19 pandemic with a range of business lending and corporate bond purchase programs to provide credit to nonfinancial firms. In this paper, we try to provide some conceptual grounding for thinking about the goals and design of these business credit programs. For concreteness, we draw motivation from two programs introduced by the US Treasury and the Federal Reserve—the suite of Main Street business lending facilities and the corporate bond purchase facilities known as the Primary Market Corporate Credit Facility (PMCCF) and Secondary Market Corporate Credit Facility

Conflict of Interest Disclosure: Jeremy C. Stein, Samuel G. Hanson, and Adi Sunderam have served as unpaid consultants for the Federal Reserve Bank of Boston’s president Eric Rosengren on the design of the Federal Reserve’s Main Street Lending programs. Jeremy C. Stein also served as consultant to Key Square Capital Management through March 2020 and on the board of directors of the Harvard Management Company. Other than the aforementioned, the authors did not receive financial support from any firm or person for this paper or from any firm or person with a financial or political interest in this paper. Other than the aforementioned, none of the authors are currently officers, directors, or board members of any organization with an interest in this paper.

(SMCCF). However, we believe that the main messages of our analysis apply more broadly and may be useful to other countries that are developing similar business credit programs.

We develop two distinct models. The first model, built with the Main Street and PMCCF facilities in mind, pinpoints the primitive market failures that might justify direct government lending to nonfinancial firms. Using this model, we explore how the market failures arising from today's pandemic-induced recession differ from those in garden-variety recessions as well as those experienced in the 2007–2009 global financial crisis. Thus, the model helps us understand why many governments have taken the extraordinary step of lending directly to nonfinancial businesses in recent months.

We highlight two features of the current COVID-19-induced recession that differentiate it from previous recessions. First, due to the pandemic and associated public health interventions, the relationship between a firm's current cash flows—and hence its ability to service its debts and other fixed obligations—and its long-run post-pandemic viability is likely to be much weaker than in a typical recession. A large number of firms, including many that are likely to be viable in the long run, have suffered precipitous revenue declines in recent months. In the presence of credit market frictions that prevent these firms from borrowing against the full value of their future cash flows, they will not be able to survive the pandemic without government support.

A second distinguishing feature of the current recession is extreme macroeconomic uncertainty due to our lack of knowledge about the path of the pandemic itself. We show that the combination of this high level of uncertainty with aggregate demand externalities means that there is social option value in keeping firms alive. If a surviving firm exerts positive spillovers on other surviving firms, then government support for firms essentially preserves society's option to capture such spillovers if macroeconomic uncertainty resolves favorably (e.g., if a vaccine is developed relatively quickly). These rationales are quite different from the ones that motivated government intervention in the global financial crisis, suggesting that policies should also be designed differently this time around; we flesh out this logic in what follows.

Our second model looks at corporate bond purchase programs such as the SMCCF, where the government announces its intention to buy securities that carry credit risk on the secondary market. As the US case illustrates, even the announcement of such a purchase program can have powerful effects on market prices and primary issuance activity, before the government actually purchases any risky securities. While undeniably

helpful in providing short-run stability to markets, we ask what potential risks might be associated with these strong announcement effects. In particular, we allow for the possibility that investors misperceive the implicit commitment that the Federal Reserve is making when it unveils its purchase programs—that is, that investors fail to properly anticipate the states of the world in which the Federal Reserve will actually step in and buy risky bonds. We show that such misalignments of expectations can help stabilize markets in the short run but also create the risk of sharp unwinds and fire sales further down the road. Of course, the costs and benefits of trading near-term stability for potential future instability depend on how actively firms, financial institutions, and households use the tranquil period to increase their financial buffers and prepare for a downturn. Nonetheless, the potential for the market to misinterpret the Federal Reserve’s intentions means that how it communicates its intentions about future security purchases and how it adjusts its purchases in light of economic and financial developments have the potential to become key policy challenges going forward.

Although our two models are quite different, there is an overarching common theme. A classic framework for thinking about government interventions in financial markets is one in which there are important coordination problems between private market actors that raise the prospect of multiple equilibria. In these settings, the mere promise of decisive action by the government can eliminate the bad, Pareto-inferior equilibrium, leaving only the good, Pareto-superior equilibrium. In the good equilibrium, the economy is sufficiently healthy that the government never actually loses any money on its lending programs, so the government is really just committing resources in an out-of-equilibrium sense. Indeed, the more aggressive the government’s commitments in such a multiple-equilibrium setting, the less it may stand to lose, and the better the overall economy may perform. In other words, a forceful and broadly encompassing promise of government support can be a “free lunch” proposition. Diamond and Dybvig’s (1983) seminal paper—in which a sufficiently committed lender of last resort can eliminate bank-run equilibria—is one example of this kind of logic and has helped shape a generation of crisis management policy thinking, including the dominant thinking in the global financial crisis. As former Treasury secretary Timothy Geithner argues, “it is also true for financial policymakers that once war is unavoidable, you need to commit to overwhelming force” (Geithner 2014, 519).

By contrast, we argue that in the current pandemic setting, this multiple-equilibrium free lunch logic is not the right frame. Policy can certainly improve outcomes, but it is better thought of as fiscal policy, in which

government expenditures potentially deliver high returns for society. Given the magnitude of the shock induced by the pandemic, policy cannot hope to fully stem the coming wave of corporate financial distress. A more forceful policy response—in either the Main Street or corporate bond buying programs—therefore requires the government to accept a greater risk of credit losses. Of course, such risk does not imply that a forceful response is inappropriate. Indeed, we argue the opposite: the government needs to embrace the prospect of losing money on its programs if it is to have any hope of mitigating the economic and financial fallout from the pandemic. As it stands, however, the Main Street and PMCCF facilities are designed to take relatively little risk and in our view are therefore unlikely to be as effective as they might otherwise be.

That said, it appears that the Federal Reserve’s unprecedented efforts to stabilize financial markets since March have for the time being shut down the potential for a macro-financial doom loop, in which deteriorating financial conditions amplify the initial shock to the real macroeconomy. Thus, our analysis here amounts to a set of suggestions for enhancing the future effectiveness of government interventions. The need for such enhancements may become especially relevant if the recovery that has been under way since May stalls in the coming months.

The remainder of the paper proceeds as follows. In section I, we provide a brief timeline of the US government’s interventions in credit markets since the onset of the COVID-19 pandemic in early 2020. Section II develops a model of government intervention in primary credit markets, which both provides rationales for such interventions and suggests how they should be designed. Section III analyzes secondary market bond purchase programs and the potential for investors to misperceive the extent of the government’s backstop. Section IV concludes.

I. Business Credit Programs in the United States

We begin by briefly outlining the timeline of the US government’s interventions in financial markets—emphasizing its interventions in business credit markets—since the onset of the COVID-19 pandemic in early 2020.

Investors’ concerns about the economic and financial impact of the COVID-19 pandemic escalated rapidly beginning in late February 2020, with the US stock market losing roughly 33 percent of its value between February 19 and March 23. Credit markets were also roiled, with credit spreads on high-yield corporate bonds rising by 730 basis points over this same period.

The Federal Reserve responded to these developments with unprecedented speed and force. On March 3, the Fed cut the (upper end of its target range for the) federal funds rate from 1.75 percent to 1.25 percent (Federal Reserve System Board of Governors 2020a). On March 15, it cut the funds rate to 0.25 percent and announced that it would purchase \$500 billion in Treasury securities and \$200 billion in agency MBS, resuming the large-scale asset purchases that it had undertaken from 2008 to 2014 (Federal Reserve System Board of Governors 2020b). On March 17, the Fed announced a number of measures to support liquidity and functioning in short-term funding markets, including reopening the Primary Dealer Credit Facility, the Commercial Paper Funding Facility, and the Money Market Mutual Fund Liquidity Facility, which were crucial components of its response to the global financial crisis (Federal Reserve System Board of Governors 2020c).¹ Finally, on March 23, the Fed signaled that it would purchase Treasury securities and agency MBS in whatever quantities were needed to hold down long-term Treasury and mortgage rates, which rose significantly in mid-March (Federal Reserve System Board of Governors 2020d).² Thus, in less than three weeks, the Fed had cut the short-term policy rate to its effective lower bound and had deployed the full arsenal of nonconventional policy tools that it had developed during the global financial crisis.

On March 23, the Federal Reserve and the Treasury broke new ground and announced their intent to intervene directly in business credit markets, unveiling the PMCCF and SMCCF (Federal Reserve System Board of Governors 2020e). Under the original March 23 PMCCF terms, the Fed would purchase up to \$100 billion of newly issued bonds and loans (maturing in less than four years) from investment-grade US firms (i.e., those with credit ratings of at least BBB–/Baa3).³ To finance these purchases, the PMCCF received an initial \$10 billion equity investment from

1. Federal Reserve, Policy Tools, “Primary Dealer Credit Facility,” <https://www.federalreserve.gov/monetarypolicy/pdcf.htm>; Federal Reserve, Policy Tools, “Commercial Paper Funding Facility,” <https://www.federalreserve.gov/monetarypolicy/cpff.htm>; Federal Reserve, Policy Tools, “Money Market Mutual Fund Liquidity Facility,” <https://www.federalreserve.gov/monetarypolicy/mmlf.htm>.

2. On March 23, the Fed and the Treasury also announced they would reestablish a \$100 billion Term Asset-Backed Securities Loan Facility, which had been formed during the global financial crisis to support the issuance of asset-backed securities; Federal Reserve, Policy Tools, “Term Asset-Backed Securities Loan Facility,” <https://www.federalreserve.gov/monetarypolicy/talf.htm>.

3. Federal Reserve, Policy Tools, “Primary Market Corporate Credit Facility,” <https://www.federalreserve.gov/monetarypolicy/pmccf.htm>.

the Treasury's Exchange Stabilization Fund (ESF), and the Fed agreed to lend the PMCCF the remaining \$90 billion on a secured basis under section 13(3) of the Federal Reserve Act. Under the SMCCF's original terms, the Fed would purchase up to \$100 billion of investment-grade corporate bonds (maturing in less than five years) in the secondary market as well as exchange traded funds (ETFs) that provide broad exposure to US investment-grade bonds.⁴ The SMCCF would also be financed using a \$10 billion equity investment from the ESF, with the Fed providing \$90 billion of secured debt financing.

On March 27, the Coronavirus Aid, Relief, and Economic Security (CARES) Act was signed into law.⁵ The CARES Act allocated an additional \$454 billion to the ESF to enable the Treasury to expand its joint lending facilities with the Fed. In addition, the act established the Small Business Administration's (SBA) Paycheck Protection Program (PPP) to assist small firms—generally defined as those with fewer than 500 employees—in retaining their employees.⁶ While firms applied for PPP loans through private banks, these low-interest loans were guaranteed by the SBA. In addition, if most of the loan proceeds were used to cover payroll expenses, PPP loans would be forgiven by the SBA. The CARES Act initially appropriated \$349 billion for PPP loans, but an additional appropriation of \$320 billion was made on April 24 after demand from small firms exhausted the initial allocation. The SBA stopped accepting applications for PPP loans on August 8.⁷

On April 9, the Federal Reserve and the Treasury significantly expanded the size of the PMCCF and SMCCF from the original \$200 billion to a combined \$750 billion (Federal Reserve System Board of Governors 2020f). They also expanded the scope of the PMCCF and SMCCF so both facilities could purchase the debts of “fallen angel” firms—that is, firms that had investment-grade credit ratings on March 22 but had been subsequently downgraded to no worse than BB–/Ba3. In addition, they changed the scope

4. Federal Reserve, Policy Tools, “Secondary Market Corporate Credit Facility,” <https://www.federalreserve.gov/monetarypolicy/smccf.htm>.

5. Coronavirus Aid, Relief, and Economic Security (CARES) Act, Pub. L. 116–136, 134 Stat. 281 (March 27, 2020), <https://www.congress.gov/116/plaws/publ136/PLAW-116publ136.pdf>.

6. Small Business Administration, “Paycheck Protection Program,” <https://www.sba.gov/funding-programs/loans/coronavirus-relief-options/paycheck-protection-program>.

7. Granja and others (2020), Autor and others (2020), Chetty and others (2020), Bartik and others (2020), and Hubbard and Strain (2020) study the effects of the PPP. Congress added an appropriation of \$284 billion in December 2020 for a third round of PPP loans.

of the SMCCF, allowing it to buy ETFs that provide broad exposure to the high-yield corporate bond market.⁸

In the same April 9 announcement, the Federal Reserve and the Treasury also established the \$600 billion Main Street Lending Program (MSLP) to provide loans to small and medium-sized US firms, with the Treasury making a \$75 billion equity investment in the MSLP. Under the terms eventually adopted on July 28, private banks make Main Street loans—which are typically secured—to qualifying firms with the MSLP purchasing 95 percent of the loan and the originating bank retaining the remaining 5 percent.⁹ Firms are eligible for the Main Street program if they satisfy size restrictions on the number of employees and revenues and also have relatively low leverage.¹⁰ All loans made under the program have a five-year maturity with principal payments deferred for two years and carry an interest rate of LIBOR plus 300 basis points. Firms are generally prohibited from using Main Street loans to prepay or refinance existing debt. In addition, firms that participate in the MSLP are subject to restrictions on executive compensation, dividends, and repurchases.

On May 29, Federal Reserve Chair Jerome Powell made remarks at a Princeton University event that underscored the Fed's commitment to market stability, saying:

The Fed is strongly committed to using our tools to do whatever we can for as long as it takes to provide some relief and some stability now, to support the recovery when it comes, and to try to avoid longer-run damage to people's lives through long spates of unemployment, or to their businesses through unnecessary

8. See Boyarchenko, Kovner, and Shachar (2020) and Gilchrist and others (2020) for analyses of the PMCCF and SMCCF. Falato, Goldstein, and Hortaçsu (2020) and Haddad, Moreira, and Muir (2020) also analyze bond markets in the COVID-19 crisis. On April 9, the Fed and the Treasury introduced a Paycheck Protection Program Liquidity Facility (PPPLF) that would extend credit to banks that had originated PPP loans, taking the PPP loans as collateral at face value; Federal Reserve, Policy Tools, "Paycheck Protection Program Liquidity Facility," <https://www.federalreserve.gov/monetarypolicy/ppplf.htm>. The Fed and the Treasury also announced the creation of a \$500 billion Municipal Liquidity Facility (MLF) that would purchase short-term notes issued by US states as well as eligible counties and cities; Federal Reserve, Policy Tools, "Municipal Liquidity Facility," <https://www.federalreserve.gov/monetarypolicy/muni.htm>.

9. Federal Reserve, Policy Tools, "Main Street Lending Program," <https://www.federalreserve.gov/monetarypolicy/mainstreetlending.htm>.

10. To qualify for a Main Street loan, firms and organizations must have fewer than 15,000 employees or 2019 revenues of less than \$5 billion. For for-profit firms, the firm's ratio of total debt to 2019 EBITDA is capped at either four or six, depending on the specific Main Street subprogram. Nonprofit organizations must meet a lengthy list of financial conditions.

Table 1. Capacity and Take-up for the US Government's Business Credit Programs

<i>Program</i>	<i>Total capacity (\$ billion)</i>	<i>Utilization (\$ billion)</i>
PMCCF and SMCCF	750	12.8
... of which is PMCCF		0.0
... of which is SMCCF		12.8
Main Street Lending Program	600	1.2
Paycheck Protection Program	659	525

Sources: Federal Reserve H.4.1 Release and the Small Business Administration.

Notes: Lending capacity and take-up as of September 2, 2020.

insolvencies. . . . We crossed a lot of red lines, that had not been crossed before. . . . This is that situation in which you do that, and then you figure it out afterward. (Jeff Cox 2020, m4:10)

On June 15, the Federal Reserve further amended the terms of the SMCCF, indicating that it would begin buying a portfolio of bonds designed to track a diversified index of corporate bonds that meet the program's eligibility requirements (Federal Reserve System Board of Governors 2020g). This indexing approach was intended to complement the SMCCF's purchases of ETFs. Importantly, in a set of FAQs, the Fed indicated that it expected to slow or suspend its secondary market bond purchases if indicators of market functioning, including credit spreads, were to return "to levels at or near those prevailing prior to the COVID-19 dislocation" and, conversely, that it expected to increase its purchases if market conditions deteriorated.¹¹

As shown in table 1, of the numerous credit programs announced by the Federal Reserve and the Treasury in response to the COVID-19 pandemic, only the PPP had seen significant take-up as of September 2, 2020. The PPP closed on August 8 after extending \$525 billion of loans to small businesses, compared to a program capacity of \$659 billion. By contrast, the PMCCF and SMCCF have a combined program capacity of \$750 billion, but the PMCCF had not purchased any newly issued bonds or loans as of September 2, and the SMCCF had purchased only \$12.8 billion of bonds and ETFs. Similarly, the Main Street program has the capacity to lend up to \$600 billion but had made just \$1.2 billion of loans as of September 2.

11. Federal Reserve Bank of New York, "FAQs: Primary Market Corporate Credit Facility and Secondary Market Corporate Credit Facility," <https://www.newyorkfed.org/markets/primary-and-secondary-market-faq/corporate-credit-facility-faq>.

II. A Model of Government Intervention in Business Credit Markets

We start our analysis by developing a model that provides a rationale for government support to private firms during the COVID-19 pandemic. A key goal is to highlight how the current pandemic-induced recession differs from both garden-variety recessions and the global financial crisis and why these differences provide a motive for direct intervention in credit markets today.

In the model, there are two key frictions that drive a wedge between the private market outcome and the social planner's solution. First, credit market frictions can prevent firms from borrowing to survive the pandemic, even if continuation would be value maximizing in the absence of these financing frictions. Second, aggregate demand externalities exist: the benefits to society if a given firm survives can exceed the private value of survival.

While these frictions provide broad rationales for government intervention that could apply in any recession, we use the model to highlight how pandemic-specific conditions turbocharge these rationales. First, in the presence of credit market frictions, the government finds it attractive to provide firms with a bridge through a recession to preserve the value those firms can create in the subsequent recovery. This rationale is strongest in recessions where firm cash flows are very low in the short run but are expected to recover in the long run, and when credit market frictions are more severe. While credit market frictions are always potentially present, the COVID-19 recession differs from typical recessions in that a decline in firm cash flows today is less informative about long-run firm viability than in an ordinary recession. Normally, one might argue that government support for firms in financial distress amounts to keeping alive a set of economically nonviable "zombies." Our point is that in the current pandemic-induced recession this zombie argument loses much of its normal force.

Aggregate demand externalities can also provide a general rationale for government action. However, we focus on the interplay between aggregate demand externalities and the heightened macroeconomic uncertainty created by the pandemic. In the model, the aggregate demand externality from keeping alive an additional firm is larger if the economy recovers quickly than if the economy stagnates in a protracted recession. Thus, by keeping alive firms that the private market would allow to fail, the government preserves the option to have a large, positive aggregate demand externality if the health emergency subsides quickly. In other words, there is social option value for the government in providing short-term aid to firms. Of

course, in the private market equilibrium, there is also some option value for individual firms in delaying their exit decisions—some firms are willing to operate with negative cash flows, in case the economy recovers. However, as we show below, aggregate demand externalities create additional social option value, which makes preserving the option to exit later even more attractive to the planner than to private firms. Thus, unusually high macroeconomic uncertainty of the sort that exists today strengthens the case for government intervention.

II.A. Model Setting

The model has three periods—which we label $t = 1$, $t = 2$, and $t = \infty$ —and a continuum of firms $f \in [0, 1]$ that differ solely in their exposure to a negative shock that first hits the economy at $t = 1$. Specifically, we assume the economy enters the initial stages of a recession at $t = 1$, which leads to a larger decline in cash flows for more highly exposed firms. There is also aggregate uncertainty at $t = 1$: the recession will be mild or severe at $t = 2$. Finally, at $t = \infty$, the economy arrives at a new steady state. This steady state depends on the severity of the recession realized at $t = 2$, meaning that the recession may have a permanent scarring effect on firms' cash flows even in the long run.

All agents in the economy are risk neutral with a constant time discount factor given by $\delta \in (0, 1)$. We use F_{S_t} to denote the mass of firms that are operating in state S_t at time t . It will turn out that all firms $f \in [0, F_{S_t}]$ will operate in state S_t at time t .

Each firm can be shut down at any date t . If a firm is shut down, it generates zero cash flow in that period and all future periods. If a firm operates in a given period, it generates some cash flow. If this cash flow is positive, some portion of it can be paid to the firm's outside investors. If the cash flow is negative, it represents an investment that the firm's investors must make to keep it alive.

If firm f operates at $t = 1$, it generates the following cash flow:

$$(1) \quad X_1(f, R_1) = \mu + \gamma - R_1 - \Delta \times f.$$

Here $R_1 > 0$ parameterizes the impact of the recession on firm cash flows at $t = 1$, while f captures cross-sectional heterogeneity in firms' exposure to the recession, with higher f representing greater exposure. In the current pandemic, high- f firms might represent firms in nonessential industries that rely on close physical proximity, for example, firms in the hospitality and leisure sector.

All uncertainty is resolved at $t = 2$, and there are two possible states at $t = 2$: $S_2 \in \{B_2, G_2\}$. With probability p the recession will be severe, denoted $S_2 = B_2$, and with probability $(1 - p)$ the recession will be mild, denoted $S_2 = G_2$. If firm f operates in state S_2 at $t = 2$ it generates cash flow:

$$(2) \quad X_2(f, R_{S_2}, F_{S_2}) = \mu + \gamma \times F_{S_2} - R_{S_2} - \Delta \times f.$$

The term $\gamma \times F_{S_2} \geq 0$ is a reduced form for the aggregate demand externality we assume exists at $t = 2$. The cash flows of any individual firm are greater when more firms are operating at $t = 2$. Individual firms take as given the total number of firms operating, while the social planner recognizes that an additional surviving firm generates positive aggregate demand spillovers on all other surviving firms.¹²

The severity of the recession can affect firm cash flows in the long-run steady state. Specifically, at $t = \infty$, the state of the economy is $S_\infty = B_\infty$ if $S_2 = B_2$ and $S_\infty = G_\infty$ if $S_2 = G_2$. If firm f operates in state S_∞ at $t = \infty$, we assume it generates cash flow:

$$(3) \quad X_\infty(f, R_{S_\infty}) = \mu + \gamma - R_{S_\infty} - \Delta \times f.$$

To introduce financial market frictions at $t = 1$, we assume that private investors can only appropriate a fraction $0 < (1 - \varphi) \leq 1$ of the firm's total value of $t = 2$, where $\varphi \in [0, 1]$. Thus, if firm f requires an outside cash investment at $t = 1$ —that is, if $X_1(f, R_1) < 0$ —it cannot raise the full value of continuation from outside investors. Financial markets are frictionless in the limit where $\varphi = 0$. Limited pledgeability constraints of this sort emerge from moral hazard problems between investors and firm managers (Holmstrom and Tirole 1997). Alternatively, $\varphi > 0$ can be seen as capturing the idea that some of the surplus a firm generates accrues to stakeholders other than the firm's investors and managers (e.g., to employees).

This model setup abstracts from many of the real-world political economy and microeconomic considerations involved in designing a business credit program. Our goal here is to elucidate the broad macroeconomic rationales for such programs.

12. Aggregate demand externalities refer to market failures that can arise from the fact that individual agents fail to internalize how their actions impact aggregate demand in the macroeconomy and, hence, the broader economic conditions faced by other agents. These externalities arise generically in the presence of nominal price rigidities or a zero lower bound on nominal interest rates (Farhi and Werning 2016), but vanish in frictionless, flexible price settings.

PARAMETRIC ASSUMPTIONS We make a few technical assumptions to focus on the most interesting part of the parameter space. First, we assume a natural ordering of cash flows across states and time periods so firm cash flows are lower in the bad state than the good state and there is recovery between $t = 2$ and the new steady state. Second, we assume that the most exposed ($f = 1$) firms have negative cash flows in all states and all time periods, implying that the recession renders some firms nonviable in the long run and that some firms must tap external investors to survive at $t = 1$ and $t = 2$. Third, we assume that aggregate demand externalities at $t = 2$ are not so powerful that the social planner wants to keep all firms alive at $t = 2$. Finally, to isolate cases where there is option value to delaying exit at $t = 1$, we assume that the marginal firm that operates at $t = 1$ continues to operate at $t = 2$ if the good state is realized but exits if the bad state is realized. These conditions are stated more formally in the online appendix.

II.B. Model Solution

In the online appendix, we solve the model by backward inducting from $t = \infty$. Specifically, for each state S_t , we conjecture that we enter the state with all firms $f \in [0, F_{S_{t-1}}]$ still intact from the preceding state S_{t-1} at time $t - 1$. We then find a new cutoff $F_{S_t} \leq F_{S_{t-1}}$ such that all firms $f \in [0, F_{S_t}]$ continue operating in state S_t at time t . Thus, an equilibrium in our model is a set of five cutoffs $\{F_1, F_{G_2}, F_{B_2}, F_{G_\infty}, F_{B_\infty}\}$ that identify the most exposed firm that is still operating in each state.

At each time, a firm's private value reflects the fact that it has the option to exit and earn zero. Thus, the private value of f firm at $t = \infty$ is:

$$(4) \quad V_\infty(f, S_\infty) = \frac{1}{1 - \delta} \cdot \max\{X_\infty(f, R_\infty), 0\},$$

which is simply the value of receiving the greater of $X_\infty(f, R_\infty)$ or zero in perpetuity. At $t = 2$ the private value of the firm is:

$$(5) \quad V_2(f, R_{S_2}, F_{S_2}) = \max\{X_2(f, R_{S_2}, F_{S_2}) + \delta \cdot V_\infty(f, R_{S_\infty}), 0\},$$

and at $t = 1$ the private value of the firm is:

$$(6) \quad V_1(f, F_1) = \max \left\{ \begin{array}{l} X_1(f, R_1) + (1 - \phi)\delta \\ \cdot \left[(1 - p) \cdot V_2(f, R_{G_2}, F_{G_2}(F_1)) \right. \\ \left. + p \cdot V_2(f, R_{B_2}, F_{B_2}(F_1)) \right], 0 \end{array} \right\}.$$

In equation (6), the potential for financial market frictions at $t = 1$ is captured by the fact that the term in square brackets—that is, the firm's expected value at $t = 2$ —is multiplied by $(1 - \phi) \delta \leq \delta$.

The planner's solution and the private market solution diverge when there are either aggregate demand externalities at $t = 2$ ($\gamma > 0$) or credit market frictions at $t = 1$ ($\phi > 0$). When there are aggregate demand externalities, the key difference between the planner's solution and the private market's is that private firms take as given the endogenous state of aggregate demand in the macroeconomy at $t = 2$, captured by F_{s_2} . In contrast, the planner recognizes that its decisions change F_{s_2} , having an impact on the $t = 2$ cash flows of all surviving firms. When there are credit market frictions, the key difference between the planner and the private market is that the planner ignores the friction, effectively acting as though $\phi = 0$. This does not mean that we are assuming that the planner is immune to frictions facing the private market. We are instead assuming that the planner is willing to make investments that are negative net present value (NPV) from the private market's perspective. Because the planner is maximizing total social surplus, the planner is willing to make an investment in a firm that exceeds the pledgeable value of future firm cash flows even if it will take a direct loss on such an investment.

II.C. Comparing the Planner's Solution with the Private Market Solution

Letting $F_{s_t}^{**}$ denote the cutoffs in the planner's solution and $F_{s_t}^*$ denote the cutoffs in the private market solution, the following proposition outlines the basic properties of each solution.

Proposition 1

Under the assumptions outlined above, weakly more firms operate at $t = 1$ than at $t = 2$ in both the planner's solution and the private market solution, reflecting the option value of delaying exit. When either $\phi > 0$ or $\gamma > 0$, weakly more firms survive in the planner's solution than in the private market outcome at $t = 1$ and in all possible states at $t = 2$ and $t = \infty$. When $\gamma > 0$, strictly more firms survive at all times. Specifically, we have:

$F_1^{**} > F_1^*$ when $\phi > 0$ or $\gamma > 0$. Moreover, $F_1^{**} - F_1^*$ is strictly increasing in both ϕ and γ .

$F_{s_1}^* \geq F_{s_2}^*$ and $F_{s_1}^{**} \geq F_{s_2}^{**}$. Furthermore, $F_{s_2}^{**} \geq F_{s_2}^*$ when $\phi > 0$ or $\gamma > 0$ (with strict inequality when $\gamma > 0$). $F_{s_2}^{**} - F_{s_2}^* \geq 0$ is strictly increasing in γ and is weakly increasing in ϕ .

$F_{s_2}^{**} = F_{s_\infty}^{**}$ and $F_{s_2}^* = F_{s_\infty}^*$.

In both solutions, some firms with negative cash flows continue operating at $t = 1$ in hopes that the good state is realized at $t = 2$. If the bad state occurs, these firms exit. Both market failures in our model lead to fewer surviving firms at $t = 1$ in the private solution than in the planner's solution—that is, the private market underinvests in firm continuation. And, naturally, the underinvestment at $t = 1$ becomes more pronounced as each of the market failures becomes more severe.

We next explore how the initial severity of the recession affects the wedge between the private market and planner's solutions. To capture the intuition as simply as possible, we assume there is no uncertainty about the path of the recession, that is, we assume $R_{G_2} = R_{B_2} = \bar{R}_2$ and $R_{G_\infty} = R_{B_\infty} = \bar{R}_\infty$.

Proposition 2

If $\phi > 0$ and $\gamma = 0$ and there is no uncertainty about the path of the recession, then, under the assumptions outlined above, $F_1^{**} - F_1^*$ is increasing in R_1 and decreasing in both $\bar{R}_2$ and $\bar{R}_\infty$.

For starkness, we focus on the case where there are credit market frictions but not aggregate demand externalities.¹³ In this case, the planner and the private market disagree most about firm continuation when the recession is expected to be sharp (i.e., R_1 is large), but short (i.e., $\bar{R}_2$ and $\bar{R}_\infty$ are small). When the shock to the average firm in the economy becomes more transient (i.e., $\bar{R}_2$ and $\bar{R}_\infty$ fall holding fixed R_1), more firms will survive in both the planner's solution and the private market solution. As the initial shock becomes more severe (i.e., R_1 rises holding fixed $\bar{R}_2$ and $\bar{R}_\infty$), however, it becomes more necessary for firms to borrow against the value of future cash flows to survive. When credit market frictions are significant, firms cannot borrow enough in the private market. As a result, injecting funds into these firms so that they can survive is socially worthwhile, even though the planner may not be able to financially recoup these investments in full. In other words, when the fundamental shock that hits the economy is expected to be short and severe, the planner wants to build a temporary bridge to the economy's new steady state. Private markets are less willing to provide this bridge to individual firms because they will be unable to fully capture its social benefits.

13. More generally, the comparative static on R_1 in proposition 2 holds when credit market frictions are relatively important relative to aggregate demand externalities in the sense that $\phi(\Delta - (1 - \delta)\gamma) > (1 - \delta)\gamma$. The comparative statics on $\bar{R}_2$ and $\bar{R}_\infty$ hold whenever either $\phi > 0$ or $\gamma > 0$.

This bridging motive is particularly strong in the current recession because the COVID-19 pandemic and associated public health interventions have had an unprecedented short-run impact on firm cash flows. In more normal circumstances, including in a garden-variety recession, if a firm's revenue falls by 75 percent, this is likely to be a strong signal that the firm is not viable in the long run. Thus, it is both privately and socially optimal for firms to exit when they suffer significant revenue losses, and if the government leans against such exits, it may rightly be accused of propping up economically nonviable zombie firms. In contrast, in the current pandemic setting, sharp declines in near-term firm revenues are less informative about long-run firm viability. While the prospects of some businesses may suffer long-run damage from the pandemic (e.g., hotels catering to business travelers), others seem likely to recover once the health emergency ends (e.g., bars, daycare providers, gyms, and restaurants).

While our formal analysis emphasizes government investments that are designed to enable firms to continue operating, a related motive for government investments may arise if financial distress leads to deadweight losses—for example, because financial distress can distort firm investment (debt overhang) or destroy valuable business relationships. In this case, government investments that prevent a temporary decline in firms' cash flows from resulting in value-destroying financial distress may create surplus that private actors are unable to capture on their own due to financial frictions—for example, because of conflicts between a firm's existing debt and equity holders. See Greenwood, Iverson, and Thesmar (2020) for an assessment of financial distress costs in the COVID-19 pandemic.

We next explore the impact of macroeconomic uncertainty on the wedge between the private market and planner's solutions.

Proposition 3

Under the assumptions outlined above, $F_1^{**} - F_1^*$ is decreasing in both R_{G_2} and R_{G_w} when either $\phi > 0$ or $\gamma > 0$, but does not depend on either R_{B_2} or R_{B_w} . As a result, a small increase in the amount of time-1 uncertainty about exogenous macroeconomic fundamentals at either $t = 2$ or $t = \infty$, raises $F_1^{**} - F_1^*$. Specifically, suppose R_{G_2} declines and R_{B_2} increases such that $\bar{R}_2 = pR_{B_2} + (1 - p)R_{G_2}$ remains fixed. This is associated with an increase in $F_1^{**} - F_1^*$.

When $\phi = 0$ and $\gamma > 0$, there is social option value to keeping firms alive at $t = 1$, over and above the option value each firm perceives in the private market solution. If the good state is realized at $t = 2$, then many firms are viable. The existence of aggregate demand externalities ($\gamma > 0$) means that the demand spillovers the private market does not internalize

are particularly large if the good state is realized. Intuitively, society has access to a valuable real option of generating positive spillovers, which will make the recession shallower, if aggregate uncertainty resolves favorably. Consistent with standard intuitions, the value of this social real option is increasing in the uncertainty about the severity of the recession, so the motive for government interventions is stronger when there is greater uncertainty at $t = 1$ about the future course of the macroeconomy.¹⁴

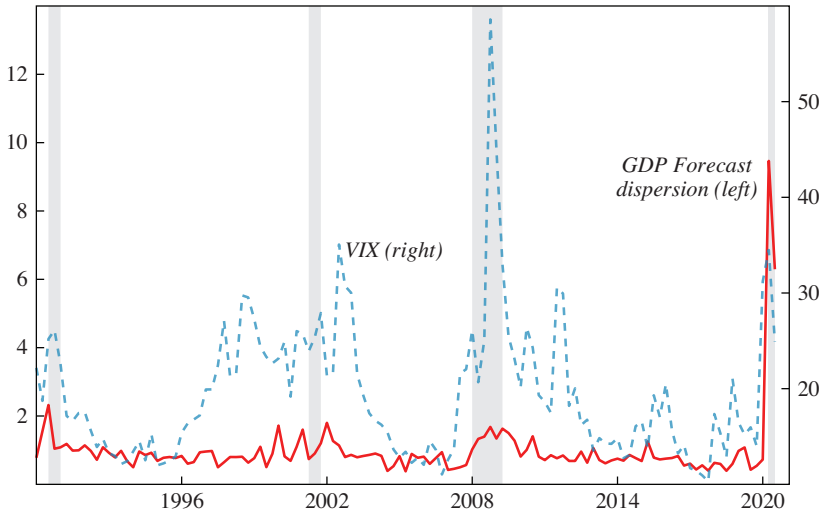
When $\phi > 0$ and $\gamma = 0$, the intuition is even simpler. In this case, an increase in time-1 uncertainty raises the private option value of keeping firms alive until $t = 2$. However, when there are credit market frictions ($\phi > 0$), private investors cannot fully capture the value of this option. Thus, an increase in time-1 uncertainty leads private markets to underinvest more in firm continuation.

These considerations loom large in the current context. As detailed in Altig and others (2020), macroeconomic uncertainty has arguably never been greater than it is today due to the uncertainty about factors including the underlying epidemiology of COVID-19, the efficacy of our public health responses, new treatment options, and the search for a vaccine. Figure 1 makes this point by plotting cross-sectional dispersion in the Survey of Professional Forecasters (SPF) expectations for current-period real GDP growth and option-implied stock market volatility.

II.D. Implications for Program Design

In addition to providing rationales for government aid to firms during the COVID-19 pandemic, the model also has implications for how the support should be designed. The model does not explicitly feature a support program, but one is implicit in the difference between the planner's solution and the private market outcome. Since the planner's solution involves keeping alive some firms that would exit in the private market solution, we are implicitly assuming that the government provides the funds necessary

14. This social option value point hinges on the idea that the externality is larger when aggregate uncertainty resolves favorably. This need not be the case. For instance, suppose there are fire-sale externalities at $t = 2$. When deciding whether to shut down and liquidate an individual firm, private investors take liquidation prices as given. By contrast, the social planner internalizes the fact that liquidating an additional firm reduces the liquidation price for all firms. In the presence of financial market frictions, the resulting pecuniary externality leads to too many private market liquidations when compared to the social planner's solution. Since this fire-sale externality is more pronounced when the recession is more severe at $t = 2$, a model with only fire-sale externalities will imply that the disagreement between private markets and the planner is *increasing* in R_{G_2} and R_{G_s} .

Figure 1. Macroeconomic Uncertainty and Financial Market Volatility

Sources: Federal Reserve Bank of Philadelphia (SPF data); CBOE and FRED (VIX data).

Notes: This figure shows the quarterly time series of the CBOE Stock Volatility Index (VIX; right axis) and cross-sectional dispersion in the Survey of Professional Forecasters (SPF) expectations for current-period real GDP growth (left axis) from 1990:Q1 to 2020:Q2. The SPF dispersion measure is calculated as the difference, in percentage points, between the 75th and 25th percentile forecasts reported.

for those firms to keep operating and finances these investments with lump-sum taxes. While these investments are socially worthwhile, the future cash flows of the specific firms receiving funds need not be sufficient to repay the government. In other words, the government's support may be thought of as containing an element of outright grant to the firms it aids.

Three elements of program design emerge directly from the model. First, the government must be willing to make investments in risky, marginal firms that the private sector is unwilling to finance. In proposition 1, $F_{S_i}^{**} \geq F_{S_i}^*$ state by state. The planner supports more firms—in other words, it makes financing more widely available—than the private market, and the marginal firms it supports are more exposed to the shock (i.e., they are higher- f firms). To the extent that government support in the model is targeted, it is allocated based on the temporary component of firms' current cash flow shortfalls.

Second and relatedly, the government should expect to lose money on the investments it makes in some firms. When there are either aggregate demand externalities or credit market frictions, the planner is willing to invest enough in marginal firms that they can survive at $t = 1$, even though

it will not directly recoup these investments in expectation. When there are aggregate demand externalities, the spillovers these firms generate if the good state is realized outweigh the direct losses from supporting them. When there are credit market frictions, the marginal firms create enough value to warrant support themselves, but the planner may not be able to directly recoup that value for the same reasons private investors cannot—for example, because some of it accrues to other stakeholders.

Put differently, the logic of intervention in the model is not the standard multiple-equilibrium logic for lender-of-last-resort interventions (Diamond and Dybvig 1983). In a lender-of-last-resort context where there is the potential for a purely non-fundamentally driven bank run, government interventions can coordinate private agents on the good equilibrium where there are no credit losses. In contrast, here the government cannot shift the economy from the bad state to the good state at $t = 2$. Whether we are in the good or bad state at $t = 2$ is solely determined by the path of the pandemic, which is not affected by government financial policies toward firms (though it is, of course, influenced by the government's public health policies). Instead, government intervention here counteracts market failures that lead private markets to underinvest in firm continuation, both in the face of the incipient recession at $t = 1$ and ex post once the severity of the recession is realized at $t = 2$.

A third implication of the model is that government financial support should be staged. That is, disbursements of government financing should initially be just enough to keep firms alive between $t = 1$ and $t = 2$ but should not be sufficient to guarantee that firms can survive beyond that. Proposition 3 implies that this staged financing approach is particularly important when aggregate uncertainty is high. In this case, the planner helps many firms survive at $t = 1$ in hopes that the good state is realized at $t = 2$. If the bad state is realized, however, the planner allows some firms to fail. As in a venture capital setting, staged financing is necessary for the planner to adapt to the information that is revealed over time and to capture the social option value of delaying firm exit. At $t = 1$, the planner should not commit to supporting firms until the steady state; it simply wants to support firms long enough to see whether a quick economic recovery is possible.¹⁵

In addition to these direct implications for the design of government aid, the logic of the model informally suggests that the repayment terms of any

15. Staging refers to the quantity of funds provided, not to the maturity of the government's investment. Specifically, staging simply means that the first round of funding is only enough to allow firms to survive until $t = 2$.

government investments should be relatively soft rather than hard. Hard investments are more debt-like in an economic sense, featuring repayment terms like short maturities, high collateralization requirements, and little flexibility for borrowers in the timing and amount of interest and principal payments. In contrast, soft investments are more equity-like; they afford borrowers more flexibility in repayment terms and do not require significant collateral. One relevant observation from the model is simply that the government's investments are not riskless: the government cannot expect to directly recoup the full amount it provides to firms in all states of the world. Thus, using relatively hard repayment terms in an effort to guarantee that the government's investments are fully repaid in all states runs counter to the basic logic for providing government support in the first place.

One could imagine further enriching the model to capture other benefits of softer terms. In particular, reducing the seniority of the government's debt claims or giving firms the option to defer interest or principal payments without filing for bankruptcy protection could help bridge more firms through the pandemic and maintain the health of firm balance sheets, mitigating future debt overhang problems that could otherwise hamper the subsequent recovery.¹⁶ In the language of the model, softer contractual terms on government investments would serve three purposes: (1) increasing the cash flows each firm generates at $t = 2$ by mitigating debt overhang, (2) decreasing any potential credit market frictions facing firms at $t = 2$ by improving the health of their balance sheets, and (3) increasing positive spillovers across firms at $t = 2$ by raising the number of firms that survive.

In practice, governments often prefer to make debt rather than equity investments in firms to avoid the significant political economy problems that arise when they have control rights over firms' operating decisions. With this in mind, the terms of the government's debt investments could be softened by reducing seniority and collateralization, extending maturities, and making principal and interest payments deferrable. In other words, government investments could be made more similar to preferred stock.¹⁷

16. Crouzet and Tourre (2020) analyze the potential for the PMCCF and SMCCF to induce debt overhang.

17. Based on our (admittedly imperfect) understanding of the CARES Act and section 13(3) of the Federal Reserve Act, the government's investments would need to legally qualify as a form of indebtedness. In other words, based on current law, it seems unlikely that the Treasury and the Federal Reserve could establish a facility that made true equity investments in firms. Thus, while existing facilities could not literally purchase preferred stock in firms, they could purchase economically very similar securities—for example, junior subordinated debt with deferrable interest payments.

Notably, the US government's investments in banks during the global financial crisis under the Troubled Asset Relief Program (TARP) took the form of preferred stock, for a similar reason: putting more debt into already over-leveraged banks would have exacerbated their solvency problems; and yet the government was reluctant to put in common equity because it did not want to be seen as nationalizing the banks. To further protect taxpayers, the government could also consider taking equity warrants in participating firms as it did under the TARP program during the global financial crisis.

II.E. Application to the Main Street Lending Program

The implications for program design that emerge from our model stand in contrast to the current design of some of the US government's business lending facilities. Take for instance the Main Street Lending Program (MSLP) that was created by the Federal Reserve and the Treasury to support small and medium-sized businesses. As discussed above, under Main Street, private banks make secured loans to qualifying firms with the MSLP purchasing 95 percent of the loan and the originating bank retaining the remaining 5 percent. Firms are eligible for the Main Street program if they satisfy size restrictions on employees and revenues and have relatively low leverage. All loans have a five-year maturity with no principal payments for two years and carry an interest rate of LIBOR plus 300 basis points.

The requirement that banks retain an economic stake in their Main Street loans seems likely to hamper the program's ability to provide aid to firms that a social planner would choose to invest in but that the private sector is unwilling to finance. Though banks must retain only a small fraction of the loans they make, they will still require a privately satisfactory return on the piece that they must retain. Since the government and banks share borrower repayments proportionally, the return on the piece the banks retain is the same as the return on the overall loan.¹⁸ Thus, unless banks are highly capital constrained, the Main Street program seems unlikely to lead banks to make many additional loans that they would not already be willing to make. In contrast, the model suggests that a key element of any effective government intervention is a willingness to aid marginal firms that private lenders would not see fit to support, even when those private lenders are not capital constrained.

18. This problem can be mitigated to some extent if the banks are also granted generous origination and servicing fees for making the loans. Such fees are indeed a feature of the Main Street Lending Program.

Similarly, Main Street's tight restrictions on firm leverage may also interfere with the program's ability to provide support to marginal firms that private lenders would not finance on their own. By only supporting firms with relatively low leverage, the government may effectively be shutting out those firms where the planner's motives diverge most sharply from those of the private capital providers, and where our model suggests that intervention is most socially valuable.

In addition, the maximum new loan size in the Main Street program is relatively large, ranging from \$35 to \$50 million depending on the specific subprogram. These large loan sizes may mean that for those small and medium-sized firms that do pass the government's and the banks' lending screens, the program may actually be too generous, in the sense of giving firms enough financing to last several quarters, rather than staging the financing and re-upping only in more positive states of the world.

Putting these observations together, our recommendation would be that, to the extent the government wants to protect its Main Street investments, it should do so less by imposing tough *ex ante* underwriting standards to decide who qualifies for the facility, and more by meting out the financing in stages for those who do qualify. Again, the analogy to venture capital is helpful here. In a situation of very high uncertainty, venture capital intermediaries do not seek to avoid investing in risky firms, because, of course, that is where all the value-added lies. Rather they protect themselves by carefully controlling the quantity of financing they provide and only adding to their investments when positive new information comes in. This is exactly the option-value approach that we are advocating.

Finally, the terms of Main Street's loans are relatively hard. These loans must be contractually senior to all other firm indebtedness, so we would generally expect participating banks to require collateral to secure Main Street loans. Moreover, their five-year maturity means that firms may be significantly squeezed by the obligation to repay their loans, even if the public health emergency subsides in the next year. Thus, the terms of Main Street loans may create significant future debt overhang problems. To the extent firms anticipate these problems, these terms may limit program take-up *ex ante*.¹⁹

19. In some respects, the Small Business Administration's Paycheck Protection Program is closer to the program suggested by the model, though its primary focus was on helping firms maintain employment rather than helping them survive. PPP was widely available—in fact, since it did not condition on firm revenue declines, it may have been too widely available. For firms spending most of the funds on payroll, the terms of the program were quite soft: their loans were fully converted to grants. However, for other firms, the terms were quite hard—e.g., the loans initially had a two-year maturity.

Alternatively, if there is ultimately a lot of take-up, the hardness of the loans may contribute to an otherwise avoidable wave of defaults and bankruptcies just as the economy is beginning to emerge from the recession.

Our discussion thus far has treated the US government as a single integrated actor. In practice, the relevant fiscal powers reside with the Treasury, which controls the ESF. The Federal Reserve only has the authority to establish facilities making loans that “are secured to the satisfaction” of the Fed.²⁰ In other words, while the Treasury can assume the risk and even the expectation of losses on its ESF investments, the Fed is not supposed to take risk on the loans it extends (English and Liang 2020). Thus, while it makes no difference for the US government’s consolidated fiscal position, it is legally necessary for the Treasury to make sufficiently large equity investments in each credit facility so that the Fed is highly unlikely to suffer any losses.

Nevertheless, it would seem that the Treasury and the Federal Reserve could together implement all of our core recommendations for the Main Street program under current law. The Treasury has considerable untapped fiscal capacity under the CARES Act—by our count, the Treasury has made equity investments totaling \$215 billion across all of the Fed’s facilities versus a \$454 billion appropriation under the CARES Act—that could be used to insulate the Fed from losses if Main Street or other facilities were to extend credit to riskier, more marginal firms.²¹ Thus, most of Main Street’s restrictive terms likely reflect an institutional unwillingness to assume risk, rather than a legal inability to take on risk.

II.F. Business Credit Programs outside the United States

In countries outside the United States, business credit programs feature some, but not all, of the characteristics suggested by our model. Table 2 gives a brief summary. Programs in the United Kingdom, France, and Germany feature both cash grants and loan subsidies or guarantees. In other words, these programs provide financing to firms on terms the private sector

20. Furthermore, the Federal Reserve cannot establish section 13(3) lending facilities that extend credit to “insolvent” borrowers—that is, firms who are currently in bankruptcy proceedings—or to firms that are on the verge of failing.

21. To be sure, there is also scope for helpful congressional action. For instance, to the extent that it is desirable for Main Street’s loans to have a grant-like character, Congress could remove the provision in the CARES Act that explicitly forbids the government from forgiving any loans made by joint Treasury and Federal Reserve facilities. Relatedly, Congress could further clarify its intention under the CARES Act that the Treasury has the power to make ESF investments that expose taxpayers to the risk of loss when the Treasury deems this necessary to stabilize financial markets and the broader economy.

Table 2. Characteristics of Government Business Credit Programs: International Context

Country	Program name	Better terms than private sector			
		Widely available	Staging	Soft loan terms	
United Kingdom	Coronavirus Business Interruption Loan Scheme	Yes	No	Yes, interest holiday	
United Kingdom	Coronavirus Large Business Interruption Loan Scheme	No	No	Yes, interest holiday	
United Kingdom	Bounce Back Loan Scheme	Yes	No	Yes, interest holiday	
United Kingdom	Future Fund	No, matching fund	No	No	
United Kingdom	Small Business Grant Fund and Retail, Hospitality, and Leisure Grants Fund	Yes	No	Yes, grant	
Germany	Immediate Assistance Program (Soforthilfe)	Yes	Uncertain	Yes, grant	
	Financial assistance for SMEs (Überbrückungshilfe für kleine und mittelständische Unternehmen)	Yes	Uncertain	Yes, conditional grant	
Germany	Economic stabilization fund (Wirtschaftsstabilisierungsfonds)	No	No	No	
Germany	Instant loans (KfW-Schnellkredit)	Yes	Uncertain	No	
Germany	Entrepreneur loans (KfW-Unternehmerkredit)	Yes	No	No	
Germany	Special program (KfW-Konsortialfinanzierung)	No	No	No	
Germany	Corona matching facility (Corona Matching Fazilität)	No, VC participation	No	Yes, equity investments	
		coinvestment			
France	Government-guaranteed loans (Prêt garanti par l'État)	Yes	Uncertain	Yes, payment holiday	
France	Solidarity fund (Fonds de solidarité)	Yes, small firms	Yes	Yes, grant	
France	Subsidized loans (Prêts à taux bonifiés)	Yes, medium firms	No	No	
France	Equity loans (Prêts participatifs exceptionnels)	Yes, small firms	No	Yes, junior in priority	

Source: Authors' compilation.

Notes: This table lists major business support programs in the United Kingdom, Germany, and France and interprets their characteristics through the lens of features in our model. We use "Uncertain" in cases for which the government's future actions will determine whether that characteristic ultimately applies. Information on UK programs comes from HMRC guidance pages (available at <https://www.gov.uk>) and from press reports in the *Financial Times* and BBC. Information on German programs comes from official government websites for each program (e.g., <https://www.kfw.de>) and from Bruegel, which is a European think tank. Information on French programs comes from fact sheets at the Ministry of the Economy and Finance (available at <https://www.economie.gouv.fr>) and press reports in the *Financial Times* and *Le Monde*.

will not. In the United Kingdom under the Bounce Back Loan Scheme and Coronavirus Business Interruption Loan Scheme, in France under the Prêt garanti par l'État program, and in Germany under the KfW-Schnellkredit program, guarantees cover the full loan, ensuring that private sector willingness to lend does not restrict the set of firms that can participate.

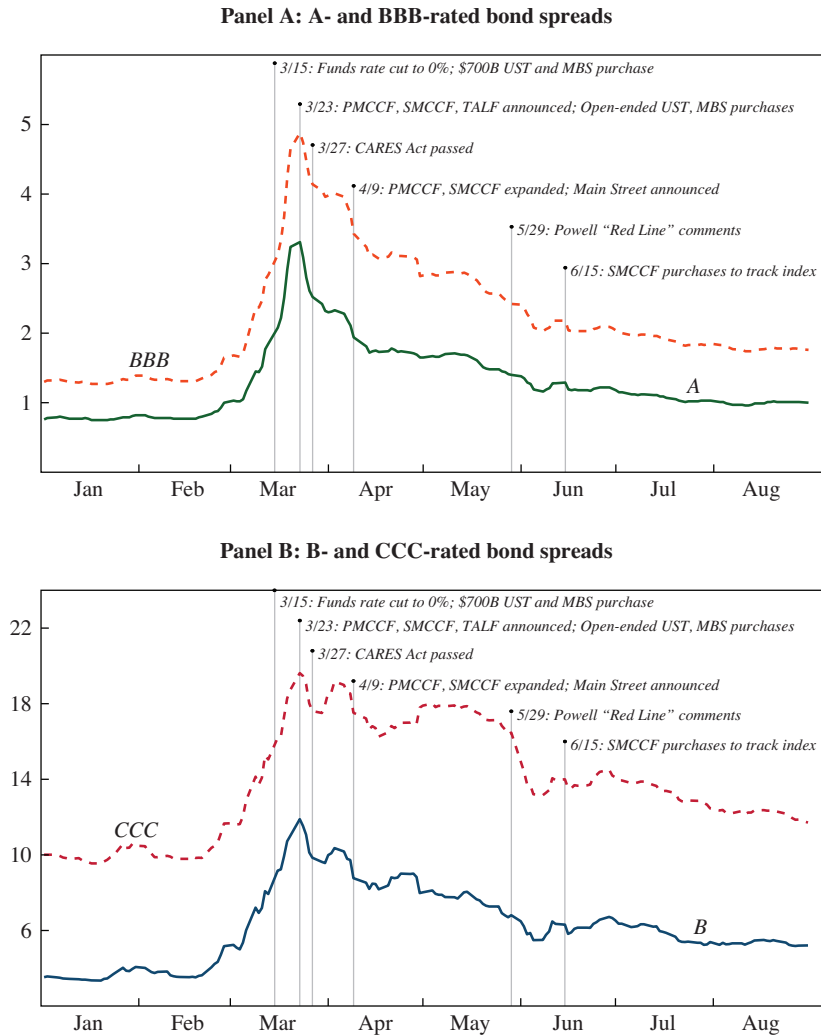
Generally speaking, these programs are widely available, with restrictions only based on firm size and recent revenues. In some cases, such as the United Kingdom's Retail, Hospitality, and Leisure Grant Fund and Germany's Überbrückungshilfe für kleine und mittelständische Unternehmen, eligibility for grants or loan forgiveness extends only to firms in hard-hit industries or with substantial revenue losses due to the pandemic.

In many countries, including the United Kingdom, France, and Germany, the maximum amount of support is a fraction of firms' precrisis annual revenues, costs, or profits. While this financing is not explicitly staged, the governments have the option of renewing the programs, thus capturing some of the benefits of staging suggested by our model. Few countries have granted loans with soft terms, though France has a program (Prêts participatifs exceptionnels) focused on making equity investments, and the United Kingdom and Germany have small programs (the Future Fund and Corona Matching Fazilität, respectively) that match equity or convertible investments made by private investors. Finally, several countries have used value-added tax or payroll tax deferrals and holidays, which provide additional liquidity to firms.

III. Secondary Market Corporate Bond Purchase Programs

While the US government's existing programs are quite different from the policy interventions suggested by our model in section II, they have had surprisingly powerful effects on financial markets. As figure 2 shows, the corporate bond market, which had been under tremendous strain in March, rallied sharply following the announcement of the PMCCF and SMCCF on March 23, 2020. In this section, we present a simple model exploring the possibility that the sharp increase in corporate bond prices since March has occurred, in part, because investors are overestimating the Federal Reserve's willingness to intervene in markets going forward.

In the model, the Federal Reserve may purchase outstanding corporate bonds in response to shocks—in other words, the Fed has a bond purchase reaction function. Even before the Fed actually buys anything, the prospect of its state-contingent purchases can increase bond prices, for two reasons: they reduce the future volatility anticipated by private market investors

Figure 2. Investment-Grade and High-Yield Corporate Bond Spreads in 2020

Source: ICE Bank of America/Merrill Lynch Corporate Bond Indexes, obtained from FRED.

Notes: This figure shows the daily time series of Option-Adjusted Spreads, in percentage points, for A-, BBB-, B-, and CCC-rated corporate bonds. The sample begins on January 1, 2020, and ends on August 31, 2020. Gray lines indicate the following news events: March 15, when the Federal Reserve cut the funds rate to 0 percent and announced \$700 billion of Treasury and MBS purchases; March 23, when the Federal Reserve announced the PMCCF, SMCCF, TALF, and open-ended Treasury and MBS purchases; March 27, when the CARES Act was passed; April 9, when the Federal Reserve expanded the PMCCF and SMCCF programs and announced Main Street; May 29, when Chairman Powell gave his "Red Line" speech at Princeton; and June 15, when the Federal Reserve announced the SMCCF would purchase corporate bonds to track an index. Panel A shows the time series of A- and BBB-rated spreads; panel B shows the time series of B- and CCC-rated spreads.

and thus the risk premium investors charge *ex ante*; and they create an asymmetric put, mitigating downside outcomes for investors while allowing them to keep the upside.

Private market investors make conjectures about the Federal Reserve's purchase reaction function, and crucially, we allow for the possibility that these conjectures may be incorrect. We show that when the market's expectations about the Fed's reaction function are overly optimistic, bond prices will initially be too high and there is a risk of a subsequent crash. If a negative fundamental shock is realized, bond prices fall both because of the direct effect of the shock and because the market learns that the Fed will not provide the support it had previously anticipated.

III.A. Baseline Amplification Model without Federal Reserve Intervention

We first introduce our baseline model without Federal Reserve intervention. The model considers the market for a single defaultable corporate bond and has three dates: $t = 1, 2$, and 3 . The bond pays a random cash flow equal to X_3 at $t = 3$ —that is, the bond is subject to fundamental credit risk. Specifically, we assume that the bond's time-3 cash flow is given by:

$$(7) \quad X_3 = \bar{X} + \varepsilon_{x_2} + \varepsilon_{x_3},$$

where $\bar{X} > 0$ is a constant and ε_{x_2} and ε_{x_3} are mean-zero independent and identically distributed random variables that are realized at dates $t = 2$ and 3 , respectively, each with variance $\sigma_x^2 > 0$.

At $t = 1$ and $t = 2$, the net supply of the bond must be held by a group of risk-averse investors with mean-variance preferences over their one-period-ahead wealth. We solve the model backward. At $t = 2$, investors' demand for risky bonds is given by:

$$(8) \quad D_2 = \frac{1}{\gamma} \frac{E_2[X_3] - P_2}{\text{Var}_2[X_3]} = \frac{1}{\gamma} \frac{[\bar{X} + \varepsilon_{x_2}] - P_2}{\sigma_x^2},$$

where $\gamma > 0$ denotes investors' risk aversion.

We assume that there is financial market amplification at $t = 2$: the marginal investors we focus on must hold a larger quantity of corporate bonds when the price of these bonds turns out to be lower than expected. Specifically, the net supply, S_2 , that these investors must hold at $t = 2$ is:

$$(9) \quad S_2 = \bar{S} + \varepsilon_{s_2} - \lambda \cdot (P_2 - \bar{P}_2),$$

where $\bar{P}_2 = \bar{X} - \gamma\sigma_x^2\bar{S}$ is the unconditional average price at $t = 2$. Net supply at $t = 2$ has two components. The first component, $\bar{S} + \varepsilon_{s_2}$, is an exogenous net supply term, where $\bar{S} > 0$ and ε_{s_2} is a mean-zero supply shock with variance $\sigma_s^2 \geq 0$ that is uncorrelated with fundamental news ε_{x_2} . The second component, $-\lambda \cdot (P_2 - \bar{P}_2)$, captures in a reduced form a variety of positive feedback mechanisms in financial markets. These include: (1) biased investors outside the model who over-extrapolate recent price changes (De Long and others 1990; Barberis and others 2015); (2) traders who face price-based leverage constraints and are forced to unwind at fire-sale prices following an initial negative shock (Geanakoplos 2009; Stein 2012); and (3) open-ended investment vehicles—for example, hedge funds and mutual funds—that face capital outflows when performance is poor and are similarly forced to liquidate their holdings (Shleifer and Vishny 1997). The expression $\lambda \geq 0$ captures the strength of these channels. When $\lambda > 0$, the marginal investors in our model must hold a larger than expected quantity of bonds when prices are lower than expected.

Equating demand and supply—that is, setting $D_2 = S_2$ —the equilibrium price at $t = 2$ is:

$$(10) \quad P_2^* = [\bar{X} - \gamma\sigma_x^2\bar{S}] + \frac{\varepsilon_{x_2} - \gamma\sigma_x^2\varepsilon_{s_2}}{1 - \lambda \cdot \gamma\sigma_x^2}.$$

We assume $0 < \lambda \cdot \gamma\sigma_x^2 < 1$, implying that $1/(1 - \lambda \cdot \gamma\sigma_x^2) > 1$ so there is amplification at $t = 2$. Specifically, when λ becomes larger, time-2 prices become more responsive to both fundamental news ε_{x_2} and to the exogenous net supply shock ε_{s_2} .

Folding back to $t = 1$, the additional volatility induced by financial market amplification at $t = 2$ makes bonds riskier for investors at $t = 1$. Due to this additional risk, time-1 prices are lower than they would be in a world without amplification. Specifically, at $t = 1$, we assume that the net supply of corporate bonds is $S_1 = \bar{S} > 0$ and that investors' demand for bonds is given by:

$$(11) \quad D_1 = \frac{1}{\gamma} \frac{E_1[P_2^*] - P_1}{Var_1[P_2^*]}.$$

Thus, equating demand and supply—that is, setting $D_1 = S_1$ —the equilibrium price at $t = 1$ is:

$$(12) \quad P_1^* = E_1[P_2^*] - \gamma Var_1[P_2^*] \bar{S}.$$

Computing the expected time-2 price and the variance of the time-2 price as of $t = 1$ and substituting these values into equation (12), we find that:

$$(13) \quad P_1^* = [\bar{X} - \gamma\sigma_x^2\bar{S}] - \gamma \left[\frac{\sigma_x^2 + (\gamma\sigma_x^2)^2\sigma_s^2}{(1 - \lambda \cdot \gamma\sigma_x^2)^2} \right] \bar{S}.$$

When $\sigma_s^2 = \lambda = 0$, equation (13) becomes $P_1^* = \bar{X} - \gamma 2\sigma_x^2\bar{S} = E_1[X_3] - \gamma \text{Var}_1[X_3]\bar{S}$, which one can think of as the benchmark efficient markets price in our model. This price is equal to the expected time-3 cash flow ($E_1[X_3]$) minus a risk premium that depends only on investor risk aversion (γ), the volatility of the time-3 cash flow ($\text{Var}_1[X_3]$), and the initial supply of bonds ($\bar{S}$).

When $\sigma_s^2 > 0$ or $\lambda > 0$, time-1 prices are lower than this efficient markets benchmark. Specifically, equation (13) shows that time-1 prices are lower when time-2 amplification is high—that is, $\partial P_1^*/\partial \lambda < 0$ —because amplification raises the volatility of time-2 prices. Similarly, time-1 prices are lower when there is more nonfundamental supply risk at $t = 2$ —that is, $\partial P_1^*/\partial \sigma_s^2 < 0$.

III.B. A Federal Reserve Purchase Reaction Function

We now extend this baseline model to allow for Federal Reserve purchases and sales at $t = 2$. We begin by supposing that the Fed has a linear purchase reaction function that governs the quantity of corporate bonds it will purchase in different states of the world at $t = 2$:

$$(14) \quad B_2 = \theta_s \cdot \varepsilon_{s_2} - [\theta_x / (\gamma\sigma_x^2)] \cdot \varepsilon_{x_2} - \theta_p \cdot (P_2 - \bar{P}_2).$$

Equation (14) says that the Fed will purchase more bonds when the net supply rises unexpectedly (when ε_{s_2} is high), when credit fundamentals are unexpectedly poor (ε_{x_2} is low), or when prices are lower than expected.²² The linear form of the reaction function makes the algebra simple to work with but prevents us from analyzing nonlinear, put-like behavior on the part of the Fed. We return to this point in more detail below.

In the model, corporate bonds are all of the same credit quality and the Federal Reserve has one purchase reaction function. In reality, bonds differ in their riskiness with high-yield bonds having substantially higher default

22. Since there are just two shocks at $t = 2$, the three-parameter reaction function in equation (14) is over-parameterized. We over-parameterize the reaction function this way to exposit different economic rationales for purchasing risky bonds.

probabilities than investment-grade bonds. If we extended the model to include a range of bonds with different credit risk exposures, our mean-variance investors would apply a consistent price of credit risk across all bonds and would require higher returns on riskier bonds. Further, the Fed would have a bigger impact on time-1 prices if it purchased riskier bonds—that is, if it concentrated its purchases in high-yield bonds. This is the analog of the idea that quantitative easing has larger effects when the Fed buys longer-maturity Treasury bonds (Tobin 1958; Vayanos and Vila 2021). In such an extended model, if the Fed primarily bought investment-grade bonds, it would have a smaller impact on overall credit spreads.

Equating demand and supply—that is, setting $D_2 + B_2 = S_2$ —the price at $t = 2$ is given by:

$$(15) \quad P_2^{**} = [\bar{X} - \gamma \sigma_x^2 \bar{S}] + \frac{(1 - \theta_x) \cdot \varepsilon_{x_2} - (1 - \theta_s) \cdot \gamma \sigma_x^2 \varepsilon_{s_2}}{1 - (\lambda - \theta_p) \cdot \gamma \sigma_x^2}.$$

Thus, there will be less time-2 price volatility when the Federal Reserve chooses θ_x closer to 1, θ_s closer to 1, or θ_p closer to λ .

Folding back to time 1, we begin by assuming that investors accurately perceive the Federal Reserve's time-2 reaction function and know it with certainty. The equilibrium time-1 price is then given by:

$$(16) \quad P_1^{**} = [\bar{X} - \gamma \sigma_x^2 \bar{S}] - \gamma \frac{(1 - \theta_x)^2 \cdot \sigma_x^2 + (1 - \theta_s)^2 \cdot (\gamma \sigma_x^2)^2 \sigma_s^2}{(1 - (\lambda - \theta_p) \cdot \gamma \sigma_x^2)^2} \bar{S},$$

which can be contrasted with the no-intervention price in equation (13). A more aggressive reaction function raises time-1 prices—that is, we have $\partial P_1^{**} / \partial \theta_p > 0$, $\partial P_1^{**} / \partial \theta_x > 0$, and $\partial P_1^{**} / \partial \theta_s > 0$.

One case of interest is where $\theta_s = 1$, $\theta_x = 0$, and $\theta_p = \lambda$. In this case, the Federal Reserve completely offsets exogenous net supply shocks ($\theta_s = 1$) and neutralizes all market-based amplification at $t = 2$ ($\theta_p = \lambda$) but allows prices to impound whatever fundamental news arrives ($\theta_x = 0$). Loosely speaking, this reaction function seeks to fully offset the effect of any “technical” factors that push prices away from fundamental value but does not interfere with the adjustment of prices to fundamental news. This reaction function shares some similarities with traditional lender-of-last-resort functions: the goal is not to offset weak fundamentals but rather to dampen positive feedback loops that push market prices away from fundamentals. However, if λ and σ_s^2 are large, this reaction function necessarily

requires the Federal Reserve to take on large amounts of credit risk in some states at $t = 2$. Thus, even in this case, when it does not attempt to lean against fundamental news, the Fed is going well beyond its normal lender-of-last-resort role. In this case, equation (16) becomes $P_2^{**} = \bar{X} + \varepsilon_{x_2} - \gamma\sigma_x^2\bar{S} = E_2[X_3] - \gamma\text{Var}_2[X_3]\bar{S}$ —that is, the efficient-markets price at $t = 2$. Similarly, equation (10) reduces to $P_1^{**} = \bar{X} - \gamma\sigma_x^2\bar{S} = E_1[X_3] - \gamma\text{Var}_1[X_3]\bar{S}$, the efficient-markets time-1 price.

Another interesting case is where $\theta_s = 1$ and $\theta_x = 1$. Here the Federal Reserve is committed to pegging the time-2 risky bond price at the constant level: $\bar{P}_2^{**} = \bar{X} - \gamma\sigma_x^2\bar{S} = \bar{P}_2$. To operationalize such a peg and prevent bond prices from impounding any negative fundamental information, the Fed would need to purchase risky bonds very aggressively in response to any negative fundamental news at $t = 2$. Such a reaction function would potentially require the Fed to take on even more credit risk at $t = 2$.

III.C. Investor Misperceptions about the Federal Reserve's Purchase Reaction Function

Next, we consider the possibility that investors may hold mistaken beliefs at $t = 1$ about the Federal Reserve's time-2 reaction function. Specifically, we assume investors believe that the Fed's reaction function is given by:

$$(17) \quad B_2 = \hat{\theta}_s \cdot \varepsilon_{s_2} - [\hat{\theta}_x / (\gamma\sigma_x^2)] \cdot \varepsilon_{x_2} - \hat{\theta}_p \cdot (P_2 - \bar{P}_2).$$

Given these beliefs, the equilibrium time-1 price becomes:

$$(18) \quad \hat{P}_1^{**} = [\bar{X} - \gamma\sigma_x^2\bar{S}] - \gamma \frac{(1 - \hat{\theta}_x)^2 \cdot \sigma_x^2 + (1 - \hat{\theta}_s)^2 \cdot (\gamma\sigma_x^2)^2 \sigma_s^2}{(1 - (\lambda - \hat{\theta}_p) \cdot \gamma\sigma_x^2)^2} \bar{S}.$$

Of course, time-1 prices will be higher when investors believe that the Fed has a more aggressive reaction function at $t = 2$ —that is, $\partial\hat{P}_1^{**}/\partial\hat{\theta}_p > 0$, $\partial\hat{P}_1^{**}/\partial\hat{\theta}_x > 0$, and $\partial\hat{P}_1^{**}/\partial\hat{\theta}_s > 0$.

We can then compare the actual market price ($\hat{P}_1^{**}$) to what the market price would be if investors properly perceived the Federal Reserve's reaction function (P_1^{**}). Doing so, we obtain:

$$(19) \quad \hat{P}_1^{**} - P_1^{**} = \gamma \left[\frac{(1 - \theta_x)^2 \cdot \sigma_x^2 + (1 - \theta_s)^2 \cdot (\gamma\sigma_x^2)^2 \sigma_s^2}{(1 - (\lambda - \theta_p) \cdot \gamma\sigma_x^2)^2} - \frac{(1 - \hat{\theta}_x)^2 \cdot \sigma_x^2 + (1 - \hat{\theta}_s)^2 \cdot (\gamma\sigma_x^2)^2 \sigma_s^2}{(1 - (\lambda - \hat{\theta}_p) \cdot \gamma\sigma_x^2)^2} \right] \bar{S}.$$

Equation (19) says prices will initially be too high if investors overestimate the aggressiveness of the Fed's future reaction function. This effect arises since time-2 prices will be more volatile than investors anticipate and because investors do not charge for this unanticipated risk at $t = 1$. Thus, one implication of equation (19) is that it illustrates the scope for a sudden decline in prices if investors update their beliefs about the Fed's reaction function in the direction of the truth. This might happen, for example, following new Fed communications that occur shortly after $t = 1$.²³

Alternatively, we can compare the realized price change between times 1 and 2 when investors initially have mistaken beliefs ($P_2^{**} - \hat{P}_1^{**}$) with the corresponding price change when investors have correct beliefs ($P_2^{**} - P_1^{**}$). Suppose investors are overly optimistic about the Federal Reserve's purchase reaction function, so $\hat{P}_1^{**} > P_1^{**}$. It follows that for any possible realization of fundamentals or time-2 supply, we will have $P_2^{**} - \hat{P}_1^{**} < P_2^{**} - P_1^{**}$. Thus, the realized change in prices is always less favorable when investors initially overestimate the aggressiveness of the Fed's purchase reaction function. Misperceptions of the Fed's reaction function create an obvious trade-off: greater misperception raises the time-1 price but always results in a less favorable price change between times 1 and 2.

III.D. An Asymmetric Federal Reserve Purchase Reaction Function

Thus far we have assumed the Federal Reserve's purchase reaction function is linear. To capture the idea of a Fed put, we instead suppose the Fed's reaction function is asymmetric and is given by

$$(20) \quad B_2 = \theta_p \max\{\bar{P}_2 - P_2, 0\},$$

and that investors believe that the Fed's reaction function is

$$(21) \quad B_2 = \hat{\theta}_p \max\{\bar{P}_2 - P_2, 0\},$$

23. As opposed to overestimating the government's resolve, one might theoretically expect rational investors to discount government commitments to make large purchases of risky bonds in certain future states. Specifically, the government may have a time-consistency problem, finding it desirable to stabilize markets by announcing interventions and then failing to follow through on those announcements to avoid actually taking risk. If markets recognize this time-consistency problem, they may react little to government announcements. While such a situation may arise in the future, it does not seem to capture the market's response to recent events.

where $\bar{P}_2 = \bar{X} - \gamma\sigma_x^2\bar{S}$. In other words, the Fed will buy when P_2 is lower than $\bar{P}_2$ and will buy more as prices fall further. However, the Fed will not sell if P_2 is higher than $\bar{P}_2$. Further, since $\hat{\theta}_p$ need not equal θ_p , we allow for the possibility that investors misperceive the Fed's purchase reaction function.²⁴

Equation (21) implies that investors anticipate the following time-2 pricing function:

$$(22) \quad \hat{P}_2^{**} = [\bar{X} - \gamma\sigma_x^2\bar{S}] + \frac{1}{1 - (\lambda - \hat{\theta}_p) \cdot \gamma\sigma_x^2} \times (\varepsilon_{x_2} - \gamma\sigma_x^2\varepsilon_{s_2}) \\ + \left(\frac{1}{1 - \lambda \cdot \gamma\sigma_x^2} - \frac{1}{1 - (\lambda - \hat{\theta}_p) \cdot \gamma\sigma_x^2} \right) \times \max\{\varepsilon_{x_2} - \gamma\sigma_x^2\varepsilon_{s_2}, 0\}.$$

In other words, $\hat{P}_2^{**}$ is an increasing, piece-wise linear function of the time-2 news ($\varepsilon_{x_2} - \gamma\sigma_x^2\varepsilon_{s_2}$) with a smaller slope when time-2 news is bad ($\varepsilon_{x_2} - \gamma\sigma_x^2\varepsilon_{s_2} < 0$) and a larger slope when time-2 news is good ($\varepsilon_{x_2} - \gamma\sigma_x^2\varepsilon_{s_2} > 0$). This change in slope reflects the fact that the Federal Reserve is only anticipated to buy bonds when time-2 news is bad, muting downside amplification but not upside amplification. The actual time-2 pricing function takes a similar form, replacing $\hat{\theta}_p$ in equation (16) with θ_p . Folding back to $t = 1$, we have $\hat{P}_1^{**} = E_1[\hat{P}_2^{**}] - \gamma Var_1[\hat{P}_2^{**}]\bar{S}$. If we assume the news shocks are normally distributed, we can compute $E_1[\hat{P}_2^{**}]$ and $Var_1[\hat{P}_2^{**}]$ in closed form to obtain:

$$(23) \quad \hat{P}_1^{**} = [\bar{X} - \gamma\sigma_x^2\bar{S}] \\ + \overbrace{\left(\frac{1}{1 - \lambda \cdot \gamma\sigma_x^2} - \frac{1}{1 - (\lambda - \hat{\theta}_p) \cdot \gamma\sigma_x^2} \right) \sqrt{\frac{\sigma_x^2 + (\gamma\sigma_x^2)^2\sigma_s^2}{2\pi}}}^{\text{Impact of perceived Fed put on } E_1[\hat{P}_2^{**}]} \\ - \gamma \left[\left(\frac{1}{1 - \lambda \cdot \gamma\sigma_x^2} - \frac{1}{1 - (\lambda - \hat{\theta}_p) \cdot \gamma\sigma_x^2} \right)^2 \frac{\pi - 1}{2\pi} \right. \\ \left. + \left(\frac{1}{1 - (\lambda - \hat{\theta}_p) \cdot \gamma\sigma_x^2} \right) \left(\frac{1}{1 - \lambda \cdot \gamma\sigma_x^2} \right) \right] \\ \underbrace{(\sigma_x^2 + (\gamma\sigma_x^2)^2\sigma_s^2)\bar{S}}_{\text{Investors' perception of } Var_1[\hat{P}_2^{**}]}$$

24. The analysis here is qualitatively unchanged if we instead assume that the Fed's purchase reaction function is $B_2 = \max\{\theta_s \cdot \varepsilon_{s_2} - [\theta_x/(\gamma\sigma_x^2)] \cdot \varepsilon_{x_2} - \theta_p \cdot (P_2 - \bar{P}_2), 0\}$.

This expression implies intuitive comparative statics: since $\partial E_1[\hat{P}_2^{**}]/\partial \hat{\theta}_p > 0$ and $\partial \text{Var}_1[\hat{P}_2^{**}]/\partial \hat{\theta}_p < 0$, a higher value of $\hat{\theta}_p$ now raises $\hat{P}_1^{**}$ through two separate channels. The fact that the expectation of a more aggressive Federal Reserve reaction function raises time-1 prices because it reduces anticipated time-2 price volatility ($\partial \text{Var}_1[\hat{P}_2^{**}]/\partial \hat{\theta}_p < 0$) is the same effect we emphasized above in the case where the Fed has a symmetric reaction function. The fact that $\partial E_1[\hat{P}_2^{**}]/\partial \hat{\theta}_p > 0$ is new and arises from the option-like payoff created by investors expecting the Fed to step in to mute price declines but not expecting the Fed to mute price increases. Thus, if we initially have $\hat{\theta}_p > \theta_p$ and investors revise down their beliefs about the aggressiveness of the Fed's purchase reaction function shortly after time-1, this will lead prices to fall for two distinct reasons.

With an asymmetric reaction function, there will also be an asymmetry in the way that investors revise their beliefs about the Federal Reserve's reaction function when news is revealed at $t = 2$. Specifically, when $\hat{\theta}_p > \theta_p$ and the news at $t = 2$ is good, the Fed will not transact in the bond market at $t = 2$ and investors will never realize that they had misperceived the Fed's reaction function at $t = 1$. By contrast, if $\hat{\theta}_p > \theta_p$ and the news at $t = 2$ is bad, prices will fall for two reasons. First, prices will fall because of the bad news. However, prices will fall even more because the bad news will lead investors to realize that they had overestimated the Fed's willingness to support prices. Thus, when $\hat{\theta}_p > \theta_p$, the time-2 price expected at time-1 by a rational and fully informed outside observer who knows the true level of θ_p will be less than the time-2 price that is expected by investors who think $\hat{\theta}_p > \theta_p$.

Our model is essentially a one-shot game between investors and the Federal Reserve. As a result, if the time-2 news is bad and the Fed intervenes less aggressively than investors had anticipated, time-2 prices will still be higher than they would have been if the Fed had not intervened at all. However, in a multi-shot extension of our model, investor misperceptions of the Fed's purchase reaction function could lead prices to fall below the no-intervention counterfactual. For instance, assume investors initially expect the Fed to always make some minimal purchases $\underline{\theta}_p > 0$ to mute downside amplification. Suppose a financial crisis leads the Fed to want to provide a higher level of downside support $\theta_p > \underline{\theta}_p$ to market prices, but investors overinterpret the Fed's commitment and expect $\hat{\theta}_p > \theta_p > \underline{\theta}_p$. If the Fed's subsequent purchases disappoint investors, this might reduce the Fed's credibility, leading investors to revise their estimate of the Fed's downside support to some new $\hat{\theta}_p < \underline{\theta}_p$. In a multi-period setting, this could actually lead prices to fall to a lower level than they would have if the Fed had never signaled its heightened commitment to support prices.

III.E. Is the Market Currently Misperceiving the Federal Reserve's Reaction Function?

As the above discussion suggests, the risk of an abrupt market correction in the prices of risky bonds is related to the extent to which investors overestimate the aggressiveness of the Federal Reserve's bond-purchase reaction function. In what follows, we present some suggestive—although admittedly not dispositive—evidence that the market may be misperceiving the Fed's current intentions to intervene in the corporate bond market going forward.

We focus on two lines of argument. First, with a few exceptions, the Federal Reserve's announcements suggest a greater willingness to purchase investment-grade than high-yield corporate bonds. For instance, under its current terms, the SMCCF will purchase individual corporate bonds that either currently have an investment-grade rating or that had an investment-grade rating on March 22, 2020, but have since been downgraded to a rating no lower than BB-/Ba3. Similarly, while the SMCCF has purchased some high-yield ETFs, it has concentrated its purchases in investment-grade ETFs.²⁵

In the same way that Federal Reserve purchases of short-dated Treasuries should have a smaller impact on term premia than purchases of long-dated Treasuries, a commitment to purchase low-risk investment-grade bonds should have a smaller impact on credit risk premia than a commitment to purchase higher-risk, speculative-grade bonds. However, despite their focus on investment-grade bonds, the Fed's announcements appear to have had a powerful impact on spreads throughout the corporate bond market, suggesting that investors may be overinterpreting the scope of the Fed's backstop. Specifically, as shown in figure 2 and table 3, the announcement of the PMCCF and SMCCF was associated with large rallies not only in investment-grade bonds but also in high-yield bonds. Further Fed communications about these programs—in particular, the expansion of the programs on April 9 and Chairman Powell's "red lines" comments on May 29—were also associated with large rallies in lower-rated bonds.²⁶

25. Specifically, the Fed is targeting a portfolio of individual corporate bonds consisting of 42 percent AAA-, AA-, and A-rated bonds, 55 percent BBB-rated bonds, and 3 percent BB-rated bonds. As of August 31, the Fed had purchased \$8.7 billion of corporate bond ETFs, of which \$1.1 billion or 13 percent have been high-yield ETFs.

26. The window around Chairman Powell's May 29 speech also includes Gilead's June 1 announcement that the antiviral drug Remdesivir showed promise in phase 3 trials. While most market participants attribute the market rally to Chairman Powell's speech and not this public health news, we cannot cleanly separate these two events.

Table 3. Changes in US Corporate Bond Spreads around Major Market Announcements during 2020

		AAA	AA	A	BBB	BB	B	CCC
<i>Panel A: Federal Reserve announcements</i>								
March 23	PMCCF, SMCCF, TALF; open-ended Treasury purchases ^a	-68	-66	-70	-64	-143	-176	-160
April 9	Expansion of PMCCF, Main Street	-19	-29	-39	-61	-134	-153	-188
May 29	Powell's "red line" comments	-8	-4	-6	-9	-15	-48	-196
June 15	Term sheet for SMCCF amended	-9	-10	-10	-15	-41	-45	-44
<i>Panel B: Public health news</i>								
April 6	Wuhan reopens; NYC deaths plateau over weekend	-18	-20	-22	-29	-60	-63	-64
April 13	Governors of NY, NJ, CT, and PA announce reopening plans	-1	-12	-20	-30	-27	-29	-71
May 18	First Moderna human trial results; Italy begins to reopen	-18	-15	-17	-22	-61	-64	-66
July 1	EU reopens borders	-1	-4	-5	-8	-44	-48	-55
<i>Panel C: Macroeconomic news</i>								
March 27	CARES Act signed into law	-24	-25	-29	-28	-53	-56	-8
April 29	2020:Q1 GDP release: -4.8 percent	0	-2	-6	-26	-16	-99	84
May 8	April jobs report: -20.5 million jobs	2	0	2	1	-16	-20	-22
June 5	May jobs report: +2.5 million jobs	-1	-3	-8	-15	-4	-10	-42
July 2	June jobs report: +4.8 million jobs	-5	-6	-6	-7	-26	-35	-30
July 30	2020:Q2 GDP release: -32.9 percent	0	1	-2	0	0	0	-40

Source: ICE Bank of America/Merrill Lynch Corporate Bond Indexes, obtained from FRED.

Notes: We report three-day changes ($S'_{i,t2} - S'_{i,t-1}$) surrounding events in basis points.

a. The reported three-day changes are over $S'_{i,t3} - S'_{i,t}$. We do this since credit spreads rose initially on March 23 but fell dramatically over the following three days.

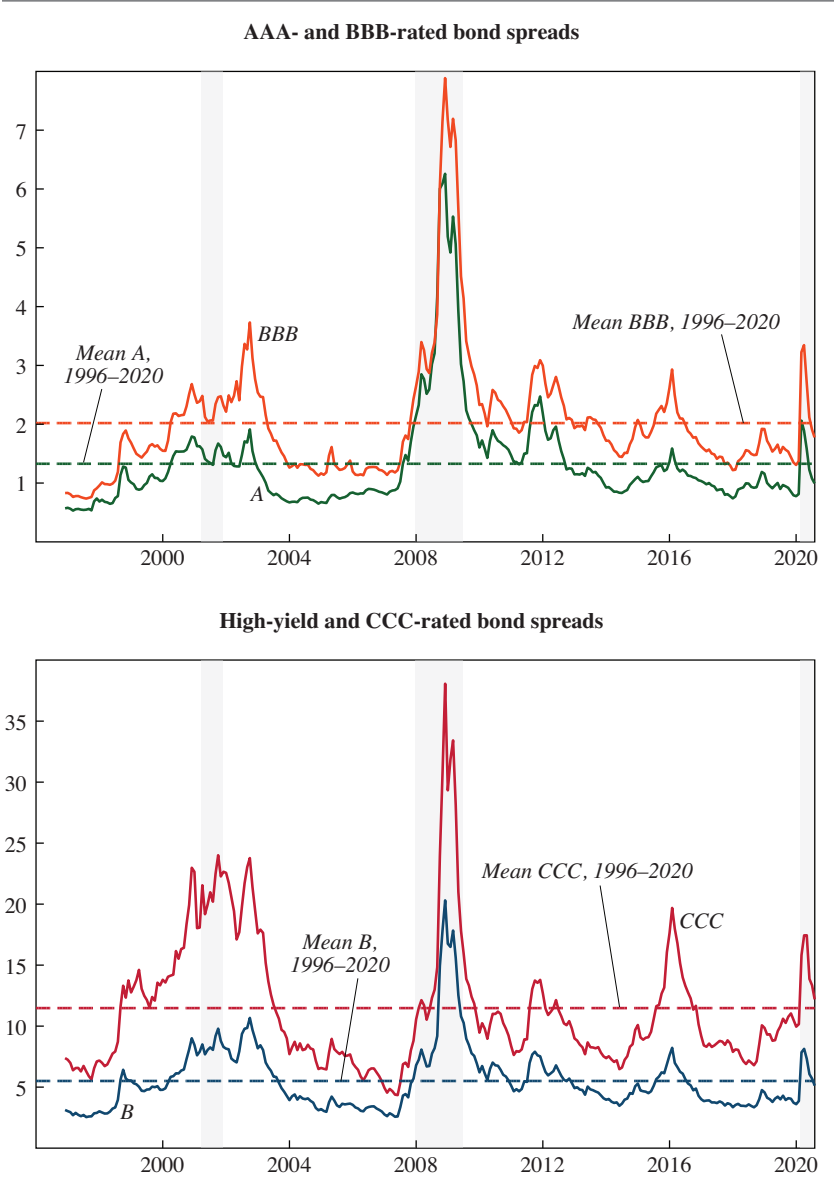
Second, while in the language of our model it is plausible that the Federal Reserve's reaction function effectively embeds meaningfully positive values of θ_s and θ_p , it seems unlikely that it embeds a nonzero value of θ_x . In words, one can imagine the Fed leaning against non-fundamental supply shocks or market amplification mechanisms, but it is much harder to believe that they will try to prevent bond prices from adjusting to a significant deterioration in credit fundamentals. For example, the Fed might step in to stem a fire sale that is driven by outflows from bond mutual funds, but if there is a wave of downgrades or defaults because firms are facing large cash flow shortfalls, it seems quite doubtful that the Fed will—or even can—try to support the prices of these fundamentally distressed bonds. Indeed, when the Fed first announced the PMCCF and SMCCF in March 2020, there was evidence of market dysfunction in the corporate bond market, particularly for investment-grade bonds. Given this timing, one could interpret the Fed's program announcements as declaring that θ_s and θ_p were positive.

Yet, it is difficult to rationalize current market pricing, particularly of high-yield bonds, without appealing to the notion that investors believe that $\hat{\theta}_x > 0$. Simply put, credit spreads are currently at a level that suggests that investors believe the Federal Reserve will offset even fundamental shocks to the value of risky bonds. Specifically, figure 3 shows that the rally that began after March 23 has resulted in credit spreads significantly below the levels typically witnessed during recessions. Even more strikingly, figure 3 shows that spreads on investment-grade and most high-yield bonds are currently below their unconditional averages over the past twenty-five years. (Spreads on CCC-rated bonds remain slightly above their long-run average level today.) By standard asset pricing logic, these low credit spreads must either signal low future credit losses or low future excess returns over default-free Treasuries. Specifically, under simplifying assumptions, the expected return on a corporate bond in excess of like-maturity default-free Treasuries is given by $E[R_{Corp} - R_{Govt}] = S - \pi \times L$, where S is the bond's initial credit spread over Treasuries, π is the bond's constant default hazard probability (i.e., the probability the bond defaults in the next year conditional on surviving thus far), and L is the bond's expected loss given default (i.e., the expected fraction of par an investor will lose upon default).

Consider B-rated corporate bonds.²⁷ Based on data from the ICE BofAML Index, the average level of B-rated corporate bond spreads since 1996 has

27. The formula is valid if a bond's default hazard probability is expected to be constant over time. In the data, this assumption has historically been reasonable for B-rated bonds.

Figure 3. Investment-Grade and High-Yield Corporate Bond Spreads, 1996–2020



Source: ICE Bank of America/Merrill Lynch Corporate Bond Indexes, obtained from FRED.
Notes: This figure shows the monthly time series of ICE BofAML Option-Adjusted Spreads for A-rated, BBB-rated, B-rated, and CCC- and lower-rated bonds. Dashed lines indicate each series' unconditional mean over the sample period, which runs from December 1996 to August 2020.

been 5.5 percent. According to S&P Global Ratings (Kraemer 2020), the one-year default rate for B-rated bonds averaged 3.3 percent from 1981 to 2019. Thus, assuming a typical loss given default of 60 percent, our formula implies an average excess return on B-rated bonds of $E[R_{Corp} - R_{Govt}] = 5.5 \text{ percent} - 3.3 \text{ percent} \times 60 \text{ percent} = 3.5 \text{ percent}$. On August 31, 2020, B-rated bond spreads stood at 5.2 percent, slightly below their long-run average, despite the fact that the United States is now in the midst of a severe recession. According to S&P Global Ratings (Kraemer 2020), the default rate on B-rated bonds has topped 11 percent in the last three recessions, reaching 13.8 percent in 1991, 11.6 percent in 2001, and 11.0 percent in 2009. If the default rate were to again reach 11 percent in this recession, that would imply an expected excess return of $E[R_{Corp} - R_{Govt}] = 5.2 \text{ percent} - 11 \text{ percent} \times 60 \text{ percent} = -1.4 \text{ percent}$. However, since B-rated bonds are quite risky, as well as less liquid than Treasuries, investors should always require a positive expected excess return to hold them. While highly simplistic, this analysis suggests that investors either expect defaults of highly levered firms to be much lower in the COVID-19 recession than in past recessions or that the Federal Reserve will somehow put a firm floor beneath the prices of these highly risky bonds.²⁸

The rally in CCC-rated bonds is also noteworthy. CCC-rated bonds have very high default probabilities even in normal times (averaging 27 percent from 1981 to 2019) and their default probabilities topped 45 percent in the last two recessions (Kraemer 2020). Under the current terms of the SMCCF, the Federal Reserve will not purchase CCC-rated bonds directly and will only support them indirectly through its purchases of high-yield bond ETFs. Moreover, because of limitations in section 13(3) of the Federal Reserve Act, the Treasury and the Federal Reserve's joint facilities cannot buy the bonds of firms that are in bankruptcy proceedings, which presumably reduces the US government's appetite for buying CCC-rated bonds, which are close to default. Thus, the large compression in CCC-rated spreads since March is particularly striking.

Firms have responded to this powerful market rally by issuing record quantities of corporate bonds and equity in recent months. The issuance

28. Cox, Greenwald, and Ludvigson (2020), Gormsen and Koijen (2020), and Landier and Thesmar (2020) conduct analogous exercises for the US stock market and conclude that either low investor risk aversion or positive market sentiment play a key role in explaining the current high level of US stock prices.

boom began in the investment-grade bond market following the Federal Reserve's March 23 announcement. US investment-grade corporations issued \$808 billion in bonds between March and May 2020, more than double the amount in any prior three-month period on record. The issuance boom spread to lower-rated corporate bonds in April and then to public equities in May. According to data from Refinitiv Thomson ONE, the volume of high-yield bond issuance (\$125 billion), convertible bond issuance (\$46 billion), and seasoned public equity issuance (\$100 billion) between April and June each exceeded any prior three-month period in US history.

There is an alternative explanation for today's low level of corporate bond spreads that does not involve investor misperceptions: the Federal Reserve's interventions may have actually reduced the amount of corporate credit risk in the economy. Specifically, the market rally and subsequent issuance wave may have allowed firms to build up enough of a cash buffer to survive until the public health emergency ends and cash flows return to more normal levels. In this case, the lower credit risk going forward means that the Federal Reserve will not actually have to lean against fundamental shocks in its bond buying.

This alternative is difficult to rule out definitively, but a couple of pieces of evidence suggest it is not the whole story. First, as shown in table 3, other types of news—for example, news about recent improvements in the labor market—have not had as powerful an effect on credit spreads as Federal Reserve announcements. In other words, the market appears to be reacting more strongly to Fed news than to fundamental macro news. Second, we are in fact already seeing a surge in credit rating downgrades and defaults. According to S&P Global Ratings (Kraemer, Palmer, and McCabe 2020), the number of corporate defaults in the first six months of 2020 (eighty-three) exceeded the total for the entirety of 2019 (seventy-seven). Furthermore, S&P tallied more rating downgrades in the first six months of 2020 than in any prior twelve-month period.

III.F. Normative Implications: When Is Central Bank Magic Most Potent?

On July 26, 2012, in the face of escalating market worries about the potential breakup of the euro, European Central Bank president Mario Draghi famously said: "Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough." In the wake of Draghi's speech, yields on Spanish and Italian sovereign debt declined

dramatically and financial markets stabilized more generally.²⁹ The words “whatever it takes” have since become a shorthand for the almost magical ability of central bank announcements to stabilize markets, in some cases with little in the way of follow-up action.

The power of central bank magic of this sort is most easily rationalized in the context of models with multiple equilibria such as Diamond and Dybvig’s (1983) seminal model of bank runs. With regards to Draghi’s quote, one can readily imagine circumstances in which there may be multiple equilibria in the market for Italian sovereign debt. If Italian interest rates are high, Italy will struggle to service its debt load, and there will be a significant risk of an Italian default, validating the high interest rates. Conversely, if Italian interest rates are low, Italy can more comfortably service its debt, and Italian default risk is mostly eliminated, validating the low interest rates.³⁰ In a setting like this, if Italy is initially stuck in the high-rate equilibrium, a powerful commitment by the European Central Bank to buy Italian bonds can shift the market to the low-rate equilibrium. And once the market shifts to this new low-rate equilibrium, little bond buying may actually be necessary; all that is required is a credible off-equilibrium-path commitment. This ability to affect outcomes with promises alone, without taking any risk in equilibrium, is one way of thinking about central bank magic.

On the surface, the Federal Reserve’s March announcements of the PMCCF and the SMCCF, and the Fed’s follow-up communications, including Chairman Powell’s May 29 “red lines” remarks, have had a similar “whatever it takes” shock-and-awe kind of impact on markets. Moreover, these words have not only led to a powerful rally in credit and equity markets, they have unleashed a wave of issuance by both investment-grade and high-yield firms that has undoubtedly helped improve the balance sheet health of issuing firms and, thus, the resilience of the broader economy. Indeed, in some recent models (He and Milbradt 2014; Greenwood, Hanson, and Jin 2019) improvements in investor sentiment may enable firms who might otherwise default to survive by allowing them to refinance maturing debt on more favorable terms. In other words, there is some potential for

29. On July 24, 2012, the spread between the yield on ten-year Spanish government bonds and that on ten-year German bonds had reached 630 basis points. The corresponding spread for Italy was 530 basis points. By July 27, one day after Draghi’s speech, Spanish and Italian spreads had fallen to 530 and 450 basis points, respectively. And, by the end of 2012, Spanish and Italian spreads stood at 390 and 320 basis points.

30. Beginning with Calvo (1988) and Cole and Kehoe (2000), there is a large body of literature that studies the potential for self-fulfilling sovereign debt crises of the sort.

self-fulfilling dynamics to exist in the corporate bond market, just as in the sovereign bond market.³¹

Nevertheless, despite the potential for such positive feedback effects, it is hard to argue that we are currently in a situation where the strongest form of central bank magic is available to the Federal Reserve—namely that the Fed can stabilize credit markets and move the economy to a better equilibrium without the prospect of having to actually take on significant credit risk. While all the issuance sparked by the Fed’s communications has undoubtedly lowered the near-term default risk of many firms, given the magnitude of the economic downturn triggered by the pandemic, we still face the possibility of a coming wave of credit downgrades and defaults. If this negative scenario comes to pass, the Fed may feel pressure to step in and assume a considerable amount of credit risk to avoid disappointing investors. Alternatively, if the Fed does not step in, there is a risk that these downgrades and defaults will lead market sentiment to worsen considerably, generating a credit crunch that triggers further firm defaults. In the latter case, the favorable self-fulfilling dynamics we have witnessed in credit markets since late March may begin to go in reverse.

To be clear, none of this is to suggest that the Federal Reserve’s aggressive response to the crisis—or even the market’s potential overinterpretation of the Fed’s intentions—have been undesirable from a normative perspective. Quite the contrary: the Fed’s efforts to stabilize financial markets since March, and especially the large volumes of issuance they have triggered, have had a clear benefit to the real economy. Indeed, we would argue that the Fed’s forceful efforts to stabilize financial markets since March have thus far stemmed the potential for a damaging negative spiral, in which deteriorating financial conditions amplify the initial impact of the pandemic-induced shock. Our far more modest point is only that, in contrast to other settings where central bankers (or the government more broadly) can be helpful with their words alone, and without assuming a significant amount of fiscal risk, we are in a situation where risk-taking by the government may be a crucial part of the equation.

31. In Greenwood, Hanson, and Jin (2019), there is a two-way feedback loop between investors’ biased beliefs and credit market outcomes. Investors form beliefs about default probabilities in part by naively extrapolating firms’ recent repayment history. Following periods of low defaults, investors believe that corporate debt is safer than it truly is, and they refinance maturing debt on more attractive terms than unbiased investors would. Thus, investors’ current biased beliefs influence future credit market outcomes, and past credit market outcomes shape investors’ current biased beliefs.

This observation connects back to the themes in the first part of the paper. There is an obvious parallel between the key point there—namely, that we are not in a classic multiple-equilibrium lender-of-last-resort situation and the Main Street facility therefore will have to take on meaningful levels of credit risk if it is to be effective—and our point here about the bond purchase programs. Simply put, the economic impact of the pandemic is so devastating that even with the best possible financial policy response, enormous fundamental uncertainty remains; there is no low-solvency/risk equilibrium that can be readily attained. And if the government is not willing to take some credit risk in its programs, these programs cannot hope to be fully effective. The question then becomes not whether the government should take risk, but how to balance the fiscal costs of these risks against the benefits of intervention, and how to mitigate these risks with intelligent program design features where possible.³²

IV. Conclusion

The recession induced by the COVID-19 pandemic has not only been unusually severe, it has differed qualitatively from recent recessions in two important ways. First, the current level of macroeconomic uncertainty is extraordinarily high, and the resolution of this uncertainty seems to depend largely on noneconomic factors, such as the future path of the pandemic and the rate of progress in developing and then deploying a vaccine against the novel coronavirus. Second, the precipitous revenue declines that many firms have experienced in recent months have been driven primarily by their exposure to this temporary public health crisis—with those in so-called nonessential industries that rely on close physical proximity being especially hard hit—and thus may carry little information about the long-run economic viability of these firms.

Our basic point is that, in such a setting, the theory of the case for government intervention in business credit markets is fundamentally different from the classic lender-of-last-resort liquidity provision motive that shaped much of the response to the 2007–2009 global financial crisis and that remains a dominant policy paradigm more generally today. In particular, an effective policy response to the pandemic will require the government to accept the prospect of meaningful losses on any credit it extends to private sector firms. An analysis based on this premise also yields a number of

32. See, for example, Hanson, Scharfstein, and Sunderam (2019) for an explicit analysis of government fiscal risk-taking.

more specific implications for policy design, which we have attempted to flesh out in some detail. But unless policymakers are prepared to embrace the essentially fiscal nature of the interventions that are required today, they are unlikely to be as successful as they might otherwise be in mitigating the economic and financial fallout from the COVID-19 pandemic.

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Comment and Discussion

COMMENT BY

NELLIE LIANG This is a terrific paper. It is very constructive and provides many useful insights into designing government programs to support business credit. The paper offers two different models for designing government programs when normal channels of credit intermediation are disrupted. It uses the models to highlight the features of two programs, the Main Street Lending Program and the corporate credit facilities. The overarching message of the paper is that the 2020 pandemic crisis is not the same as the 2008 financial crisis, and government needs to embrace a greater risk of credit loss when designing programs to help businesses survive the economic fallout from the pandemic.

In this discussion, I'm going to focus on how the design and success of the two credit programs are affected by the Federal Reserve's existing authorities as a lender of last resort. Both credit programs are provided jointly by the Treasury and the Federal Reserve, with the Treasury providing equity capital available from the Coronavirus Aid, Relief, and Economic Security (CARES) Act, and the Federal Reserve lending based on that capital to absorb first losses. But even with equity, the Fed as the lender of last resort still faces constraints related to credit risk.

Two conditions provide a general picture of the limitations. First, the lending authority of the Federal Reserve, even under emergency authorities with equity capital provided by the Treasury, requires that the borrowers must be solvent, although there is some discretion for how to define solvent. Second, the security for emergency loans needs to be sufficient to protect taxpayers from losses. These conditions set limits

on lending by the Federal Reserve when there is the prospect of high credit losses.¹

I agree generally with the basic conclusion of the paper that the government needs to embrace a greater risk of credit loss in this pandemic crisis. I believe that the actions taken by the Federal Reserve and the Treasury are cushioning the economy as it adjusts to the virus and are helping to speed up the recovery. The actions have greatly reduced the potential that large losses in household and business income would initiate a negative feedback loop between financial markets and economic activity and make the pandemic recession even more severe.

But the emergency liquidity and credit actions taken by the Federal Reserve and the Treasury cannot be a full substitute for fiscal responses, which could spend taxpayer funds to support businesses. Through that lens of spending versus lending, I think the Main Street program is an odd fit for the Fed, which is restricted to lending, and believe the less-than-full alignment of objectives and authorities may explain its limited success thus far. I believe the tension for the Fed for the Main Street program to be greater than the authors of this paper do. In contrast, I agree with the authors that the corporate credit program is better aligned with the Fed's responsibilities as a lender of last resort in unusual and exigent circumstances, but I believe the Fed needs to clarify its objectives or risk that the program does not remain successful.

MAIN STREET LENDING PROGRAM The model in the paper to help describe this program is based on two key frictions that lead to differences between the private market and the planner's outcomes. The first is a credit market friction, where the near-term falloff in revenues because the virus is constraining business and consumer activities makes current financial information about any business less informative about its long-run viability. The second friction is that there are positive aggregate demand externalities that a private business would not consider when making its own decisions to borrow and continue to operate and maintain employees. These frictions lead to some interesting model predictions: the government should invest in riskier firms than the market would on its own, and the government should expect to lose some money on its investments. A third prediction—an interesting innovation of the model—is that it predicts staged financing. Staged financing provides funds to firms in increments, rather than in a one lump sum, and each installment is conditional on the firm's survival. It may

1. English and Liang (2020) spell out in more detail the constraints on Federal Reserve lending and implications for the design of the Main Street Lending Program.

encourage banks to make more loans and helps firms get to the next stage, when aggregate macro uncertainty is high.

At least two of these elements are not currently incorporated into the Main Street program. The Main Street program was extremely difficult to set up: while the Federal Reserve announced it in March, the terms were not released until a couple months later, and it has been revised multiple times since then. There has been very little take-up so far, about 120 loans for about \$1.1 billion as of August.²

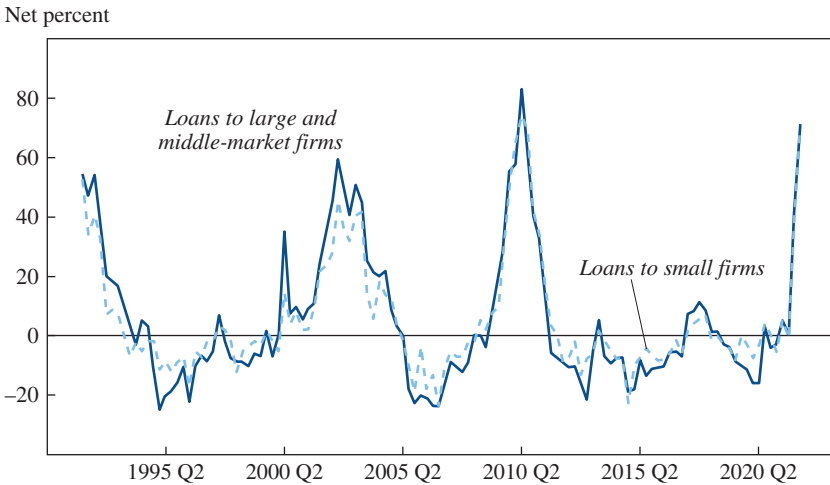
One reason for limited success is that because of its legal constraints, the Federal Reserve needs banks to underwrite the loans and provide assurance that the firms getting the loans are solvent. To ensure bank incentives are aligned with the government, banks are required to keep a share, 5 percent, of the loans they make. But if banks are required to retain a share, they are likely to stick closely to loans they would make on their own, and so the program is not expanding support to borrowers who are too risky for the market.

The most recent responses to the Federal Reserve's Senior Loan Officer Opinion Survey illustrate the problem. The recent observation from July 2020 shows that banks on net are reporting a sharp tightening of lending standards on commercial and industrial loans to small businesses (figure 1). As a reason for the tighter standards, banks reported concern about increased risks of borrowers more than that they faced balance sheet constraints. The current net tightening level is about as high as it was in the global financial crisis. But at that point in time, banks couldn't make the loans. In the current situation, banks don't want to make the loans given the new loans are likely exposed to the same risks as the loans they already have on their books.

Another consideration for designing the program is that it can help borrowers only by lending, not providing a grant, and many borrowers may not want to take on more debt in this environment. Staged financing could help because it could encourage more firms to borrow. If firms are highly uncertain about the path of the pandemic and the economy, they may not want to take on a lot more debt. Staged financing would give firms more options and could help lenders too, and total loan commitments would be less burdensome if the recovery did not stay on track. In addi-

2. Board of Governors of the Federal Reserve System, "Funding, Credit, Liquidity, and Loan Facilities," <https://www.federalreserve.gov/funding-credit-liquidity-and-loan-facilities.htm>.

Figure 1. Net Percentage of Domestic Respondents Tightening Standards for Commercial and Industrial Loans



Source: Board of Governors of the Federal Reserve System (US).

tion, I agree with the authors that softer standards, such as more equity-like features for the loans, could help borrowers and still be consistent with the Federal Reserve's legal constraints.

But I also think the program may need to pay more fees to the banks to encourage them to make some loans, basically to offset the risk of losses for the share of the loan they are required to retain. English and I (2020) have suggested higher fees, as well as some other marginal changes to increase the use of this program; given the Federal Reserve was assigned this task to help small to midsize businesses with a Main Street program, they should do it as well as they can. But after several revisions by the Fed, each to loosen more terms, I now think a more fundamental change in the program is warranted. Mainly, rather than additional marginal changes, it would be more helpful for Congress to acknowledge this type of support for businesses should really be a fiscal program. One idea would be to revise the CARES Act legislation to allow Main Street loans to offer conditional forgiveness if macro conditions were to deteriorate. This would involve some fiscal resources and not rely principally on the Fed, which can provide only liquidity. But there may still be some political risk for banks because when the Fed is involved, banks would still need to retain a share.

CORPORATE BOND FACILITIES In contrast to the Main Street program, the corporate bond purchase programs have dramatically eased financial conditions, with most of the improvement occurring well before any bonds were actually purchased by the Secondary Market Corporate Credit Facility (SMCCF). Moreover, no new bonds have been issued to the Primary Market Corporate Credit Facility (PMCCF). But the programs helped to ignite a boom in bond issuance with corporations issuing long-term bonds to private investors and locking in low interest rates. This financing has greatly reduced the near-term default risks of corporations.

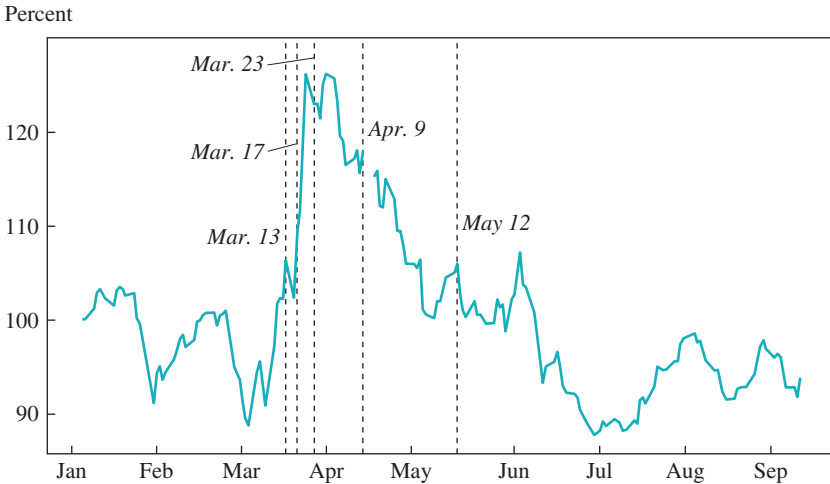
The second model presented by the authors highlights that this program, despite its apparent success, may not be credit-risk free if investors misperceive the Federal Reserve's reaction function. I believe, as I think the authors do, that this program may not be well understood by market participants.

Certainly, the language around the introduction of the SMCCF "to support credit to employers by providing liquidity to the market" allows for some ambiguity about the Federal Reserve's intentions.³ One intent that is clear is that it aims to fix dysfunction in market liquidity. That action, however, will also boost asset prices, raising expectations that the goal is to raise the value of corporate bonds, rather than to fix the technical market functioning problems that are holding down bond prices.

To highlight the importance of these distinctions in reaction functions, the Federal Reserve as traditional lender of last resort would aim to offset technical factors that push bond prices away from its economic fundamentals, such as future cash flow. But under this reaction function, the Fed would not interfere with the adjustment of prices to changes in fundamentals. The model shows, however, that this mode of operation could still require the Fed to take on some credit risk in a future bad state of the world if investor risk aversion and supply variance were high.

Alternatively, the Federal Reserve's reaction function could be viewed as pegging the risky bond price. This would basically be an interpretation that the SMCCF is acting as a monetary policy tool—quantitative easing with purchases of corporate debt rather than Treasury debt—to reduce interest rates and promote looser financial conditions. This objective would go beyond that for a lender of last resort. In that case, the Fed would purchase risky bonds very aggressively if there were negative news and a decline in fundamentals.

3. Board of Governors of the Federal Reserve System, "Funding, Credit, Liquidity, and Loan Facilities," <https://www.federalreserve.gov/funding-credit-liquidity-and-loan-facilities.htm>.

Figure 2. Ratio of Investment-Grade to High-Yield Corporate Bond Spreads

Sources: ICE BofA High Yield Index Option Adjusted Spread, from FRED; US Corporate Index Option-Adjusted Spread.

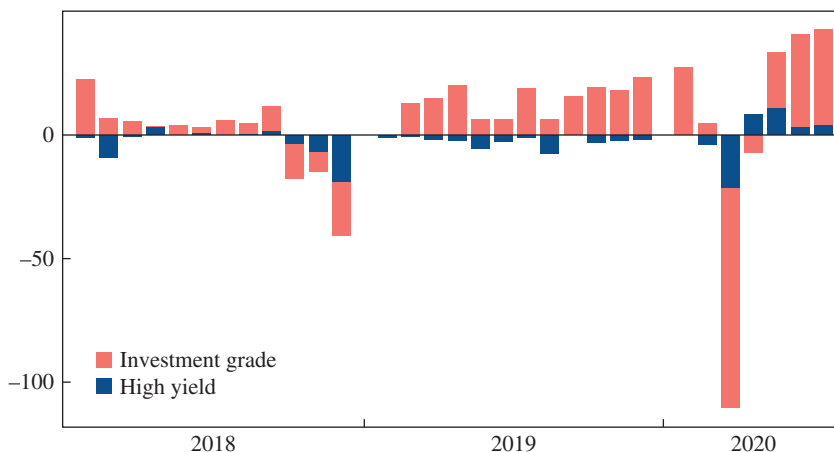
Notes: Relevant dates are when the Federal Reserve announced Treasury and mortgage-backed securities purchases (March 13); announced Primary Dealer Credit Facility (March 17); announced PMCCF, SMCCF, and additional Treasury and mortgage-backed securities purchases (March 23); expanded PMCCF and SMCCF (April 9); and made first purchases of bond ETFs (May 12).

The paper offers some evidence that investors believe the Federal Reserve is focused on price. They show that spreads are compressed relative to the past twenty-five years and that they also are well below recession levels. I think these observations are telling. But I want to offer some evidence that the Fed is operating more as a traditional lender of last resort. This is important because if investors believe the Fed is pegging the price, but in fact it is offsetting market dysfunction, there could be large costs to investors and potentially the economy if the Fed doesn't provide the high level of support that the market has come to expect, even if the economic recovery is on track.

I offer three points to argue that the Federal Reserve is operating as a traditional lender of last resort in these corporate credit programs. First, the most immediate effect of the announcement of the corporate credit facilities was a sharp decline in corporate bond spreads, with a disproportionate decline in investment-grade bonds. Figure 2 shows the ratio of investment-grade corporate bond spreads to high-yield corporate bond spreads (Liang 2020). It rose sharply in March until the Fed announced the PMCCF/SMCCF on March 23, after which it began a substantial downward

Figure 3. Net New Cash Flow to Corporate Bond Mutual Funds

Billions of dollars



Source: Investment Company Institute, "Trends in Mutual Fund Investing."

trend. In a typical recession when concern about default risk intensifies, high-yield bond spreads usually rise more than investment-grade spreads. The pattern observed suggests this crisis was unusual and that there were significant technical factors leading to greater-than-normal increases for investment-grade bonds.

Second, the price impact of trades and the bid-ask spreads for investment-grade corporate bonds rose more sharply than for high-yield bonds (O'Hara and Zhou 2020; Boyarchenko, Kovner, and Shachar 2020; Gilchrist and others 2020). As another illustration, while the credit default swap (CDS) premiums for investment-grade bonds rose between February and mid-March, the bond spreads for the same set of bonds rose considerably more, consistent with signs of illiquidity in investment-grade bond markets. In contrast, there was not a similar widening of the gap between bond spreads and CDS premiums or high-yield bonds (Haddad, Moreira, and Muir 2020). In addition, a significant gap opened between the exchange traded funds (ETF) price and the net asset value of the same pool of investment-grade bonds, but not for a pool of high-yield bonds.

A third distinction is evident in investor redemptions from bond mutual funds (figure 3). Investor redemptions from investment-grade bond mutual funds reached record levels in March, leading to large sales for corporate

bond and Treasury securities, which put significant selling pressures on both markets (Liang 2020; Ma, Xiao, and Zeng 2020). While there also were significant outflows from high-yield bond funds as well, they were not unusually large.

Collectively, there is strong evidence of significant technical problems in the investment-grade corporate bond market which supports the need for the SMCCF. I think, however, that markets may be misperceiving the reaction function as the paper says.

The implication of this misperception is that corporate bond prices may be too high, and if fundamentals were to deteriorate, they would fall by more than justified by that deterioration. The reason is that investors would, at the same time, have to adjust perception of this reaction function to one that the Federal Reserve was not pegging bond prices. The possibility of this misperception suggests that there could be benefits for the Fed to clarify its objective function with respect to this program and how it would expect to react if the fundamentals deteriorate meaningfully.

To summarize, I think the authors' proposals to soften the terms of Main Street loans and accept some more risk could be helpful. I also think that because the Federal Reserve requires banks to participate in the program and banks already have considerable exposure to risks arising from COVID-19, the program should offer higher fees to banks to encourage more participation. That said, I think there is little interest from small to midsize firms to take on considerable debt in light of the uncertainty about the virus and the economic recovery. Instead, the program needs a much more fundamental change where it doesn't require the Federal Reserve to provide loans as a lender of last resort.

On the corporate credit programs, the authors highlight a potential cost associated with investor misperceptions about the intent of the programs and how the Federal Reserve will react to future news. I think the Fed should reduce this misperception to help ensure that these programs continue to be successful.

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GENERAL DISCUSSION Janice Eberly summarized two types of questions from the teleconferencing chat function. The first type had to do with whether the long-run costs of the program, such as debt overhang, should be taken into consideration when thinking about the design of the Main Street Lending Program. The second type wondered whether the Main Street Lending Program encouraged taking on credit risk and whether loans—instead of grants—were the right policy instrument.

Gabriel Chodorow-Reich asked about the role of regulatory forbearance. He noted that many midsize and large firms have credit lines—which have not been exhausted—with maturities into 2022 or beyond. He said that although these credit lines seem like a useful way to complement new liquidity programs, sales are down at many of these firms. He wondered how banks would react to declining sales and whether there was room for regulators to encourage the treatment of existing pre-committed liquidity as a complement to new programs.

Steven Davis stated that the political argument for supporting firms during the pandemic typically maintains that the most adversely hit sectors and firms should receive the most support. He observed that this argument contrasted with some of the paper’s policy recommendations, which call for the government to pull back financing support. Davis asked whether

and how such political economy matters should be considered when designing policy.

Wendy Edelberg commented that the Coronavirus Aid, Relief, and Economic Security (CARES) Act allocated a substantial amount of money to fund the Main Street Lending Program. But, she remarked, the Federal Reserve is not allowed to lose money for taxpayers in expectation. As a result, the Federal Reserve used the money to leverage up the Main Street Lending Program, which avoids losing money for the taxpayer in expectation. She inquired why the Federal Reserve didn't instead use the money to absorb any losses in expectation.

Şebnem Kalemli-Özcan noted that there are differences between large firms and small and midsize enterprises (SMEs), especially smaller SMEs that are not in the corporate bond market. She contemplated whether subsidizing these firms through grants, instead of loans, was a better way to support them and whether these grants could be administered through the tax system.

Michael Kiley wondered about three microeconomic aspects of emergency credit support. He mentioned first that the primary market for corporate credit facilities and the Main Street Lending Program have restrictions—which make a great deal of sense to the taxpayer—on capital distributions, compensations, and other activities of borrowers. However, he wondered what features might be incorporated to alleviate the risk that the incentives of firm insiders may lower the efficacy of the program. Second, he commented, any government credit program involves a long-run relationship between the nonfinancial borrowers and the government as a lender. The Main Street Lending Program, he continued, has overcome this challenge by relying on private lenders; however, these private lenders may view a partnership with the government as substantially risky, at least from a political or supervisory sense. Last, he remarked that the paper focused on the need to be willing to originate riskier loans. This emphasis indicates an examination of the back end—such as what happens when the borrower is under distress. Together, he concluded, these three issues point to a greater role for grants relative to loans.

Donald Kohn commented that although he agreed with Nellie Liang that the Federal Reserve could better explain its objectives, it is also important for the Treasury to clarify its appetite for risk. In addition, Kohn questioned whether the compression of spreads is really a consequence of misperception rather than a consequence of optimism around the timing of the vaccine. Finally, he discussed how permanent shifts in the economy will render some firms unviable and how these changes will make it difficult to figure out which firms to lend to.

Jeremy Stein mentioned the ambiguity surrounding both where the constraints lie and what the Federal Reserve's authority is. He stated that at a minimum the Federal Reserve has to be secured to its satisfaction, so that it is protected against losing money. This objective can be reached, Stein continued, by having a big enough equity contribution to the special purpose vehicle from the Treasury.

Stein reflected on whether the securities held by the special purpose vehicle had to be classified as debt, pointing out that the paper argues for a softer design, similar to preferred equity. Although this might not work in practice, Stein said, as it is not clear whether the special purpose vehicle is legally allowed to own preferred equity. Preferred equity, however, can be approximated through junior debt with deferrable interest payments. Unfortunately, Stein expressed, at the Treasury's insistence, many of the design features, such as seniority and collateral, go in the opposite, harder direction—which could make the workouts tougher as the banks will be well secured and more inclined to pull the plug.

Stein argued that the banks have been a bottleneck in the program. Thus, he argued, the program would likely be better off without the banks as underwriters. Even if underwriting by the banks was required, Stein contended that putting the banks on equal footing with the Federal Reserve is inimical to the idea of the program. Indeed, he affirmed, the whole point of the Main Street Lending Program was to make loans that the private sector wouldn't. One example to help with alignment would be to lop off 1 percent of whatever amount of interest is coming in and give this 1 percent to the banks only if the firm survives for five years or so. This incentive would motivate the banks to underwrite but also give them better economics than the Federal Reserve. The most important facet, Stein concluded, was for the program to do more than just make loans that are also available on the private market.

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Epidemiological and Economic Effects of Lockdown

ABSTRACT We examine the period of national lockdown beginning in March 2020 using an integrated epidemiological-econometric framework in which health and economic outcomes are jointly determined. We augment a state-level compartmental model with behavioral responses to non-pharmaceutical interventions (NPIs) and to local epidemiological conditions. To calibrate the model, we construct daily, county-level measures of contact rates and employment and estimate key parameters with an event study design. We have three main findings: First, NPIs introduced by state and local governments explain a small fraction of the nationwide decline in contact rates but nevertheless reduced COVID-19 deaths by about 25 percent—saving about 39,000 lives—over the first three months of the pandemic. However, NPIs also explain nearly 15 percent of the decline in employment—around 3 million jobs—over the same period. Second, NPIs that target individual behavior (such as stay-at-home orders) were more effective at reducing transmission at lower economic cost than those that target businesses (shutdowns). Third, an aggressive and well-designed response in the early stages of the pandemic could have improved both epidemiological and economic outcomes over the medium term.

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The COVID-19 pandemic led to an unprecedented collapse in social and economic activity in the United States. Widespread social distancing—undertaken voluntarily and in response to government interventions—succeeded in containing the initial outbreak, but at a significant cost. Over the course of the middle two weeks of March 2020, employment fell by 30 million, triggering the deepest recession of the postwar period.

This paper attempts a comprehensive assessment of the early response to COVID-19. We address three key questions: How big a role did government mandates play relative to voluntary action in the shift to social distancing and the collapse in employment? How effective were the major non-pharmaceutical interventions (NPIs) deployed in response to the pandemic—stay-at-home orders, school closures, and nonessential business closures—at reducing disease transmission while minimizing economic costs? How could the policy response to COVID-19 have been improved and, more broadly, how should NPIs be used in response to a pandemic?

To answer these questions, we extend a state-level compartmental model of the COVID-19 pandemic with behavioral responses to NPIs and to local epidemiological conditions. To calibrate the model, we develop novel measures of daily social contact rates and employment at the county level and estimate key parameters directly with a difference-in-differences approach. We then use our empirical estimates and simulations of the model to assess the determinants of epidemiological and economic outcomes from the beginning of March through the end of May.

We find that NPIs account for only 9 percent of the sharp fall in contact rates over this period. This relatively modest effect, however, led to a 25 percent reduction in deaths from COVID-19 by May 31. At the same time, we estimate that NPIs reduced employment by about 3 million, nearly 15 percent of the total decline. We also find significant differences in the effectiveness of different NPIs, with interventions that target businesses delivering less epidemiological benefit at greater economic cost than those that target individual behavior. Based on simulations from our model, we argue that enacting NPIs earlier and prioritizing the least costly NPIs could have saved more lives than the actual policy response with substantially lower economic costs.

This paper joins a growing literature on the epidemiology of COVID-19 and the effects of NPIs.¹ We make three main contributions. First, we relax

1. See, for example, Goolsbee and Syverson (2020), Baqaee and others (2020), Gupta, Simon, and Wing (2020), and the literature cited therein.

the conventional assumption in epidemiological models that contact rates are independent of dynamics of the epidemic and allow agents to respond endogenously to local infection risk by changing their social behavior. Second, we extend the model with an explicit role for NPIs, so that our empirical specification arises directly from the model. Third, we combine data from many different sources to construct comprehensive daily measures of contact rates and employment. With these measures, we are able to frame our analysis directly in terms of the key outcomes (for example, total employment) rather than rely on the idiosyncratic proxies commonly used for high-frequency analysis of COVID-19.

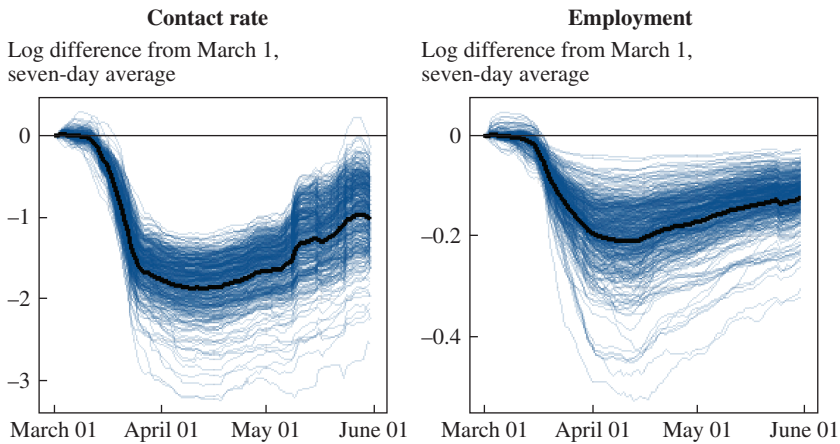
1. Background

In response to exponential growth in the number of COVID-19 cases, social and economic activity in the United States collapsed in the second and third weeks of March. The average social contact rate—defined as the probability of being in close physical proximity to someone who is not a member of the same household—declined more than 80 percent by the end of the month, while total US employment fell by 30 million. Figure 1 plots the evolution of contact rates and employment at the county level over the course of March and April, expressed as log changes relative to the beginning of March.² Both the contact rate and employment fell in almost every US county, though the magnitude of the declines varied widely.

State and local governments responded to the pandemic with an array of non-pharmaceutical interventions—policies that aim to prevent disease transmission through social distancing and other behavioral changes. By reducing the frequency of physical proximity between potentially infected and susceptible persons, social distancing limits opportunities for the virus to spread. While most individual government actions were idiosyncratic and limited (for example, closing casinos or limiting certain close-contact personal services), three broadly restrictive NPIs were eventually enacted across most of the country: school closures, stay-at-home (or shelter-in-place) orders, and nonessential business closures.³

2. We discuss the construction of these measures in section V.

3. School closures are orders to cease in-person teaching at public schools (at least) in a county. Stay-at-home orders are mandates that individuals remain at home for all “nonessential” activities. Both stay-at-home orders and nonessential business closures were typically—though not always—issued with a listing of the activities or businesses considered essential.

Figure 1. The Response to COVID-19 by County

Source: Authors' calculations.

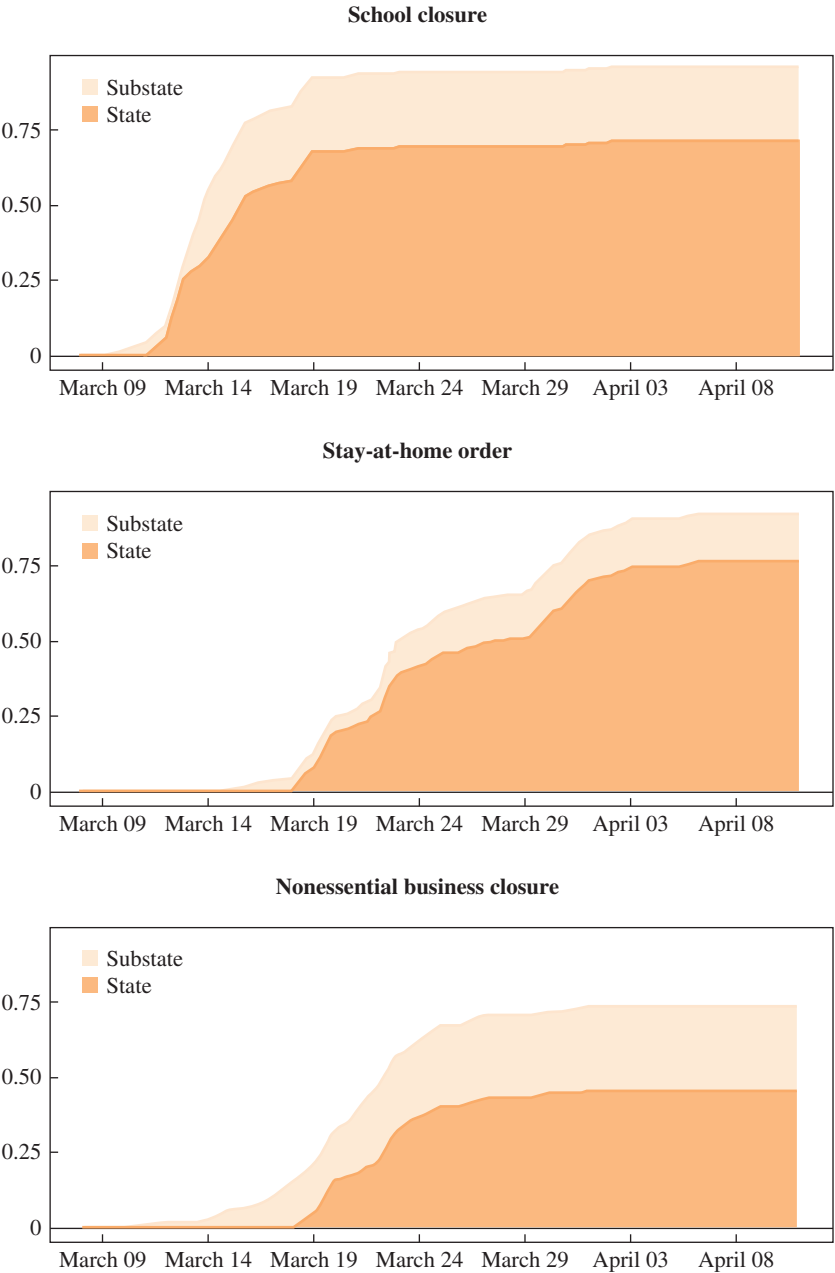
Notes: Each thin line represents one US county. The solid black line is the weighted US average. The contact rate is the probability of being in close physical proximity to someone who is not a member of the same household; the US average is weighted by county population. Employment is the number of people working in a county on a given day; the US average is weighted by the average of county employment in December 2019, January 2020, and February 2020.

Figure 2 plots the share of the US population residing in a county covered by each of these three NPIs over time. School closures expanded rapidly beginning in the second week of March to cover more than 90 percent of the population by March 20. The number of nonessential business closures and stay-at-home orders grew rapidly from the third week of March, extending over more than 70 percent of the population by the end of the month. Notably, though NPIs issued by state governments would eventually cover a greater share of the population, the earliest NPIs were generally issued by county or municipal governments.

II. Model

This section presents the augmented epidemiological framework that forms the basis of our empirical analysis. Because of the nonlinear and spatial dynamics of infectious spread, direct estimation of the epidemiological effects of NPIs using conventional methods is impractical. Instead, we extend a compartmental model of infectious disease with behavioral responses to health outcomes and an explicit role for NPIs. We model each state-level epidemic independently, allowing for heterogeneity in epidemiological and behavioral parameters.

Figure 2. Share of the US Population Covered by NPIs, by Level of Government



Sources: Data from COVID19StatePolicy and Keystone Strategy; authors' calculations.
Note: Substate governments include school districts, municipal governments, and county governments.

II.A. Epidemiological Framework

We begin with the canonical susceptible-exposed-infected-removed (SEIR) model. A fraction of the population is susceptible (S), and this group interacts with those who are infectious (I).⁴ Those who are infected with the virus but not yet infectious—that is, able to transmit the virus—are said to be exposed (E). A fraction of cases become terminal (T), at which point effective infectiousness ceases (because they are isolated and can no longer infect members of S). After some period, all terminal cases die and transition to group D . Nonterminal cases eventually recover and transition to group R and are assumed to be immune to the virus.

The following system of ordinary differential equations governs population (the total of which is represented by N) movement between compartments S , E , I , R , T , and D for US state i at time t :

$$\begin{aligned}\frac{dS_{it}}{dt} &= -\beta_{it} I_{it} \frac{S_{it}}{N_i}, \\ \frac{dE_{it}}{dt} &= \beta_{it} I_{it} \frac{S_{it}}{N_i} - \sigma E_{it}, \\ \frac{dI_{it}}{dt} &= \sigma E_{it} - \gamma I_{it}, \\ \frac{dR_{it}}{dt} &= \gamma I_{it} (1 - \mu_{i(t-1/\gamma)}), \\ \frac{dT_{it}}{dt} &= \gamma I_{it} \mu_{i(t-1/\gamma)}, \\ \frac{dD_{it}}{dt} &= \mu_{i(t+\tau_F+1/\gamma)} \left(\frac{I_{it}}{\tau_F - 1/\gamma} \right).\end{aligned}$$

The transmission rate (secondary infections caused per primary infection per day) is β_{it} . The inverse of COVID-19's latent period is σ ; that is, the duration between infection and onset of infectiousness. Note that the latent period is distinct from the incubation period—the duration between infection and onset of symptoms—which conventionally appears in the SEIR

4. Our framework assumes homogeneous population mixing wherein every individual is equally likely to come into contact with every other individual. See the online appendix for the results of a stylized experiment where we relax this assumption using a two-group SEIR model with heterogeneous contact rates and NPI effects.

framework in its place. The incubation period is appropriate when only symptomatic cases are infectious and is preferred because it is, in principle, observable. Given the significant role of presymptomatic infectiousness in COVID-19 transmission, however, the latent period is the relevant concept for epidemic dynamics. In our model, the timing of symptom onset plays no role in disease transmission, all else being equal, and only affects the eventual outcome of an infection.

The recovery rate, the inverse of the average infectious period, is represented by γ . A share of symptomatic infections are fatal. The infected population transitions into the terminal (T) group according to the infection fatality ratio μ_{it} . After a period, these terminal infections end in death. The number of days between symptom onset and death in fatal cases is represented by τ_F . Note that the T and D compartments are used only to calculate the death toll with the appropriate lag between infection and death; these populations do not feed back into other parts of the system.

II.B. Behavioral Responses

We extend the traditional compartmental model by relaxing the assumption that the transmission rate is independent of the dynamics of an epidemic. Motivated by the strong empirical evidence of a fear-driven behavioral response to local outbreaks—which we confirm in section VII—we allow agents in the model to adjust their exposure risk based on the progression of their local epidemic.⁵ This extension of the model is important for generating plausible policy counterfactuals, as we attempt to do in section VIII. Successful interventions to lower disease transmission improve epidemiological outcomes but consequently reduce the fear of infection, inducing an offsetting behavioral response. Ignoring this offset leads to overstatement of the effects of interventions.

The transmission rate β_{it} is the product of the contact rate κ_{it} and the infection rate ζ_{it} :

$$(1) \quad \beta_{it} = \kappa_{it} \zeta_{it}.$$

We define κ_{it} as the daily probability that two persons residing in state i at time t will be in sufficiently close physical proximity to each other for a sufficient period of time to enable disease transmission—an event we refer to as a contact. We define ζ_{it} as the probability that disease transmission

5. See Goolsbee and Syverson (2020).

actually occurs in one contact between a susceptible person and an infectious person. The effective reproduction number $\mathcal{R}_{it}$ —the number of secondary infections per infection—is given by:

$$(2) \quad \mathcal{R}_{it} = \frac{\beta_{it}}{\gamma_{it}},$$

where γ_{it} is the duration of infectiousness.

We model the contact rate as a function of an endogenous response to local infection risk and two exogenous behavioral factors: precautionary social distancing and the response to NPIs. The precautionary component captures changes in the contact rate driven by general fear and uncertainty about the pandemic, as opposed to specific concerns about local infection risk. The NPI component captures the impact of state and local social distancing mandates and other interventions.

We assume the contact rate takes the following functional form:

$$(3) \quad \kappa_{it} = \exp(\Omega_{it} \cdot \Phi_{it} \cdot (C_{it})^\rho),$$

where Ω_{it} is the precautionary component of behavior, Φ_{it} is the response to NPIs, and C_{it} is the total number of confirmed COVID-19 cases. The parameter ρ determines the responsiveness of the contact rate to perceptions of infection risk. We assume agents assess infection risk on the basis of confirmed cases rather than the true number of infections, which is unknown to agents in the model.⁶ The relationship between the underlying epidemiological dynamics and the observed dynamics of confirmed cases C_{it} is given by

$$C_{it} = \sum_{t=0}^T \lambda_{it} \sigma E_{it(t-\tau_S-\tau_P)},$$

where λ_{it} measures the share of new infections that are eventually confirmed through a diagnostic test, τ_S is the duration from the onset of infectiousness

6. We considered several alternatives for which observed outcome drives perceptions of local infection risk: new cases (instead of or in addition to total cases), including total or new deaths, and normalizing by population. We view this as an empirical question. In our empirical estimates (see section VI.B) we found that all choices imply roughly the same aggregate response. We therefore select the most straightforward option: total confirmed cases.

to the onset of symptoms, and τ_p is the duration from symptom onset to a positive test result.⁷

The precautionary response Ω_{it} varies over time and across states as a function of the characteristics of the local population. For example, older populations may respond more strongly to news of a novel infectious respiratory disease. The response to NPIs Φ_{it} depends on the set of interventions that have been implemented in a state and on parameters governing the impact of different NPIs on the contact rate. We define $\Omega_{it} = \omega_i X_i$ and $\Phi_{it} = \phi P_{it}$, where X_i is a set of fixed attributes characterizing the local population and P_{it} is a set of indicators characterizing the set of NPIs in effect in i . Taking logs of equation (1) and substituting for Ω_{it} and Φ_{it} yields

$$(4) \quad \ln \kappa_{it} = \omega_i X_i + \phi P_{it} + \rho c_{it}.$$

Relating behavior back to disease transmission, substituting equations (1) and (3) into equation (2), and taking logs yields the following expanded definition of the reproduction number:

$$(5) \quad \ln \mathcal{R}_{it} = \omega_i X_i + \phi P_{it} + \rho c_{it} + \ln \zeta_{it} - \ln \gamma_{it}.$$

Throughout our analysis, we take the infection rate ζ_{it} as exogenous and given. In practice, ζ_{it} is likely affected by the same kinds of precautionary and endogenous responses as κ_{it} . While the NPIs we consider below explicitly target the contact rate, other significant interventions (such as mask mandates) target the infection rate. Ideally, we would specify an expression analogous to equation (4) for ζ_{it} and estimate its parameters explicitly. This is not possible, however, due to the limitations of available epidemiological data from the initial stages of the pandemic.

Data limitations also pose serious challenges for direct estimation of equation (5), as daily $\mathcal{R}_{it}$ is not observed and must be estimated historically. We therefore focus our empirical analysis on equation (4). We discuss these issues in more detail in section VI.

II.C. Employment

The necessity of physical proximity for a wide range of economic activities means that voluntary or governmental efforts to limit contacts lead to unavoidable economic disruption. Indeed, many studies of the effects

7. Note that $\alpha^{-1} + \tau_s$ is equal to the incubation period—the time between infection and the onset of symptoms.

of COVID-19 use measures of economic behavior, such as visits to retail establishments, as proxies for the contact rate. More broadly, there is some trade-off between epidemiological gains and economic costs. The response to COVID-19 provides ample evidence that policymakers view this trade-off as a meaningful constraint on their ability to deploy NPIs to combat a pandemic.

No analysis of this trade-off can answer the question of whether the economic costs of a particular intervention are “worth it” given some epidemiological benefits, which is not an analytical question. However, understanding the relative trade-offs offered by different types of interventions allows policymakers to design a pandemic response that maximizes the ratio of gains to costs. In order to assess these trade-offs, we incorporate local employment outcomes into our behavioral SEIR framework. Reasoning that the same factors that drive κ —precautionary behavior, NPIs, and local infection risk—are also the key determinants of economic behavior, we posit an analogous relationship to equation (2) for employment, which we denote by W_{it} and define as the number of people working in state i at time t :

$$(6) \quad \ln W_{it} = \omega_t^w X_i + \phi^w P_{it} + \rho^w c_{it}.$$

The addition of equation (3) allows us to assess the epidemiological and the economic effects of interventions in a single, integrated framework. In addition, equation (3) takes into account the relationship between local infection risk fears and economic outcomes, which—like the relationship with contact measures—emerges clearly in empirical studies. This allows for the possibility that effective suppression of an epidemic with economically costly NPIs may yield economic benefits over the long run.

III. Data

This section provides an overview of the data underlying our analysis. We rely mainly on three types of data: daily counts of COVID-19 cases, tests, and deaths; daily measures of social behavior and employment; and information on NPIs implemented by state and local governments.

III.A. Epidemiological Data

Confirmed COVID-19 cases and deaths form the starting point of our epidemiological estimates. A number of organizations track the spread and death toll of COVID-19 in the United States over time. Rather than rely on

a single source for our analysis, we draw on four separate sources: Johns Hopkins Center for Systems Science and Engineering, the *New York Times*, the COVID Tracking Project, and USAFacts. These sources employ different data collection methods and assumptions and often differ in terms of the number and timing of new cases or deaths. We obtain counts of the number of COVID-19 tests from the COVID Tracking Project.

We correct for data reporting anomalies resulting from changes in states' standards for reporting of deaths, causing large single-day spikes.⁸ On those days, the value for deaths is linearly interpolated across previous and future observations, and the number of deaths in excess of this value reported on that day are distributed to all previous days in proportion to measured deaths. To avoid potential bias from idiosyncrasies in any one source's estimates, we isolate the common trend in confirmed cases and deaths by taking the first principal component of all four sources' estimates.

III.B. Contact and Employment Data

Our model requires state-level, daily data on contact rates and employment. To estimate parameters reliably, we require greater geographic detail than the state level. However, there are no standard, high-frequency measures of population contact rates, let alone official statistics. Official measures of employment, meanwhile, are available only at monthly frequency and geographic detail only with a long lag. We therefore rely on a range of non-traditional data sources. We collect a dozen daily, county-level measures derived from mobile device location data, business and financial services software, payroll service providers, and web search activity. As we describe in section V, we combined these various indicators to construct composite indexes of the contact rate and employment. Here we provide an overview of our sources and the measures underlying those indexes.

PLACEIQ We use a county-level measure of mobile device “exposure” developed by Couture and others (2020), based on mobile device location data from PlaceIQ. The device exposure index (DEX) reflects the average number of devices that visited locations also visited by residents of a county. It is an indirect measure of the extent to which individuals are congregating in common locations.

8. For New Jersey, an anomaly appears on June 25 in the *New York Times* and COVID Tracking Project data and on June 27 for USAFacts. For New York, an anomaly appears on June 30 in the *New York Times* and USAFacts data. For Texas, all sources report an anomaly on July 27.

SAFEGRAPH We construct county-level measures of time spent at home, time spent at a fixed location outside the home during regular workday hours (a proxy for work), and distance traveled using mobile device location data from SafeGraph.⁹ SafeGraph assigns each device a “home” based on “common nighttime location.” Data are available at the census block group-level. We aggregate to county-level weighting by number of devices.

GOOGLE MOBILITY We use county-level measures of time spent at residential locations and time spent at workplace locations from the Google Community Mobility Reports.¹⁰

UNACAST We use county-level measures of “encounter density” and distance traveled derived from mobile device location data from Unacast.¹¹ Encounter density is a measure of physical proximity between persons defined as average number of times an individual is within 50 meters of another person, normalized by a county’s physical size and relative to the pre-COVID-19 national average.

HOMEBASE We construct a county-level measure of small business employment using data from Homebase, an employee scheduling and time-tracking software company. Homebase provides anonymized daily data at individual worker level. We limit our sample to workers at firms with at least 200 hours worked between January 12 and February 22.¹² We define employment as the number of workers with positive hours and aggregate to the county level based on firm zip code.

OPPORTUNITY INSIGHTS We use a county-level measure of employment workers from the Opportunity Insights Economic Tracker developed by Chetty and others (2020).¹³ This measure is based on data from payroll service providers Paychex and Intuit; Earnin, a personal financial management company with access to clients’ payroll information; and Kronos, which provides employee time management services to business. We obtain this measure as a seven-day average and estimate daily values based on the pseudoinverse of the moving average matrix.

9. SafeGraph, Social Distancing Metrics, <https://docs.safegraph.com/docs/social-distancing-metrics>.

10. Google, COVID-19 Community Mobility Reports, <https://www.google.com/covid19/mobility>.

11. Unacast, COVID-19 Toolkit, Social Distancing Scoreboard, <https://www.unacast.com/covid19/social-distancing-scoreboard>.

12. We define a “firm” as the aggregate of all of a single company’s establishments in the same industry and county.

13. Opportunity Insights Economic Tracker, <https://www.tracktherecovery.org>.

GOOGLE TRENDS We construct daily proxies for job loss and hiring based on web search intensity from Google Trends. For job loss, we obtain data on searches that contain any of the terms “file for unemployment,” “unemployment benefits,” or “unemployment insurance.” For hiring we obtain data on searches that contain any of the terms “W-4,” “W-9,” or “I-9” (with or without hyphens). Google Trends provides indexes of search intensity by Nielsen designated market area (DMA), which are considerably broader than counties. We use the same index for all counties within a DMA.

III.C. Non-pharmaceutical Interventions

We use information on NPIs issued by state governments from COVID19StatePolicy and NPIs issued by county, municipal, or other sub-state government entities from Keystone Strategy.¹⁴ We extend the state data to the county level for state government NPIs that applied only to specified counties. We exclude advisory policies and recommendations, as well as mandates that apply to specific subpopulations (typically “vulnerable” persons or those above a certain age).

State and local governments enacted a wide range of NPIs in response to COVID-19. We focus on three major interventions: school closures, stay-at-home (or shelter-in-place) orders, and closures of all nonessential businesses. While most individual government actions were idiosyncratic and limited (for example, closing casinos or limiting indoor restaurant service), these three NPIs were widely adopted (see figure 2) and imposed meaningful constraints on a broad range of social and economic activities. Although there is some variation in the procedures for closing schools, the types of activities permitted under stay-at-home orders, and the classification of businesses as essential or nonessential, the key features of each NPI are consistent across jurisdictions and across data sources.

IV. Case Confirmation Rate and Infections

The number of confirmed COVID-19 cases understates the true number of infections. Asymptomatic cases are unlikely to be detected in the absence of widespread preventative testing, and individuals experiencing mild COVID-19 symptoms may choose not to seek a test, especially when testing capacity is limited and restricted to severe cases (as in the early

14. COVID19StatePolicy, State-Level Social Distancing Policies in Response to the 2019 Novel Coronavirus in the US, <https://github.com/COVID19StatePolicy/SocialDistancing>; Keystone Strategy, City and County Non-pharmaceutical Intervention Rollout Dates, <https://www.keystonestrategy.com/coronavirus-covid19-intervention-dataset-model>.

days of the outbreak in the United States). If underreporting of infections is constant over time, it does not affect our modeling outside of herd immunity dynamics, which are not important in the early months of an epidemic (the focus of this paper). But variation over time in the extent of underreporting leads to spurious changes in transmission rates inferred from case counts even if growth in actual infections is unchanged. Such variation is almost certainly present in the period we examine, which saw a rapid increase in the number of people being tested for COVID-19. Estimates of the spread of SARS-CoV-2 over this period based on case counts alone are therefore likely to be biased upward.

Confirmed COVID-19 deaths are less likely than cases to suffer from time-varying mismeasurement. For that reason, some COVID-19 modelers eschew confirmed cases altogether and rely entirely on counts of confirmed deaths (Gu 2020). Our approach lies somewhere in the middle and draws from both case and death data.

First, for each state i at time t , we estimate the case confirmation rate λ_{it} :

$$\lambda_{it} = \frac{C_{it} - C_{i(t-1)}}{(D_{i(t+\tau_F-\tau_P)} - D_{i(t-1+\tau_F-\tau_P)})\mu_t^{-1}},$$

where C_{it} is cumulative confirmed cases, D_{it} is cumulative confirmed deaths, τ_F is the average number of days from symptom onset to death in fatal cases, τ_P is the average number of days from symptom onset to a positive test result, and μ_t is the current infection fatality ratio. Following clinical evidence, we assign a value of 19 days to τ_F and a value of 7 days for τ_P . We assume the infection fatality ratio begins at 0.8 percent and falls linearly to 0.025 percent from mid-April to mid-August. See section VI.A for further details on parameter selection.

Using state-level data on cases, deaths, and tests, we model the case confirmation rate as a function of national-level variation over time (reflecting nationwide trends in testing infrastructure and capacity) and the test positivity rate (the share of tests with a positive result). When testing capacity is limited relative to the size of the current outbreak, tests are reserved for the most severe cases, leading to high positivity rates. As relative capacity expands, we expect the positivity rate to fall as the eligibility criteria for testing broaden.

We estimate the following regression:

$$\ln \lambda_{it} = w_t + \theta \frac{C_{it}}{T_{it}} + \varepsilon_{it},$$

where the w_i are calendar week fixed effects, T_{it} is the number of tests performed, and $\frac{C_{it}}{T_{it}}$ is the test positivity rate. We smooth both λ_{it} and $\frac{C_{it}}{T_{it}}$ with a centered two-week moving average.¹⁵ We estimate a value (standard error) of -0.57 (0.06) for θ , which represents the semi-elasticity of confirmation rate with respect to the positivity rate. To estimate the true number of new infections, we fit values of λ_{it} for each state over time and scale the number of confirmed new cases by its inverse. We then shift values backward in time by τ_p (set to one week) to reflect the date of symptom onset rather than the date of case confirmation.

In the initial days of the epidemic, the true number of new infections was nearly twenty times the number of new confirmed cases. This figure fell rapidly as testing infrastructure expanded: by early June, the ratio was around five, with the median state confirming 22 percent of new infections.¹⁶ To illustrate the common trend in reporting rates and deviations from that trend arising from local conditions, figure 3 plots our estimates of case confirmation rate for New York (a state with a severe early outbreak) and Florida (a state with a severe outbreak later).

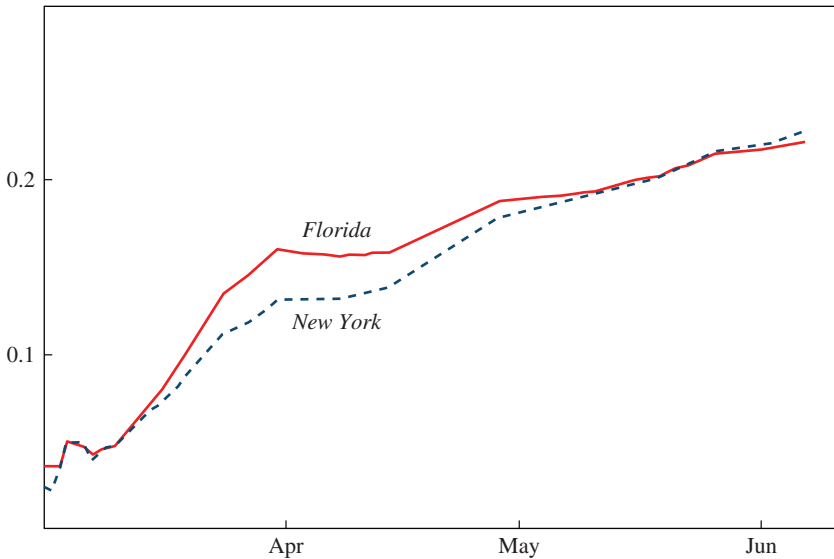
V. Contact Rate and Employment Indexes

To specify the parameters and historical inputs of the model in section II, we require geographically detailed, daily data on the contact rate κ_{it} and employment W_{it} . To our knowledge, no such data exist. Instead, we have an array of unconventional indicators described in section III.B. Rather than consider each of these individually, we divide them into two sets, one containing measures related to the contact rate and the other containing measures related to employment. We then take the first principal component of each set of related indicators and interpret the resulting indexes as direct proxies for the daily contact rate and daily employment.

Underlying measures related to the contact rate include frequency of close physical proximity to other mobile devices, time spent at home, and distance traveled. Underlying measures related to employment include time spent at workplaces, web searches related to job loss and hiring, and

15. In reality, time from symptom onset to death follows a wide distribution of outcomes rather than a deterministic average; using a moving average allows us to pool deaths and positive tests across a broader span and thus capture some of that variation.

16. Our estimates show a similar though more pronounced trend compared with those of Gu (2020), who estimates a national “prevalence ratio” that fell from about eighteen on March 1 to about seven on August 1.

Figure 3. Estimated Daily Case Confirmation Rate in Florida and New York

Source: Authors' calculations.

Note: The figure compares the estimated daily case confirmation rate in states with different epidemic curves.

direct measures of the number of persons working. For measures derived from mobile device data, we generally have multiple versions based on different samples of mobile devices.

Principal components is a convenient means of summarizing information from multiple indicators and extracting common variation.¹⁷ Each of our measures captures only one dimension of the outcomes we are actually interested in and on its own may contain a misleading signal. Moreover, daily measures at the county level are inevitably noisy. Taking the first principal component of several measures filters out both misleading idiosyncratic patterns and noise using information from all of the inputs. It also allows for geographic variation in the relevance of particular indicators, which might depend on place characteristics.¹⁸ We construct indexes independently for each county, so the weight assigned to any one underlying

17. See Lewis, Mertens, and Stock (2020) for a recent application to weekly economic activity.

18. For example, distance traveled is more closely related to time spent at home in less dense counties.

measure is determined by its relationship to the other measures in that county alone.

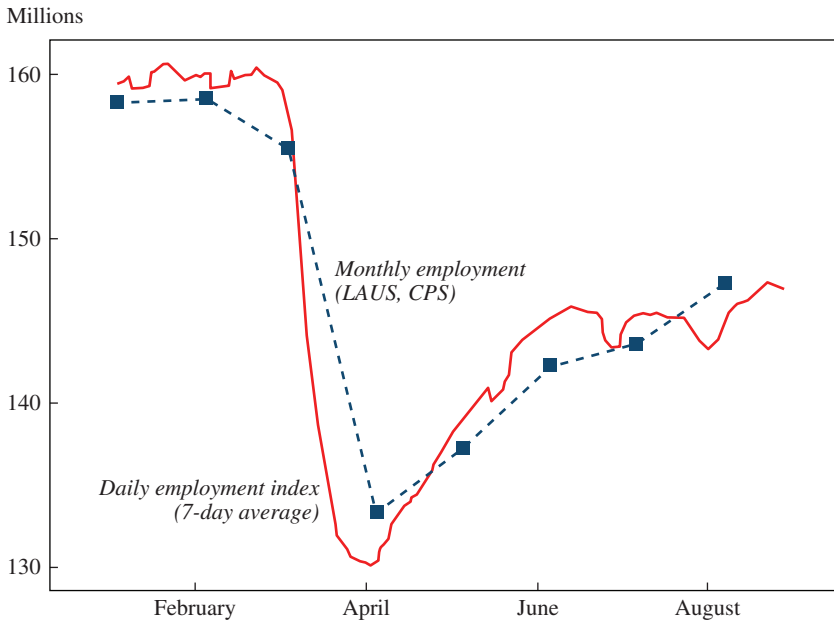
Before constructing the indexes, we normalize all measures relative to their average for the same day of the week in early 2020—generally the six-week period from January 12 to February 22.¹⁹ For series with sufficient historical data to identify seasonal patterns, we normalized relative to the same week one year earlier. Not all measures are available for counties with small populations. We aggregate counties with incomplete data into a single residual county unit by state, using whatever data are available and weighting by population.²⁰

To construct the contact rate index, we take the first principal component of two measures of physical proximity, two measures of time spent at home, and two measures of distance traveled. Given these inputs, we interpret the index as reflecting contacts between persons who do not live together. To construct the employment index, we use two direct measures of the number of persons working, two measures of time spent at workplaces, and measures of unemployment- or hiring-related web searches. We then scale the indexes into interpretable units by adjusting the (county-level) mean and standard deviation to match those of a series expressed in the desired unit. For the contact rate, no such series exists, so we use the measure of encounter density from Unacast, which is the closest of our available indicators to a direct measure of contacts. For employment, we scale indexes to monthly employment by county in 2020 from the Bureau of Labor Statistics Local Area Unemployment Statistics (LAUS). We had sufficient data to construct both indexes beginning in late January.

Figure 1 plots the evolution of the two indexes across counties during the early stages of the pandemic. While there is no external data source against which to validate our measure of the contact rate, our employment index is effectively a daily proxy for the official monthly estimates of county employment. Figure 4 plots total US daily employment aggregated from our county employment indexes against official estimates of monthly employment. Figure B1 in the online appendix compares county-level monthly changes in the daily employment index against actual monthly changes from LAUS. Although the underlying indicators are all indirect

19. Measures from Unacast and Google Mobility Reports are already normalized relative to the same day of the week over different base periods in early 2020. Measures from SafeGraph are available only from January 20.

20. For some small central states, the residual “county” is the entire state, for which data are always available. Excluding all aggregated counties with incomplete data has no discernible impact on any of the results presented below.

Figure 4. Daily Employment Index and Monthly Official Employment

Sources: Bureau of Labor Statistics (BLS); authors' calculations.

Notes: Daily employment index values are aggregated from county-level indexes. Monthly official employment through July is aggregated from county-level employment from the BLS Local Area Unemployment Statistics. The monthly value for August is from the BLS news release. Monthly official employment values are placed on the 12th of each month in the plot to align with the BLS reference week.

and partial measures of overall employment, the combined index tracks the dynamics of the official series over the first half of 2020 both in aggregate and at the county level.

VI. Parameters

This section reviews the selection or estimation of the epidemiological and behavioral parameters of the model in section II. For the former, we draw on the clinical literature on COVID-19 as well as methods from empirical epidemiology. For the latter, we estimate behavioral responses with a difference-in-differences approach using county-level data.

VI.A. Epidemiological Parameters

We first select values for parameters that are largely biological in nature—that is, least likely to vary according to behavior or policy. We draw on the

Table 1. Exogenous Parameter Definitions and Values

<i>Parameter</i>	<i>Definition</i>	<i>Value</i>
σ	$1/\tau_E$, where τ_E is the noninfectious latent period in days	1/2
γ	$1/\tau_I$, where τ_I is the infectious period in days	1/7
τ_S	Duration from infectiousness onset to symptom onset	3
τ_F	Duration from symptom onset to death for severe cases in days	19
τ_P	Duration from symptom onset to positive test result for confirmed cases (assumed)	7
μ_i	Infection fatality ratio	0.0025–0.008

Sources: Peng and others (2020); Lauer and others (2020); Zhou and others (2020); Gu (2020).

early and developing clinical COVID-19 literature where available. Parameter values and sources are shown in table 1.

Of the parameters included in table 1, only the infection fatality ratio μ_i is time-dependent. The infection fatality ratio depends not just on the biology of the disease but also on policy, medical advances, and epidemic dynamics. We base our assumption on the work of Gu (2020), one of the most consistently accurate COVID-19 forecast models.²¹ We assume the infection fatality rate was 0.8 percent through mid-April and then declined linearly to a terminal value of 0.025 percent in mid-August. This decline reflects improvements in COVID-19 outcomes over time due to a number of factors, including improved treatments, expanded hospital capacity, and possible compositional shifts in the demography of new infections (Boehmer and others 2020).

The variable μ_i is used to estimate case confirmation rates as described in section IV. Recall that infections are imputed using estimated case confirmation rates, which capture averages of time and positivity rate effects across states. This means that *effective* infection fatality ratios, calculated as actual new deaths divided by estimated new infections, vary slightly by state (hence the indexation by i in the differential equations presented in section III). When calculating marginal deaths in counterfactual scenarios, we use the simple average of the overall headline infection fatality ratio and the state-specific effective infection fatality ratio.

The final SEIR parameter is the daily transmission rate β_{it} . This parameter varies with behavior and is responsive to local epidemiological conditions, and thus it varies widely across time and place. To obtain historical

21. See COVID-19 Projections Using Machine Learning, “About /Historical Performance,” <https://covid19-projections.com/about/#historical-performance>, for a review of model accuracy.

estimates of β_{it} , we first estimate the effective reproduction number $\mathcal{R}_{it}$. From equation (2), β_{it} is given by $\beta_{it} = \mathcal{R}_{it}\gamma_{it}$.

We estimate $\mathcal{R}_{it}$ using the method developed by Cori and others (2013) and implemented using the authors' software package EpiEstim. The estimation framework is parsimonious and only requires data on new infections and an estimate of the distribution of serial intervals (the time between symptom onset in successive cases) for the virus. For each state, we iterate over hundreds of possible combinations of gamma-distributed serial interval means and standard deviations. We then simulate the SEIR model for each possible path of $\mathcal{R}_{it}$, choosing the serial interval distribution that best matches the observed trajectory of each state-level epidemic.²²

VI.B. Behavioral Parameters

We now turn to the estimation of the behavioral parameters ϕ , ρ , and ω_t from sections II.B and II.C. We adopt a daily event study design to estimate the effects of policy interventions ϕ , using variation in the implementation of NPIs across counties and over time to capture the dynamic response during the month following an intervention. We estimate the response to local infection risk ρ directly based on the number of confirmed COVID-19 cases by county. The time path of precautionary behavior ω_t is captured by calendar date fixed effects interacted with county characteristics.

Ideally, we would estimate the relationship between behavior and COVID-19 transmission directly based on county-level $\mathcal{R}_{it}$ and equation (5). However, the limitations of our data make this impractical. The procedure for obtaining historical estimates of $\mathcal{R}_{it}$ (described in sections IV and VI.A) is only feasible given a sufficient number of confirmed cases. For many counties, this threshold is not reached until late March—by which time most NPIs had already been implemented—and for a substantial number it is never reached.²³ Altogether, our sample for estimation of equation (5) is less than half the size of the full sample and drops most school closure and nonessential business closure events and many stay-at-home order events. In addition, historical estimation of $\mathcal{R}_{it}$ is based on an arbitrary time window and imposes a degree of smoothing, making it difficult to identify the timing of responses in a daily event study. We therefore estimate ϕ , ρ , and ω_t using

22. The loss function minimizes the weighted mean of absolute error in two measures of infections: cumulative infections for the most recent date of data (80 percent weight) and new cases over the most recent three days of data (20 percent weight). This arbitrary weighting scheme is chosen to target both the level and slope of the epidemic curve.

23. This problem is much less severe for the state-level estimates of $\mathcal{R}_{it}$ that we use in the SEIR model.

the contact rate κ_{it} and equation (4) instead. Where feasible, we also show estimates from equation (5) for comparison.

Reformulating the policy component in equations (4) and (6) as event studies of the three NPIs—and adding superscript κ to the parameters in equation (4)—leads to the following estimating equations for the contact rate and employment:

$$(7) \quad \ln \kappa_{it} = \eta_i^\kappa + \sum_x \omega_{xt}^\kappa X_{xi} + \sum_{j \in \text{NPIs}} \left(\sum_{\substack{k=-31, \\ k \neq -1}}^{31} \phi_{jk}^\kappa P_{it}^{jk} \right) + \rho^\kappa c_{it} + v_{it}^\kappa$$

$$(8) \quad \ln W_{it} = \eta_i^w + \sum_x \omega_{xt}^w X_{xi} + \sum_{j \in \text{NPIs}} \left(\sum_{\substack{k=-31, \\ k \neq -1}}^{31} \phi_{jk}^w P_{it}^{jk} \right) + \rho^w c_{it} + v_{it}^w.$$

The contact rate index is κ_{it} , and W_{it} is the employment index for county i on day t . The county and calendar date fixed effects are η_i and ω_{xt} , respectively. The variable X_{xi} contains a column of ones and a set of county characteristics indexed by x . The three NPIs are indexed by j . The number of days before or after an NPI is issued is indexed by k . The variable P_{it}^{jk} is an indicator equal to one if NPI j is in effect in county i on date t , which is k days from the date issued. For $k \geq 0$, the coefficients ϕ_{jk} trace out the dynamic response to j over the thirty days following announcement of the NPI. For $k < 0$, the coefficients ϕ_{jk} capture systematic differences between counties that issued NPIs and those that did not over the month immediately before the NPI was issued. Dates more than thirty-one days from the issuance of the NPI are binned in $k = -31$ and $k = 31$ and reflected in the coefficients $\phi_{j,-31}$ and $\phi_{j,31}$. The variable c_{it} is the inverse hyperbolic sine of C_{it} , the total number of confirmed COVID-19 cases in county i .²⁴

The variable X_{xi} contains information on the demographic, economic, and political characteristics of counties. In our main estimates, it includes the shares of the population age 5 to 17 and age 65 or over; the shares of workers in leisure and food services, in essential industries, and in educational services; and the Republican Party vote share in the 2016 presidential election.²⁵ The precautionary behavior terms $\omega_{xt} X_{xi}$ capture nationwide

24. The inverse hyperbolic sine $c = \ln(C + \sqrt{1 + C^2})$ has similar properties to a log transformation but is defined at zero.

25. Essential industries are defined based on guidance from the Department of Homeland Security. Election data are from the MIT Election Data and Science Lab.

common variation as well as county-specific patterns driven by heterogeneity across the characteristics in X_{xi} . These terms also absorb the average effects of all government actions not in Φ_{it} , the event study component. This includes non-mandatory guidance and an array of restrictions on particular social and economic activities (such as public events or close-contact personal services). Unlike the broad mandated closures we consider in our analysis of NPIs, the details of these limited actions vary widely across jurisdictions and generally defy classification into distinctive treatments, and so cannot be separately identified. Though we will refer to the estimated $\omega_{xi}X_{xi}$ simply as “precautionary behavior” in our discussion, it is important to keep in mind that our concept of “precaution” encompasses a range of government actions.

The event study coefficients ϕ_{jk} reflect the direct impact of NPIs on opportunities for social contact or economic activity as well as any other changes in behavior indirectly induced by NPIs. Both the announcement of NPIs and observation of their effects convey information to the public about the importance of social distancing.²⁶ Individuals may respond to this information by adjusting their behavior in ways that are not directly related to specific limitations imposed by NPIs. For example, an announcement that all nonessential businesses must close may lead some households to purchase groceries online for delivery instead of at a store, even if grocery stores are considered essential businesses and remain open.

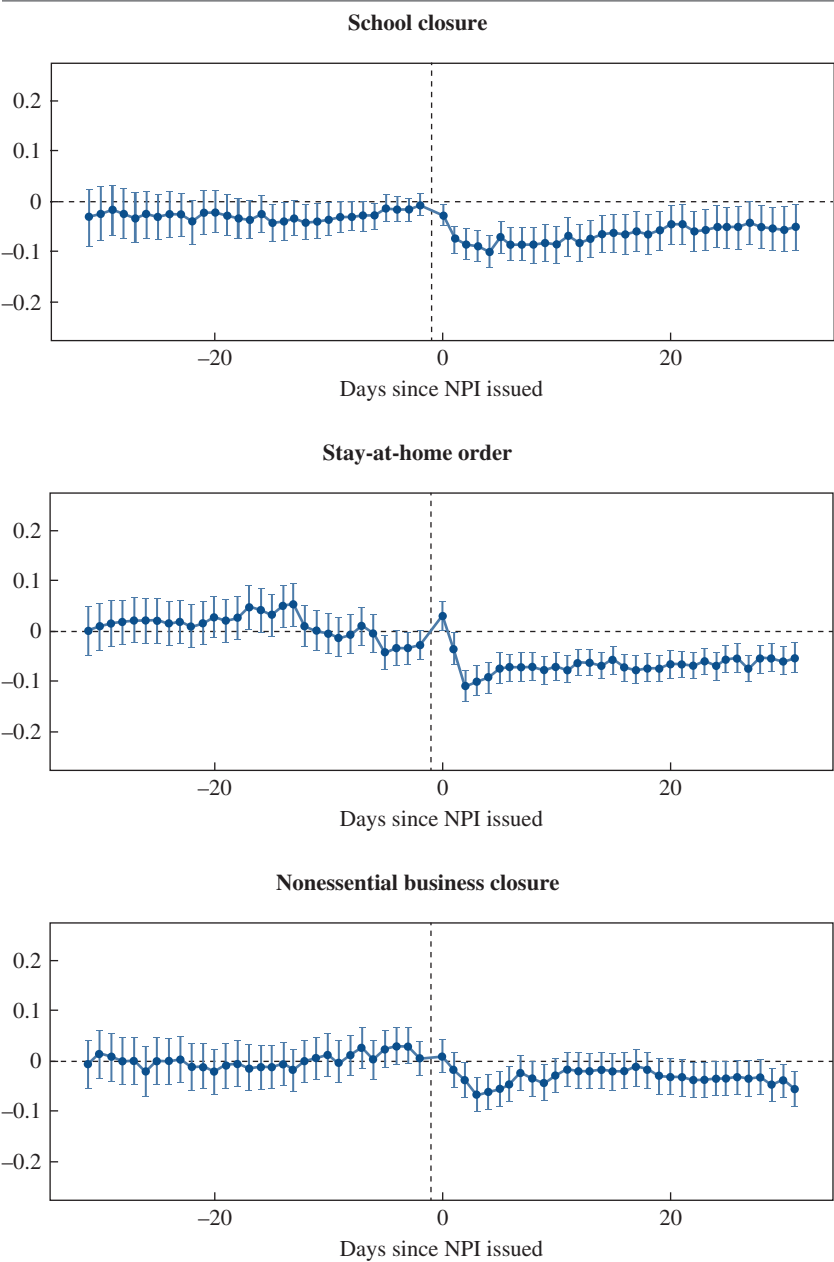
The relationship between the contact rate κ_{it} and COVID-19 cases C_{it} described in section II implies potential simultaneity in equation (7) and—to the extent employment W_{it} is related to κ_{it} —in equation (8). Identification of the causal parameters ϕ_{jk} and ρ depends on the lag between κ_{it} (or W_{it}) and C_{it} . Given the disease’s incubation period and the time from symptom onset to a positive test result, the effects of a change in behavior are not reflected in the number of cases for more than a week. Hence, we treat the contemporaneous case count as exogenous with respect to behavioral outcomes.

Figure 5 reports NPI event study estimates for the contact rate from equation (7).²⁷ Over the week following an order to close schools, the contact rate declined between 5 and 10 percent. Stay-at-home orders had larger and more immediate effects, with a sharp fall in contacts of more than

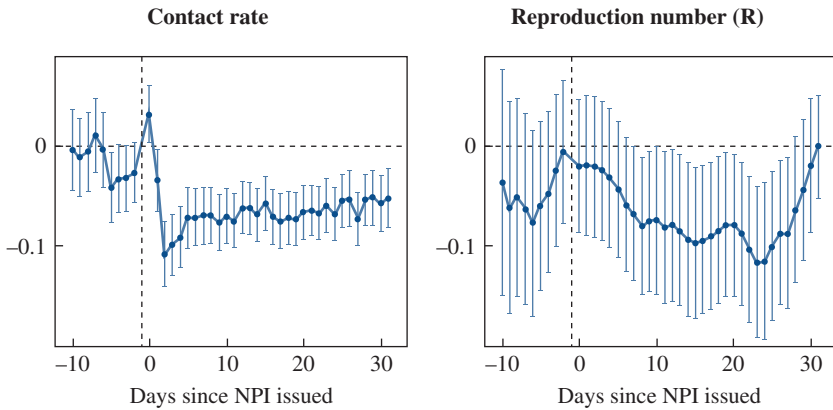
26. Gupta, Simon, and Wing (2020) highlight the informational aspect of NPIs and provide a detailed discussion.

27. We report estimates from the model excluding county characteristics (i.e., $X_{xi} = \bar{1}$) in figures B2 and B3 in the online appendix.

Figure 5. NPI Event Study Estimates: Contact Rate



Source: Authors' calculations.
Notes: The figure shows coefficient estimates and 95 percent confidence intervals for ϕ_{jkt}^k , the effect of each NPI on the log of the contact rate. Standard errors are clustered at the county level.

Figure 6. NPI Event Study Estimates for Stay-at-Home Orders

Source: Authors' calculations.

Notes: The left panel shows coefficient estimates and 95 percent confidence intervals for $\phi_{SAH,k}^k$, the effect of stay-at-home orders on the log of the contact rate. The right panel shows analogous estimates based on equation (5) instead of equation (4): the effect of stay-at-home orders on the log of the reproduction number. Standard errors are clustered at the county level.

10 percent two days after the order was issued—generally corresponding to the day after the order went into effect. For both school closures and stay-at-home orders, roughly half the decline persisted after thirty days. The effects of nonessential business closures were smaller—a decline of around 5 percent—but somewhat more persistent.

Figure 6 compares the response to stay-at-home orders estimated from the contact rate and equation (4) with estimates from the reproduction number and equation (5). Because stay-at-home orders were typically enacted later than the other two NPIs, the sample available for estimates using $\mathcal{R}_{it}$ is larger than for the other two NPIs, though still much smaller than the full sample.²⁸ For readability, we limit the plot to ten pre periods, as the standard errors of the $\mathcal{R}_{it}$ estimates become very large in earlier periods. We estimate that $\mathcal{R}_{it}$ declined about 10 percent over the weeks following a stay-at-home order—roughly the same magnitude as the estimated response of κ_{it} , though with a different time pattern.²⁹ Given the degree of uncertainty, which makes it impossible to assess prior trends in the estimates for $\mathcal{R}_{it}$, this comparison is at best suggestive but is nevertheless reassuring.

28. We report estimates for $\mathcal{R}_{it}$ for all three NPIs in figure B4 in the online appendix.

29. The difference in timing arises at least in part from the construction of historical values for $\mathcal{R}_{it}$, which are based on a rolling time window of arbitrary width.

Figure 7 reports NPI event study estimates for employment. Employment fell gradually following the announcement of school closures, eventually reaching a persistent decline of around 1 percent after two weeks. Stay-at-home orders had somewhat larger effects, with employment falling nearly 1.5 percent in the days following an order, though one-third of the decline was reversed after three weeks. Nonessential business closures had the largest employment effects, inducing a persistent decline of 2 percent.

The estimates for nonessential business closures indicate that employment began falling in the days before an order was issued. We attribute this to the effectively phased introduction of the policy in many jurisdictions. State and local governments issued a broad range of restrictions on businesses and public venues that were more limited than blanket nonessential business closures, including highly targeted interventions affecting only a handful of businesses (such as closing casinos or fairgrounds), restrictions on particular activities (such as in-person dining), and mandated closure of entire classes of business (such as beauty salons, hairdressers, and other close-contact personal services). In most cases, implementation of the full nonessential business closures we consider in our analysis was immediately preceded by one or more of these more limited restrictions. For example, Connecticut issued a statewide nonessential business closure on March 20. This followed three prior orders closing particular types of businesses: on March 16, fitness studios and movie theaters were ordered to close; on March 18, this was expanded to shopping malls, bowling alleys, and other public venues; on March 19, this was expanded to hairdressers, estheticians, and other personal services. This example is typical. In the jurisdictions for which we have reliable data on all forms of business restriction, three-quarters of nonessential business closures were preceded by lesser restrictions.

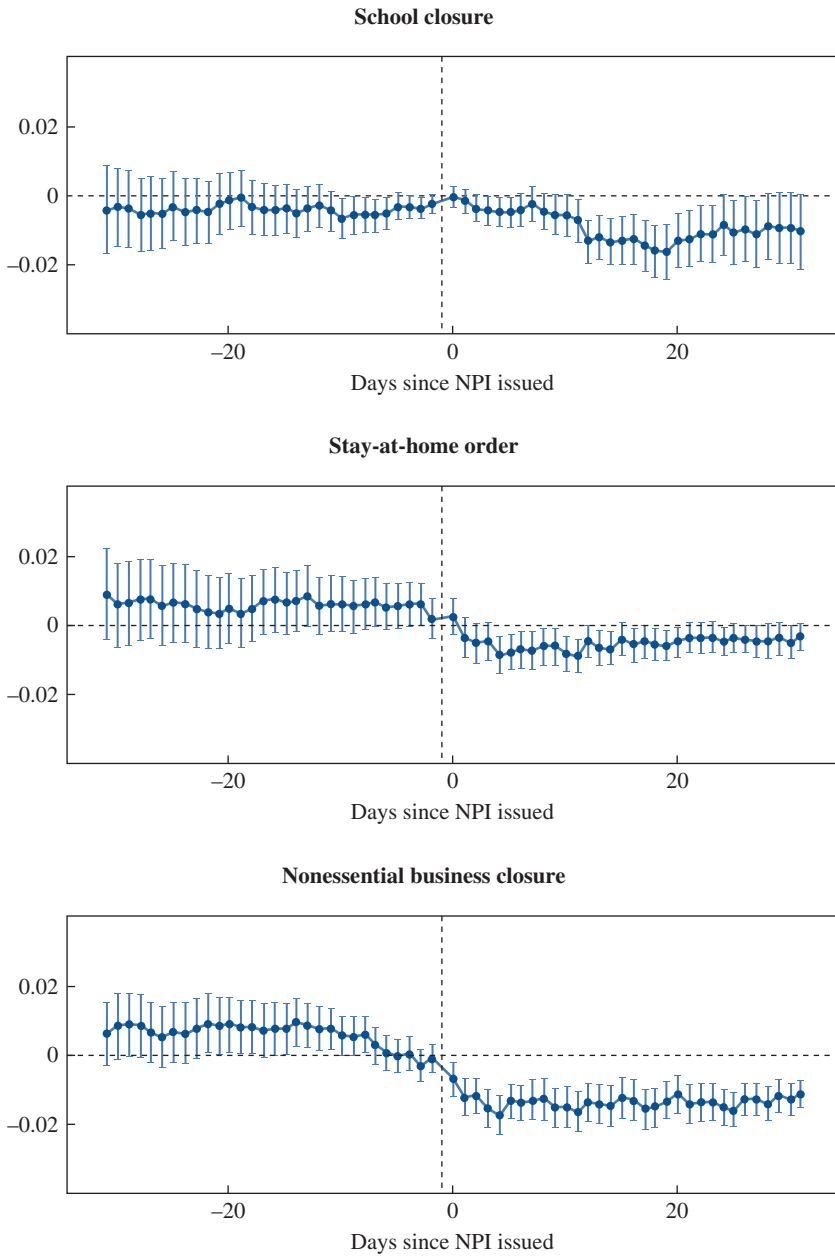
Table 2 reports estimates for ρ^* and ρ^w and the elasticity of the contact rate and of employment with respect to local infection risk.

Here we note only that these estimates have the expected sign and the magnitudes are plausible. We discuss the implied response to local infection risk in the next section.

VII. The Response to COVID-19

In this section, we assess the initial policy response to COVID-19 using the epidemiological and empirical framework described above. We have two objectives: first, to estimate what benefits and harms can reasonably be attributed to government as opposed to voluntary action; second, to provide

Figure 7. NPI Event Study Estimates: Employment



Source: Authors' calculations.

Notes: The figure shows coefficient estimates and 95 percent confidence intervals for ϕ_{jk}^w , the effect of each NPI on the log of the employment. Standard errors are clustered at the county level.

Table 2. Estimated Response to Local Infection Risk

	<i>Estimate</i>	<i>Std. Err.</i>
Contact rate (ρ^c)	-0.0541	0.0045
Employment (ρ^w)	-0.0048	0.0011

Source: Authors' calculations.

useful insights to policymakers managing the current and any future infectious disease outbreaks.

VII.A. Social and Economic Responses to the Pandemic

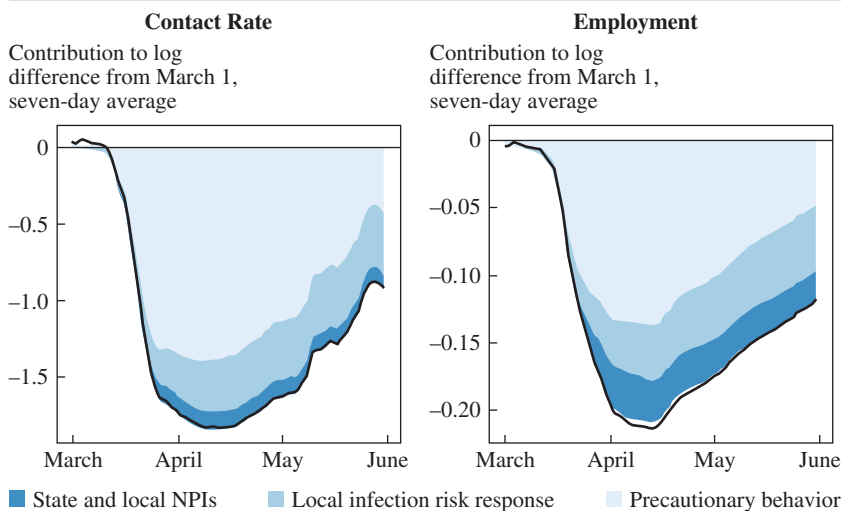
Using the estimated coefficients from equations (7) and (8), we decompose the aggregate declines in the contact rate and employment since the beginning of March into contributions from the three behavioral components: state and local NPIs, response to local infection risk, and precautionary behavior.³⁰ Figure 8 shows the results of this decomposition. We find that the early declines in the contact rate and employment in mid-March were primarily precautionary.³¹ The contact rate fell rapidly before there were substantial numbers of confirmed cases and before the introduction of most NPIs. We estimate that these precautionary changes in behavior explain 80 percent of the total decline in the contact rate in the middle two weeks of March.

As the number of COVID-19 cases surged in the second half of March and the geographic concentration of cases became apparent, the behavioral response shifted from nationwide fears to localized concerns reflecting the severity of local outbreaks. When the contact rate reached its lowest point in mid-April—a fall of almost 85 percent from the beginning of March—about 73 percent of the cumulative decline was attributable to precautionary behavior and 20 percent to local infection risk. The final component, state and local NPIs, explains only 7 percent of the change in the contact rate through mid-April.

The decline in employment initially followed a pattern similar to the contact rate, lagging a few days behind. Precautionary behavior explains

30. Aggregated values for the contact rate are weighted by county population. Aggregated vales for employment are weighted by average county employment from December 2019 to February 2020.

31. Recall that the precautionary component also includes the effects of state and local government actions other than three major NPIs considered explicitly in the analysis, such as issuing warnings and advice or imposing narrow restrictions on commercial activity.

Figure 8. Decomposition of the Response to COVID-19

Source: Authors' calculations.

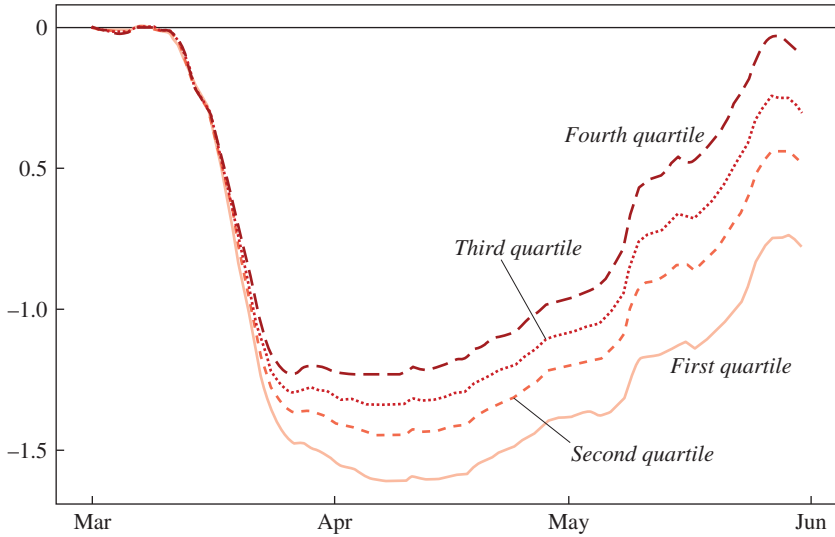
Notes: The figure shows the impact of the three components of behavior on the contact rate and employment. The solid black lines show actual changes relative to March 1. The difference between the actual change and the sum of the three components is the regression residual.

about 80 percent of the 11 percent fall in employment between March 8 and March 22. The two outcomes diverge beginning in late March due to the effects of NPIs—in particular, the employment impact of mandated business closures. By mid-April, employment was around 20 percent below its level in early March. The response to local infection risk explains about one-fifth of this decline, the same as its contribution to the fall in the contact rate. State and local NPIs explain nearly 15 percent, more than double their contribution to the fall in the contact rate. Thus, on average NPIs appear to have been somewhat inefficient in terms of employment loss relative to social distancing gains. We return to this subject below.

Figures B5 and B6 in the online appendix present the same decomposition of the contact rate and employment at the state level. In general, plains states and the south central region experienced the smallest declines, while northeastern states—along with Nevada, Colorado, and Hawaii—experienced the largest. Cross-state variation in the magnitude of decline in contact rates and, to a lesser extent, employment is driven largely by differences in the precautionary component. Variation in the contribution of NPIs is much greater for employment than for the contact rate. This difference reflects the role of nonessential business closures, which were

Figure 9. Republican Vote Share and Precautionary Changes in the Contact Rate

Contribution to log difference from March 1, seven-day average



Source: Authors' calculations.

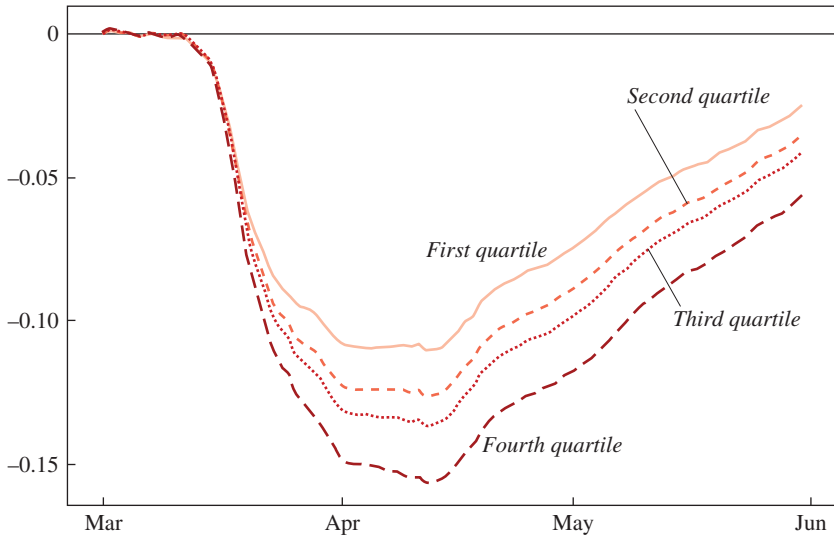
Note: The figure shows the county-level contribution of precautionary behavior to the change in the contact rate relative to March 1, averaged by quartile of county-level Republican vote share in the 2016 presidential election.

less widely adopted than the other NPIs (see figure 2) and had small effects on the contact rate but large effects on employment.

Figures 9 and 10 highlight two key drivers of heterogeneity in precautionary behavior: political preferences and industry mix. Figure 9 plots the average (county-level) contribution of precautionary behavior to the change in the contact rate by quartile of Republican Party vote share in the 2016 presidential election. The initial precautionary decline in contact rates in mid-March occurred at roughly the same rate nationwide but diverged along political lines beginning in the last week of March. The most Republican-leaning counties experienced no further declines after mid-March, while the least Republican-leaning counties continued reducing contacts through early April. Precautionary concerns began to recede across all counties in the second half of April, with recovery proceeding somewhat faster in more Republican-leaning counties. By the end of May, the precautionary effect on contact rates had largely dissipated in the most Republican-leaning counties even as it depressed contact rates by around 50 percent in the least Republican-leaning.

Figure 10. Employment in Leisure and Food Services and Precautionary Changes in Employment

Contribution to log difference from March 1, seven-day average

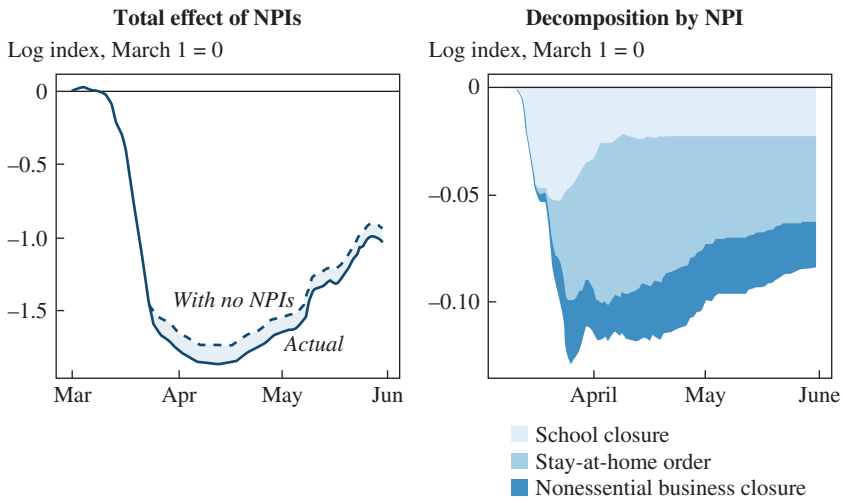


Source: Authors' calculations.

Note: The figure shows the county-level contribution of precautionary behavior to the change in the employment relative to March 1, averaged by quartile of county-level share of employment in leisure and food services.

Figure 10 plots the average precautionary behavior contribution to the change in the employment by quartile of the share of county employment in leisure and food services. Because these industries provide largely discretionary services that typically require physical proximity, they are particularly likely to suffer as a result of voluntary social distancing. We find that the precautionary decline in employment was indeed substantially larger and more persistent in counties with more workers in leisure and food services. The importance of these industries to the economies of Nevada and Hawaii in particular explains the unusually large contribution of precautionary behavior to the decline in employment in those states in figure 10.

Figures B7 and B8 in the online appendix show variation in precautionary behavior across the five other county characteristics we include in our analysis. Figures B9 and B10 show analogous plots for the contribution of NPIs. In general, we do not find strong patterns in the size of the policy response. The response was somewhat slower, smaller, and less persistent in the most Republican-leaning districts, but these differences are small compared with political variation in precautionary behavior.

Figure 11. Effect of NPIs on the Contact Rate

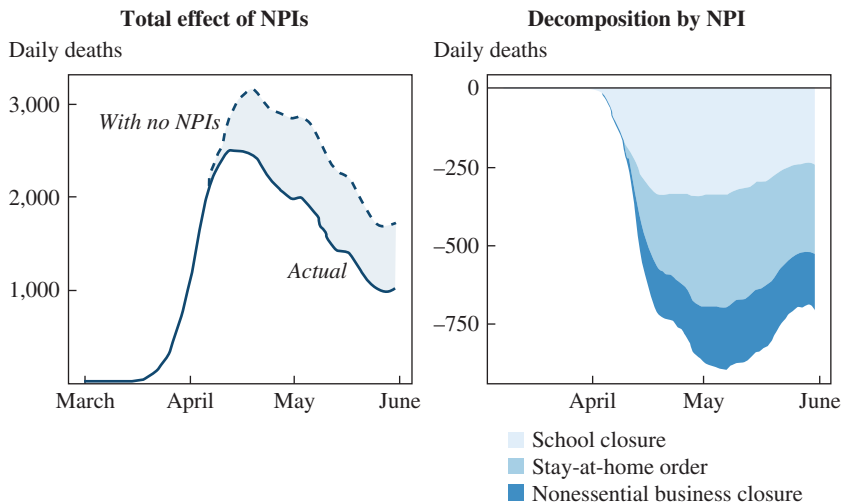
Source: Authors' calculations.

Notes: The left panel shows the actual change in the contact rate (solid line) and the estimated change in the absence of any NPIs (dashed line). The right panel decomposes the difference between the two into contributions from the three NPIs.

VII.B. The Impact of NPIs

Narrowing our focus to the role of policy, we now consider the three types of interventions separately and review their epidemiological and economic effects. Figure 11 decomposes the estimated effect of state and local NPIs on the contact rate from the previous subsection into contributions from each of the three NPIs. The initial policy response consisted largely of school closures, which expanded rapidly to cover more than 90 percent of the population by March 20. By the end of March, more than 70 percent of the population was also under either a stay-at-home-order, nonessential business closure, or both (see figure 2). We estimate that together these policies reduced the daily contact rate by an average of 9 percent between early March and the end of May, accounting for 12 percent of the total fall in the contact rate. Of this, half was explained by stay-at-home orders, 28 percent by school closures, and 22 percent by nonessential business closures.

To estimate the epidemiological effects of these responses, we use the SEIR model described in section II to simulate each state's epidemic under a counterfactual path for the contact rate (and thus for the transmission rate β_{it}) that removes the effects of one or more NPIs. Figure 12 shows the

Figure 12. Effect of NPIs on Daily COVID-19 Deaths

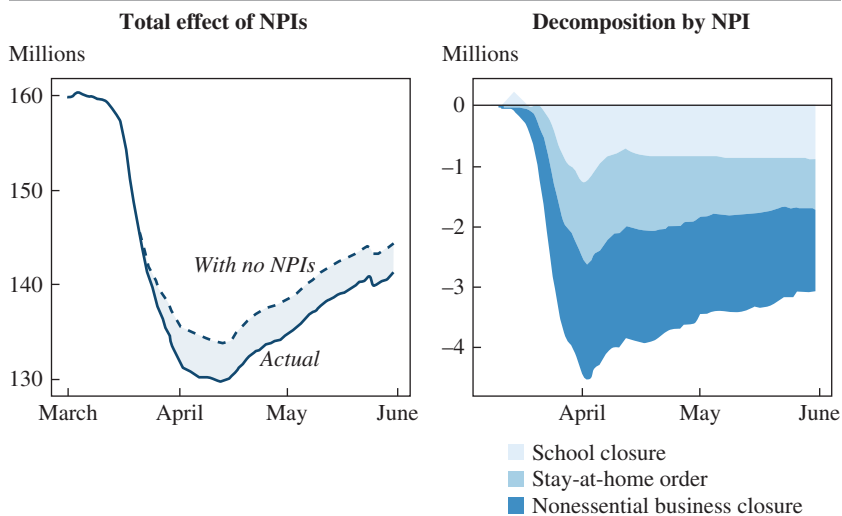
Source: Authors' calculations.

Notes: The left panel shows actual daily COVID-19 deaths (solid line) and estimated deaths in the absence of any NPIs (dashed line). The right panel decomposes the difference between the two into contributions from the three NPIs.

results for daily COVID-19 deaths. In the absence of NPIs, we estimate daily deaths would have reached a peak of roughly 3,000 in mid-April instead of the actual peak of 2,500. In total, we estimate that NPIs lowered confirmed COVID-19 deaths through May 31 by more than 39,000, bringing the cumulative total down by about 25 percent to its actual level of nearly 115,000. Taking into account the lag between infection and death, we estimate that policy-induced changes in behavior through May 31 lowered confirmed deaths through mid-June by 55,000. School closures and stay-at-home orders each explain about 40 percent of these reductions; non-essential business closures account for 21 percent.³²

Comparing results for the contact rate and for deaths, we note two significant differences. First, the 9 percent decline in contacts in response

32. Note that our homogeneous-mixture framework assumes that the NPI-driven change in the overall contact rate is consistent across population subgroups. To illustrate how this assumption has a directional impact on our headline epidemiological results, we conduct a stylized experiment using a two-group SEIR model that allows for heterogeneous contact rates and heterogeneous responses to NPIs. See the online appendix for details.

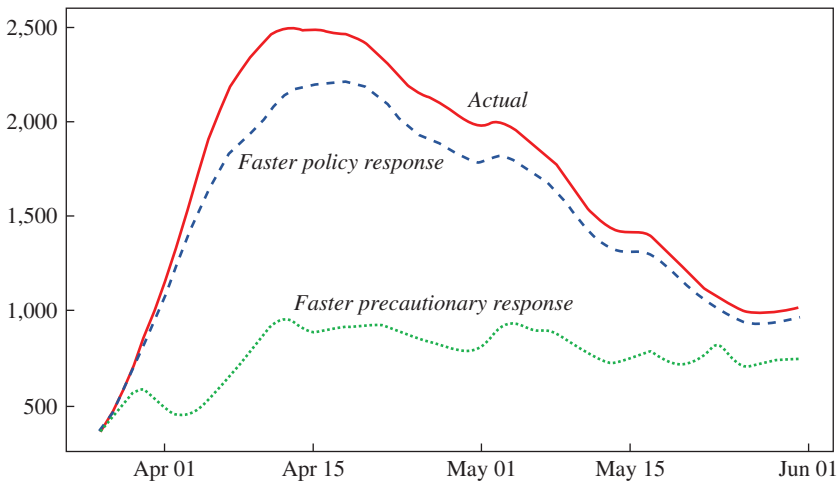
Figure 13. Effect of NPIs on Employment

Source: Authors' calculations.

Notes: The left panel shows actual employment (solid line) and estimated employment in the absence of any NPIs (dashed line). The right panel decomposes the difference between the two into contributions from the three NPIs.

to NPIs is considerably smaller than the resulting decline in deaths of about one-quarter. Second, school closures accounted for a larger share of the reduction in the deaths than the reduction in contact rates (41 percent vs. 28 percent), with a corresponding and opposite difference in the contributions of stay-at-home orders (37 percent vs. 50 percent). Both outcomes reflect the nonlinear dynamics of infectious disease transmission. Reductions in contacts in the early stages of an epidemic may prevent long chains of transmission from ever emerging, leading to disproportionate reductions in infections and deaths. The relatively greater effect of school closures on deaths than contacts is thus explained by their relatively early enactment (on average, one week before nonessential business closures and ten days before stay-at-home orders).

Figure 13 shows the impact of NPIs on employment. We estimate that the policy response to COVID-19 reduced employment by an average of 3 million between early March and the end of May—13 percent of the total fall employment. Almost half of this decline was attributable to nonessential business closures, 30 percent to stay-at-home orders, and 22 percent to school closures. Notably, business closures account for a

Figure 14. Daily COVID-19 Deaths Given Seven Days Faster Response

Source: Authors' calculations.

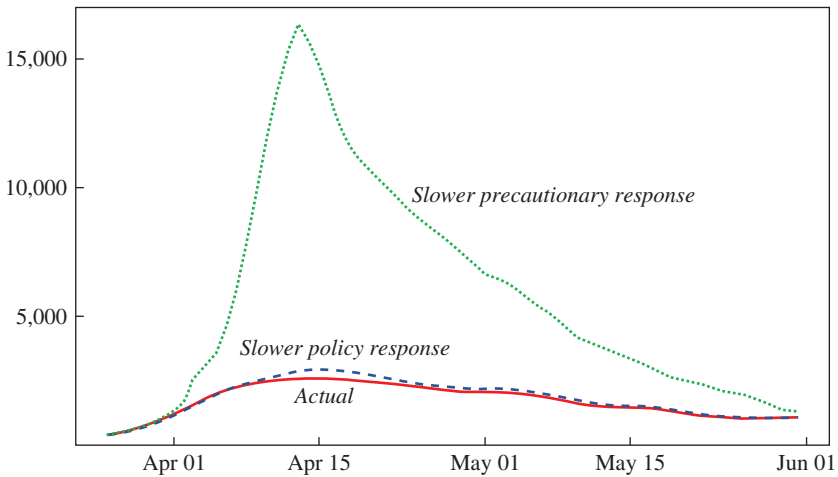
much larger share of the decline in employment than of the fall in contact rates (48 percent vs. 22 percent), while the opposite is true of stay-at-home orders (30 percent vs. 50 percent). This suggests large cost-benefit differences across the different NPIs. We discuss these differences in the next section.

VIII. Counterfactuals

In this section, we use the augmented SEIR model to examine alternative responses to the pandemic. We first present a set of illustrative scenarios to help calibrate expectations of what NPIs can plausibly accomplish. We then consider alternative policy responses to the outbreak of COVID-19. Drawing on the results from the previous sections, we ask what could have been gained by responding more aggressively and deploying a more efficient mix of NPIs.

VIII.A. Seven Days

Figure 14 compares actual daily COVID-19 deaths with simulated paths for two illustrative scenarios. First, we assume that state and local governments adopt the same set and sequencing of NPIs but implement them all seven days earlier than they actually did. Second, we assume a

Figure 15. Daily COVID-19 Deaths Given Seven Days Slower Response

Source: Authors' calculations.

precautionary response to the pandemic of the same magnitude as actually occurred but beginning seven days earlier. We find that a faster policy response would have reduced daily deaths by around 200 through much of April, preventing a cumulative 11,000 deaths by May 31. By the end of the period, however, the epidemic largely converges back to its original path. A faster precautionary response, by contrast, dramatically alters the dynamics of the epidemic. The initial surge in deaths between late March and mid-April is substantially muted, and daily deaths never exceed 1,000. In total, COVID-19 deaths are lower by 62,000 at the end of May.

We next consider the opposite scenarios, assuming that either the policy response or the precautionary response occurred seven days later than it actually did. Figure 15 reports the results. The effects of a one-week delay in the introduction of NPIs are roughly symmetrical with those of faster action, leading to a cumulative increase in deaths of nearly 10,000. The effects of a slower precautionary response are of a different order of magnitude entirely. An additional week of effectively unabated transmission in mid-March dramatically increases the death rate over the subsequent months. Daily deaths reach a peak of more than 13,000 in mid-April, almost five times the actual peak. In total, COVID-19 deaths are higher by 242,000 at the end of May.

These results highlight the qualitative difference in the impact of marginal changes in voluntary behavior and that of marginal changes in policy. While NPIs produce meaningful gains, it is unlikely that any policy response based on the set of interventions we consider here—which are the most stringent enacted in the United States—could have altered the fundamental epidemiological dynamics of COVID-19. Effective suppression of the pandemic would have required either earlier voluntary action or substantially more coercive government interventions.

VIII.B. Efficient Pandemic Response

We now consider the potential gains from a more efficient policy response to the outbreak of COVID-19. We define policy efficiency in terms of the reduction in deaths attributable to an NPI relative to the corresponding reduction in employment. Our analysis of the actual response in section VII suggests two principles to guide the deployment of NPIs: first, action should be taken as early as possible; second, interventions with the largest effect on the contact rate relative to employment should be prioritized.

On the second principle, we noted above that nonessential business closures accounted for a markedly larger share of the decline in employment than of the decline in contact rates, while the reverse was true for stay-at-home orders. The reason for this difference is clear from the event study estimates of equations (7) and (8) shown in figures 5 and 7. Of the three NPIs, nonessential business closures have the largest estimated effect on employment while delivering the smallest reduction in contacts. The trade-off is similar for stay-at-home orders and school closures, though stay-at-home orders have substantially larger overall effects. Given the nonlinear benefits of earlier reductions in contact, as well as the negative externalities of removing children from schools, we view stay-at-home orders as preferred over school closures. Thus, we argue that the NPI of first resort should be a stay-at-home order, followed first by closing schools and then by closing businesses.

With this in mind, we construct two sets of alternative policy response scenarios. First, we consider a federal, nationwide response on March 13, the date on which the president declared COVID-19 a national emergency. We simulate this scenario for responses consisting of only a stay-at-home order, a stay-at-home order and school closure, and all three NPIs issued on the same date. Second, we consider a local government (county-level) response based on the number of confirmed cases in a county. We calculate confirmed cases per capita on the date a state or substate government issued

Table 3. Counterfactual Policy Response Simulation Results

	<i>Cumulative COVID-19 deaths through May 31^a</i>		<i>Difference in employment from March 1^b</i>	
	<i>Deaths</i>	<i>Difference from actual</i>	<i>Millions</i>	<i>Difference from actual</i>
Actual	114,423		-20.5	
No NPIs	153,667	39,244	-17.8	2.67
Seven days				
Seven days slower	124,341	9,918	-20.3	0.17
Seven days faster	103,364	-11,059	-20.7	-0.15
Federal response on March 13				
Stay-at-home order	121,866	7,443	-18.9	1.62
Stay-at-home order and school closure	109,318	-5,105	-19.5	1.01
Stay-at-home order, school closure, and nonessential business closure	99,835	-14,588	-21.6	-1.08
Local response to confirmed cases				
Stay-at-home order	120,695	6,272	-18.8	1.76
Stay-at-home order and school closure	111,374	-3,049	-19.3	1.21
Stay-at-home order, school closure, and nonessential business closure	104,484	-9,939	-21.1	-0.62

Source: Authors' calculations.

a. Excludes differences in deaths after May 31 attributable to differences in infections through May 31.

b. March 1–May 31 average.

its first, second, and third NPI.³³ We take the 25th percentile of each and use the three values as thresholds to specify when a county government issues (first) a stay-at-home order, (second) an order closing schools, and (third) an order closing nonessential businesses. Hence, this scenario represents a relatively aggressive response to local outbreaks, with NPIs reordered based on efficiency. As with the federal response, we run simulations adding each of the NPIs incrementally.

Table 3 presents our results for cumulative confirmed COVID-19 deaths through May 31 and for the change in employment relative to March 1, averaged over the period March 1 to May 31. The first two rows show historical values and our estimates of what would have happened in the absence of any NPIs at all. The next two rows report results for the illustrative policy

33. For NPIs issued by state governments, we use state-level cases per capita. For NPIs issued by substate governments, we use county-level cases per capita.

scenarios discussed in section VIII.A, which we include for comparison. The remainder of the table reports results for the federal response and local response scenarios.

We highlight three main results. First, the most aggressive response we consider—nationwide enactment of all three NPIs on March 13—leads to a reduction in deaths of nearly 15,000 relative to the actual response, as well as an additional employment loss of 1.1 million. Though the number of lives is significant, it reflects a marginal change in the epidemic curve, confirming that contact-reducing NPIs alone are not sufficient to manage the epidemic.

Second, enactment of nonessential business closures led to economic costs that could have been avoided while actually improving epidemiological outcomes. Compared with the actual policy response, we estimate that wider implementation of stay-at-home orders and school closures—without any nonessential business closures—could have delivered a larger reduction in deaths while sustaining at least an additional 1 million jobs.

Third, we find that there is no significant advantage to geographic targeting of NPIs based on local epidemic conditions compared with blanket issuance of NPIs. Comparing the federal and local response scenarios, we estimate that the epidemiological benefits of applying interventions nationwide are roughly proportional to the economic costs. This outcome is partly attributable to the low case confirmation rate in the early stages of the epidemic. Policymakers relying on confirmed case counts to assess whether NPIs should be enacted will generally underestimate the progression of their local epidemic and react too slowly. Early, universal enactment of NPIs counters this bias, offsetting the economic losses suffered by counties with few actual infections.

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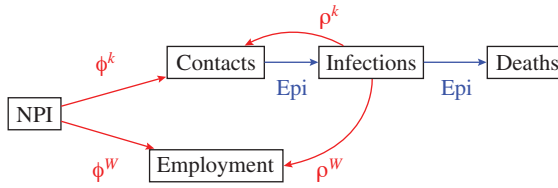
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Comment and Discussion

COMMENT BY

ALESSANDRA FOGLI In 2020, the world as we knew it has been swept away in a few weeks by a major pandemic. Governments across the globe have introduced policies with the objective of reducing social interactions to save lives. Such policies have spanned from national lockdowns of all economic activities, to stay-at-home orders, to measures aimed at specific businesses or geographic regions. The combined effect of mitigation policies and the pandemic has been a dramatic fall in employment and production. Economists and epidemiologists started working together to design policies that can save the most lives at the least cost for the economy, and in a matter of a few months, a large body of literature on the topic developed.

This paper belongs to this recent and growing literature and investigates to what extent non-pharmaceutical interventions (NPIs) contribute to saving lives after controlling for the endogenous behavior of individuals who independently reduce their interactions in response to high local infection rates. Earlier research in the area (Flaxman and others 2020; Hsiang and others 2020) found a very large impact of NPIs on infection dynamics, while recent work (Goolsbee and Syverson 2020) finds a more muted impact of NPIs and a larger role for behavioral responses. The authors exploit the variation across US regions in the implementation of mitigation policies by local governments and make some important contributions. On the modeling side, they fully integrate a standard epidemiological model of disease progression in an econometric framework designed to identify the causal impact of NPIs on the contact rate and on the employment rate. On the empirical side, they combine a lot of interesting data sets to generate proxies for unobserved variables such as the contact rate, the reproduction number, and the employment rate at the daily frequency and at the

Figure 1. A Sketch of the Model

Source: Author.

county level. The main finding is that NPIs introduced by state and local governments explain only a small fraction of the observed decline in contact rates when the endogenous response of individuals to epidemiological conditions is taken into account. This is an important message since it may inform the policies of national and local governments as they face a second wave of infections possibly even more intense and widespread than the first one.

Although I am sympathetic to the overall message of the paper and the careful analysis of rich daily-by-county data, I think there are some challenges in interpreting the results. These challenges stem from the reduced form approach of the estimation that does not take into account the role played by heterogeneity. I will first describe the model and then explain why heterogeneity matters and how its exclusion may drive the results and may lead to underestimating the role of NPIs in mitigating the pandemic.

The model developed in the paper is summarized in figure 1. NPIs directly affect the number of contacts among individuals, and the effect is captured by the parameter ϕ^k . Using a standard epidemiological model, contacts translate into infections according to the effective reproduction number, and a fraction of infections eventually end up in deaths. In turn, the infection rate affects contacts as individuals endogenously reduce their interactions in response to more infections. This effect is what the authors call the “fear-driven behavioral response” and is captured by the parameter ρ^k . A similar relationship holds for employment, as employment is affected by NPIs (ϕ^w) and by fear (ρ^w).

As the estimation of the employment equation follows closely the estimation of the contacts equation, from here on I will focus on the latter. In order to estimate the impact of NPIs and of fear on contacts the paper adopts an event study design exploiting the variation over time and across

counties in the implementation of three different NPIs. Equation (1) links contacts κ_{it} in county i at time t directly to individual fear and to the effect of a given type of NPI:

$$(1) \quad \ln(\kappa_{it}) = \eta_i + \omega_t X_i + \sum_{k=-31}^{31} \phi_k P_{it}^k + \rho c_{it} + v_{it},$$

where η_i is a county fixed effect, $\omega_t X_i$ is a time varying precautionary motive, ϕ_k is the effect of an NPI implemented at time t on contacts at time $t + k$, P_{it}^k is an indicator function that captures whether the NPI is in place at time $t + k$, ρ represents the endogenous individual response to local confirmed cases (in logs) c_{it} , and v_{it} is a random shock to the contact rate. The inclusion of the individual fear factor in the estimation of the effect of NPIs on contacts is a nice feature of the paper. Estimates that do not take into account the endogenous response of agents are likely to overestimate the contemporaneous impact of NPIs on contacts and, at the same time, underestimate their lagged impact. Since NPIs are typically implemented when cases are high (and hence fear is high), estimates that do not take into account the role of fear typically attribute to NPIs the decline in contacts due to individuals reducing their interactions in response to fear. In a dynamic sense, ignoring the effect of fear can lead to underestimating the role of NPIs in reducing contacts since, when epidemiological conditions improve, individuals perceive less fear and consequently increase their interactions, partially offsetting the effect of NPIs.

The inclusion of the fear factor in the model is definitely useful to separately identify the role of NPIs. However, I am concerned that the empirical approach employed by the authors might underestimate the causal effects of NPIs on contacts. My concern stems from the role played by heterogeneity which is dismissed in the model but is likely to matter in the estimation for two reasons. First, it is reasonable to expect significant variation in the local responses to NPIs since we observe large differences in the degree of compliance across regions. Second, it is also likely that various types of contacts affect the infection rate differently. I will show how ignoring these sources of heterogeneity can lead to significantly underestimating the true importance of policies.

HETEROGENEITY IN LOCAL RESPONSES A key assumption in equation (1) is that the effect of NPIs ϕ_k is constant across locations. The precautionary motive, on the other hand, is modeled as a time varying factor ω_t that depends on local fixed characteristics X_i . This component is the most flexible and therefore is able to explain more variation than the other components.

As a result, the estimation could understate the impact of NPIs and overstate the importance of the precautionary effect. For instance, if NPI effectiveness varies by political affiliation (because of different compliance rates or degree of enforcement), this variation would be incorrectly absorbed by the precautionary behavior. Similarly, the effect of other mitigation policies that are not included in the model (such as mask mandates or test availability) would also be absorbed by the precautionary component.

In order to illustrate to what extent unobserved heterogeneity in local responses can lead to underestimating the effect of NPIs, I report the results of a simple simulation where the contact rate is determined according to equation (1) except that in the true model the response to NPIs is allowed to vary across locations, so that the ϕ_k in equation (1) are also indexed by i .

Consider a panel of 3,000 regions (approximately the number of US counties) for twenty periods. Regions are assumed to vary across a single dimension X_i which is drawn from a normal distribution with mean 0.5 and standard deviation 0.75. The observed level of infections in each region follows a simple auto-regressive process:

$$c_{it+1} = \gamma \ln(\kappa_{it}) + \delta c_{it} + \epsilon_{it}.$$

This implies that, on average, γ contacts will turn into confirmed cases and $(1 - \delta)$ cases will resolve themselves, each period.¹ NPIs are assumed to go into effect at a random time t_0 and continue until the end of the sample.²

The response to the NPI (governed by ϕ_i) has two components: one is drawn uniformly from $[-1.2, 0.3]$ and the other is assumed to be $-X_i$. This results in the response to NPI usage being correlated with the regional characteristic. Larger draws of X_i result in a higher initial level of contacts but also translate into a larger decrease when an NPI is implemented.³ In the true model the elasticity of contacts to confirmed cases ρ (the fear factor) is set equal to -0.8 while the precautionary motive ω_i is assumed to be constant and equal to $\omega = 2.2$. This implies that any estimated reduction in ω_i is a consequence of misspecification.

Ignoring the heterogeneity in local responses leads to significantly underestimating the true importance of both policies and fear: the estimates

1. In the simulation $\gamma = 0.5$ and $\delta = 0.95$. Additionally, $v_{it} \sim N(0, \sigma_v^2)$ and $\epsilon_{it} \sim N(0, \sigma_\epsilon^2)$ with $\sigma_v = 0.1$ and $\sigma_\epsilon = 0.05$.

2. The implementation date for each region is a random draw between 3 and 13.

3. Occasionally, ϕ_i will be drawn to have a positive value. To enforce the notion that NPIs reduce contacts, positive values of ϕ_i are set equal to zero.

of the effects of NPIs and fear are respectively one-third and one-fourth of their true values.⁴

To get a sense of the magnitudes, figure 2 shows the share of the decline in contacts attributed to each component in the true model and in the misspecified model.

In the true model the precautionary motive plays no role in the decline in contacts. Fear plays a large role at the beginning of the pandemic, when no NPIs are in effect but, by the last period, NPIs account for about 60 percent of the decline. However, in the misspecified model, the precautionary motive accounts for around 65 percent of the decline in contacts, while the effect of fear and NPIs is cut by roughly two-thirds. While in the true model NPIs are very effective in reducing contacts, ignoring heterogeneity leads to mistakenly concluding that their impact is marginal.

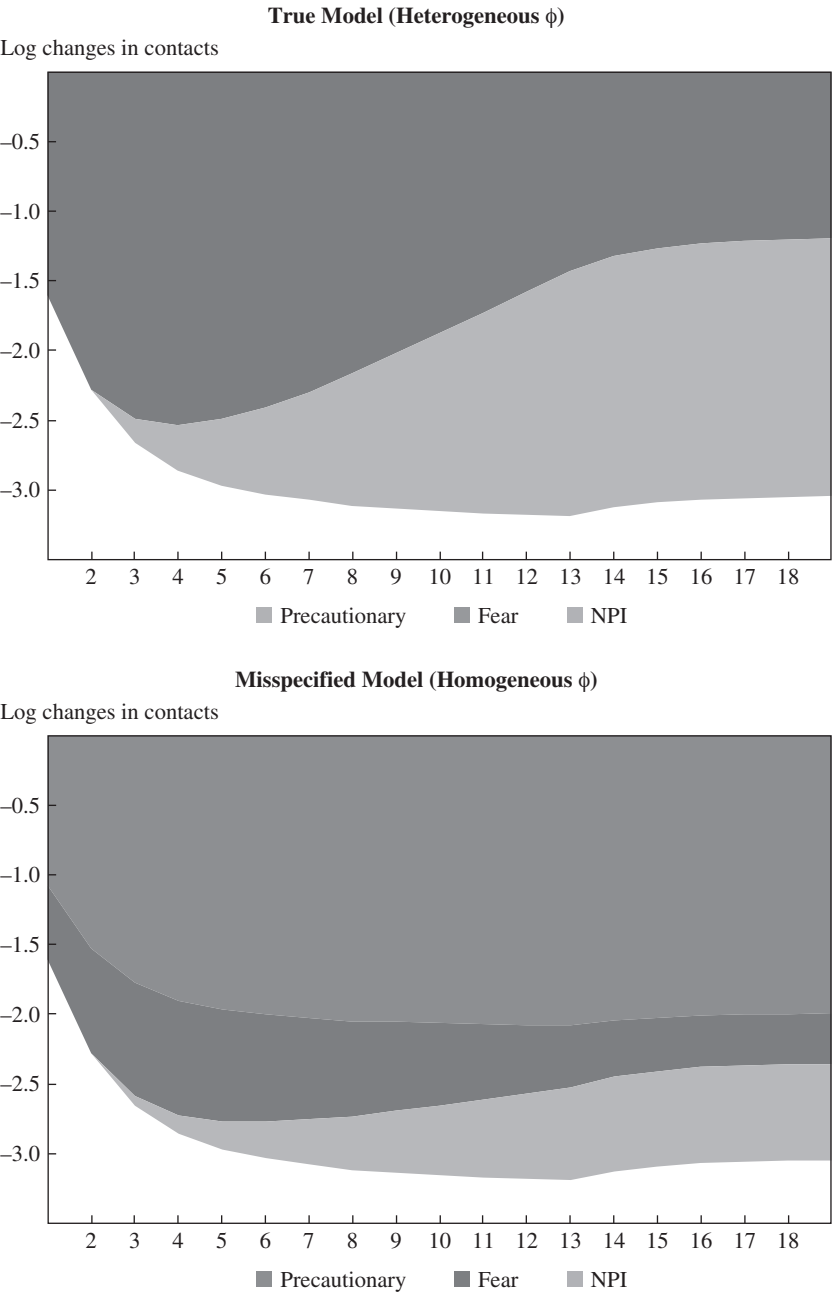
Interestingly, the extent to which abstracting from heterogeneity in local responses leads to underestimating the effect of NPIs depends on the strength of the correlation between the effectiveness of NPIs (ϕ_i) and local characteristics. Since the model includes the share of Republican voters as one of the regional controls, which has been shown to be strongly correlated with NPI compliance (Amuedo-Dorantes, Kaushal, and Muchow 2020), there is a concern that the authors significantly underestimate the role played by NPIs in reducing contacts.

Another important source of heterogeneity in the impact of policies on contacts simply stems from the heterogeneity in the initial contact structure across regions. Many NPIs (stay-at-home orders or caps on social gatherings) impose an absolute limit on the number of contacts. When these policies are introduced in regions with very different numbers of initial contacts, their implementation, even abstracting from compliance issues, leads to different reduction in contacts.

HETEROGENEITY IN THE TYPE OF CONTACTS Another important dimension of heterogeneity that the authors abstract from is the one in the type of contacts. In the model, all contacts have the same impact on infections, while recent network-based epidemiological research has highlighted that different types of contacts can have very different impacts on infections (Akbarpour and others 2020; Azzimonti and others 2020; Baqaee and others 2020). In particular contacts that are close and repeated (like those with friends and family) typically have a small effect on infections, while

4. The true ρ is equal to -0.8 , but ignoring the heterogeneity results in an estimate of $\hat{\rho} = -0.22$. The mean ϕ is -1.0 , but the model estimate is -0.33 .

Figure 2. Implied Share of Contact Decline



Source: Author's calculations.

contacts that are far and random (like those happening, for example, at a concert or at the mall) can have a much larger impact on infections. This heterogeneity can be of crucial importance when evaluating the effects of different NPIs. For example, a policy like nonessential business closure can itself have a very small reduction of contacts but by eliminating a large fraction of the far and random contacts can have a substantial impact on infection.

The implementation of NPIs during the COVID-19 epidemic has been proven very costly, both politically and economically, and even more so during the second wave when pandemic fatigue has kicked in. For these reasons, a precise assessment of the impact of NPIs on infection reduction is of paramount importance. This paper makes important steps toward this goal and finds a limited role for NPIs. In this comment I argue that heterogeneity in the impact of NPIs across counties in the United States is likely large, and it should be taken into account when performing these evaluations. First, heterogeneity can lead to significant underestimation of the effect of NPIs. Second, heterogeneity implies that the most important question is not whether or not a central authority should implement NPIs but rather where and when NPIs should be used and where and when they should not.

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GENERAL DISCUSSION Olivier Blanchard began the discussion by complimenting the authors on their work and encouraging them to reconcile their findings on the relation between formal measures and change in behavior with the findings presented by the discussant, Alessandra Fogli. Blanchard then brought up how the government at all levels had begun scaling back some of these formal measures. He asked if we should assume symmetry and that the removal of formal measures would not make a large difference in lowering the infection rate. Blanchard noted that this might be difficult to answer at that point but hoped that the authors would be able to offer some thoughts.

Ben Friedman then asked the authors how they identified the difference between NPIs and behavioral precautionary actions that people would have taken regardless of the mandates. He stated that in his community, he saw schools and nonessential businesses being ordered to close, therefore he chose to act in a way he otherwise would not have acted if it were not for the NPIs. He asks whether this endogenous response to NPIs affects the estimate of the NPIs' effect in the model.

Jim Stock praised the authors for their paper and then asked them to refine the assumptions being made on the endogeneity of responses to NPIs and even recommended fleshing out some sort of instrumentation in their further research beyond this study. Furthermore, he continued to raise concerns about whether the NPIs or endogenous behaviors were responsible for causing the decline in infection rates. Stock brought up how, at the Summer BPEA conference, Gupta, Simon, and Wing and Bartik and colleagues concluded that the endogenous responses were a major piece of the decline, while the two *Nature* papers discussed by Fogli simply excluded them.¹ Stock said that the exclusion of the endogenous response in the

1. Sumedha Gupta, Kosali Simon, and Coady Wing, "Mandated and Voluntary Social Distancing during the COVID-19 Epidemic," *Brookings Papers on Economic Activity*, Summer (2020), 269–315; Alexander W. Bartik, Marianne Bertrand, Feng Lin, Jesse Rothstein, and Matthew Unrath, "Measuring the Labor Market at the Onset of the COVID-19 Crisis," *Brookings Papers on Economic Activity*, Summer (2020): 239–68.

Nature papers led him to have less confidence in them compared to some of the more finely tuned papers seen at BPEA.

Mervyn King also reverted to Friedman's point and questioned how cross-country differences would help disentangle the endogeneity problem, pointing to Sweden as an example where the government did not mandate as many NPIs but households took a degree of caution. Furthermore, King noted the importance of Fogli's point on heterogeneity and brought up how the level of caution associated with events and actions varies across individuals and locations, so having only a single parameter could be potentially misleading.

Alexander Arnon then addressed the question on the symmetry of reopening. He mentioned the preliminary work the authors had done and discussed how difficult it is to match a given reopening event across different jurisdictions. He noted that, to the extent the authors can estimate, they do not expect it to be symmetrical.

Moving on to address Friedman's question, Arnon said that endogenous changes in behavior will be picked up as a response to NPIs and noted that there is a lack of enforcement of these NPIs across the country, so even though the policies were mandates that were required by law, they were viewed more as information advisories or as an aggressive information push by the government.

Kent Smetters mentioned that the model will allow for heterogeneity by location and that the paper will focus on the marginal effects of NPIs. Arnon then continued by mentioning that there are a number of studies that examine stay-at-home orders in the United States and that those studies' estimates are similar to the estimates arrived at by the authors.

SESSION TWO
***Epidemiology across Countries
and Labor Markets***

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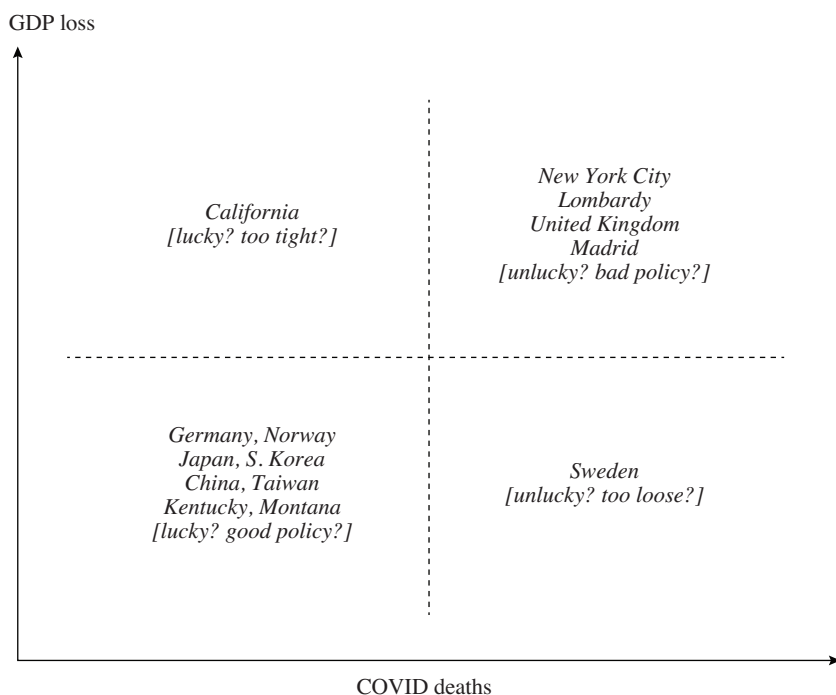
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Macroeconomic Outcomes and COVID-19: A Progress Report

ABSTRACT This paper combines data on GDP and unemployment and from Google's COVID-19 Community Mobility Reports with data on deaths from COVID-19 to study the macroeconomic outcomes of the pandemic. We present results from an international perspective using data at the country level as well as results for individual US states and key cities throughout the world. The data from these different levels of geographic aggregation offer a remarkably similar view of the pandemic despite the substantial heterogeneity in outcomes. Countries like South Korea, Japan, Germany, and Norway and cities such as Tokyo and Seoul have comparatively few deaths and low macroeconomic losses. At the other extreme, New York City, Lombardy, the United Kingdom, and Madrid have many deaths and large macroeconomic losses. There are fewer locations that seem to succeed on one dimension but suffer on the other, but these include California and Sweden. The variety of cases potentially offers useful policy lessons regarding how to use non-pharmaceutical interventions to support good economic and health outcomes.

This paper combines data on GDP and unemployment and from Google's COVID-19 Community Mobility Reports with data on deaths from COVID-19 to study the macroeconomic outcomes of the pandemic and suggest tentative policy lessons. We present results from an international perspective using data at the country level as well as results for individual US states and key cities throughout the world.

Conflict of Interest Disclosure: The authors did not receive financial support from any firm or person for this paper or from any firm or person with a financial or political interest in this paper. They are currently not an officer, director, or board member of any organization with an interest in this paper.

Figure 1. Summary of the Trade-Off Evidence

Source: Authors' construction.

The evidence to date can be summarized in a stylized way as shown in figure 1. On the horizontal axis is the number of deaths (per million population) from COVID-19. The vertical axis shows a cumulative measure of the macroeconomic losses apart from the value of the loss in life; for simplicity, here we call this the GDP loss. Throughout the paper, we will show data for various countries, US states, and global cities to fill in this graph quantitatively. We will also show the dynamics of how countries traverse this space over time. For now, though, we summarize in a stylized way our main findings.

One can divide the graph into four quadrants, based on many versus few deaths from COVID-19 and on large versus small losses in GDP. Our first significant finding is that there are communities in all four quadrants.

In the lower left corner of the diagram—the quadrant with the best outcomes—are Germany, Norway, China, Japan, South Korea, and Taiwan as well as US states such as Kentucky and Montana. Some combination of good luck and good policy means that these locations have experienced

comparatively few COVID-19 deaths as a fraction of their populations while simultaneously keeping economic activity losses relatively low.

In the upper right quadrant—the one with the worst outcomes—New York City, Lombardy, the United Kingdom, and Madrid are emblematic of places that have had comparatively high death rates and large macro-economic losses. Some combination of bad luck and policy mistakes is likely responsible for the poor performance on both dimensions. These locations were unlucky to be hit relatively early in the pandemic, perhaps by a strain of the virus that was more contagious than the one prevalent in other locations. Being hit early also meant that medical protocols at hospitals were less well developed and communities often did not take appropriate measures in nursing homes and care facilities to ensure that the most susceptible were adequately protected.

The other two quadrants of the chart stand out in interesting ways, having good performance on one dimension and poor performance on the other. Compared to New York City, Lombardy, Madrid, and the United Kingdom, Sweden and Stockholm had comparable death rates with much smaller losses in economic activity. But of course, that is not the only comparison. Relative to Norway and Germany, Sweden had many more deaths and comparable losses in economic activity. Relative to the worst outcomes in the upper right quadrant, Sweden is a success. But relative to what was possible—as illustrated by Germany and Norway—Sweden could have done better.

California, in the upper left quadrant opposite Sweden, also makes for a fruitful comparison. Relative to New York City, California had similarly large losses in economic activity, but far fewer deaths. At the start of the summer, both states had unemployment rates on the order of 15 percent. But New York City had 1,700 deaths per million residents, while California had just 300. From New York City's perspective, California looks enviable. On the other hand, California looks less successful when compared to Germany, Norway, Japan, and South Korea. These places had similarly low deaths but much smaller losses in economic activity. Once again, relative to what was possible—as illustrated by the best-performing places in the world—California could have done better.

One essential caveat in this analysis is that the pandemic continues. This chart and the graphs below may very well look quite different six months from September 2020. One of the most critical dimensions of luck is related to whether a location was hit early by the pandemic or had not yet been severely affected at the time of writing. Will a vaccine or cheap, widespread testing end the pandemic before these places are affected?

Still, with this caveat in mind, probably the most important lesson of the paper is that there are many observations that can be made based on the lower left quadrant of the graph: good outcomes on both the GDP and COVID-19 mortality are possible.

GOOD POLICY CAN SUPPORT BETTER OUTCOME We read our findings as suggestive (although not conclusive) evidence of the importance of good policies. Places like China, Germany, Japan, Norway, South Korea, and Taiwan are heterogeneous along various dimensions. The set includes large, dense cities such as Seoul and Tokyo. The set contains nations that were forewarned by experiences with SARS and MERS and countries like Germany and Norway that did not have this direct experience. There are places that were hit early, like China and South Korea, and places that were hit later, like Germany and Norway.

At the same time, our paper does not highlight precisely what these countries did to get these good outcomes. Such a task is next to impossible using aggregate data and requires the use of micro data analysis that exploits local variation (as in the many papers we cite below).

However, our findings suggest where to look for these more in-depth lessons. For example, China, Taiwan, and South Korea focused early on non-pharmaceutical interventions (NPIs) such as widespread use of masks, protection of the elderly, better indoor ventilation, limited indoor contact, and widespread testing and quarantine. In the case of Taiwan, Wang, Ng, and Brook (2020) report how the aggressive use of IT and big data supported the successful application of NPIs, a model copied to a large extent by China and South Korea.

Conversely, countries such as Spain and Italy, which suffered a harsh first wave but did not improve enough in terms of using analytics to track the epidemic, are again in a tight spot regarding number of cases, hospital occupancy, and deaths. As we move through the second wave of COVID-19 cases in the United States and Western Europe, the lessons regarding NPIs can improve both economic activity and death rate outcomes.

GOVERNMENT-MANDATED POLICY VERSUS SELF-PROTECTING BEHAVIOR By good policy, we do not just mean government-mandated actions but also all self-protecting voluntary changes in private behavior (perhaps induced by government information campaigns). Think about the case of the airline industry. Flight occupancy can fall because of government-imposed mandates such as international travel quarantines but also through the widespread voluntary cancellation of travel.

A growing consensus suggests that voluntary changes have played a crucial role. For instance, Arnon, Ricco, and Smetters (2020), using an

integrated epidemiological-econometric model and county-level data, argue that the bulk of reductions in US contact rates and employment came from voluntary changes in behavior. However, the authors show that government-mandated NPIs reduced COVID-19 deaths by 30 percent during the first three months of the pandemic.

Goolsbee and Syverson (2020) compare consumer behavior within the same commuting zones but across boundaries with different policy regimes to conclude that legal restrictions account only for 7 percentage points of the overall reduction of more than 60 percentage points in consumer traffic. Nonetheless, the authors document that NPIs shift consumer activity across different industries (e.g., from restaurants into groceries).

Equivalent results to Arnon, Ricco, and Smetters (2020) and Goolsbee and Syverson (2020) are reported by Gupta and others (2020) using smartphone data and by Forsythe and others (2020) using unemployment insurance claims and vacancy posting. Similar findings regarding the preponderance of voluntary changes in behavior are reported for Europe by Chen and others (2020), for South Korea by Aum, Lee, and Shin (2020), and for Japan by Watanabe and Yabu (2020).

At a more aggregate level, Atkeson, Kopecky, and Zha (2020), using a range of epidemiological models, highlight that a relatively small impact of government mandates is the only way to reconcile the observed data on the progression of COVID-19 across a wide cross-section of countries with quantitative theory.

Notice that even if most of the reduction in mobility comes from voluntary decisions, we might still be far from a social optimum as agents do not fully account for the contagion externalities they create. Importantly, government information surely plays a key role in shaping agents' beliefs about the state of the epidemic and therefore influences voluntary behavior.

LITERATURE REVIEW Over the last few months, a gigantic body of literature on COVID-19 and economics has appeared. It is beyond our scope to review such literature, which touches on multiple questions, from the design of optimal mitigation policies (Acemoglu and others 2020) to COVID-19's impact on gender equality (Alon and others 2020). Instead, we highlight three sets of papers that have explored the interaction between COVID-19, the policy responses to it, and economic outcomes.

The first set of papers has extended standard economic models to incorporate an epidemiological block. Among those, early efforts include Alvarez, Argente, and Lippi (2020), Eichenbaum, Rebelo, and Trabandt (2020), Glover and others (2020), and Farboodi, Jarosch, and Shimer (2020). In this tradition, the contributions of models with many different

sectors by Baqaee and Farhi (2020a, 2020b) and Baqaee and others (2020) are particularly interesting for the goal of merging micro data with aggregate outcomes and the design of optimal reopening policies. These models will also serve, in the future, as potential laboratories to measure the role of luck versus policy that we discussed above.

A second set of papers has attempted to measure the effects of lockdown policies. The results using Chinese data in Fang, Wang, and Yang (2020) indicate that early and aggressive lockdowns can have large effects in controlling the epidemic, and findings using German data (Mitze and others 2020) and Canadian data (Karaivanov and others 2020) point to the effectiveness of face masks in slowing contagion growth. Amuedo-Dorantes, Kaushal, and Muchow (2020) study US county-level data to argue that NPIs have a significant impact on mortality and infections.

A subset of these papers has dealt with Sweden, a country that implemented a much more lenient lockdown policy than its northern European neighbors. Among the papers that offer a more favorable assessment of the Swedish experience, Juranek and others (2020) have gathered administrative data on weekly new unemployment and furlough spells from all fifty-six regions of Sweden, Denmark, Finland, and Norway. Using an event-study difference-in-differences design, the authors conclude that Sweden's lighter approach to lockdowns saved between 9,000 and 32,000 seasonally and regionally adjusted cumulative unemployment/furlough spells per million population by week 21 of the pandemic. If we compare, for example, Sweden with Norway, these numbers suggest a crude trade-off (without controlling for any other variable) of around sixty-one jobs lost per life saved.¹ On the negative side, Born, Dietrich, and Müller (2020) and Cho (2020), using a synthetic control approach, find that stricter lockdown measures would have been associated with lower excess mortality in Sweden by between a quarter and a third.

The third set of papers has studied how to monitor the economy in real time (Cajner and others 2020; Stock 2020), how the sectoral composition of each country matters for the reported output and employment losses (Gottlieb and others 2020), and the impact of concrete policy measures. Among the latter, Chetty and others (2020) argue that stimulating aggregate demand or providing liquidity to businesses might have limited effects when the main constraint is the unwillingness of households to consume

1. Among many other elements, this computation does not control for the possibility that Sweden, by getting closer to herd immunity, might have saved future deaths or, conversely, that higher death rates today might have long-run scarring effects on the Swedish GDP and labor market.

due to health risks and that social insurance programs can be a superior mitigation tool. Goldberg and Reed (2020) extend the analysis of current economic conditions related to COVID-19 to emerging market and developing economies.

STRUCTURE OF THE PAPER In the remainder of the paper, we present the detailed evidence that underlies this stylized summary. Section I lays out a basic framework for thinking about figure 1. Section II presents evidence for countries using data on GDP from the first and second quarters of 2020 to measure the macroeconomic outcomes. It also shows evidence for US states, using monthly unemployment rates. Section III then turns to a complementary source of data on economic activity, the Google COVID-19 Community Mobility Reports.² We show that these economic activity measures are highly correlated with GDP and unemployment rates. The Google measures have additional advantages, however. In particular, they are available for a large number of locations at varying geographic levels of aggregation and are reported at the daily frequency and with a lag of only just a few days, an important feature given the natural lags in National Income and Product Accounts (NIPA) reporting. We reproduce our earlier findings using the Google data and produce new charts for key cities worldwide. The city-level data are important because of concerns about aggregating to, say, the national level across regions of varying densities. Section IV shows the dynamic version of our graphs at the monthly frequency using the Google data, so we can see how different locations are evolving. Finally, section V offers some closing thoughts.

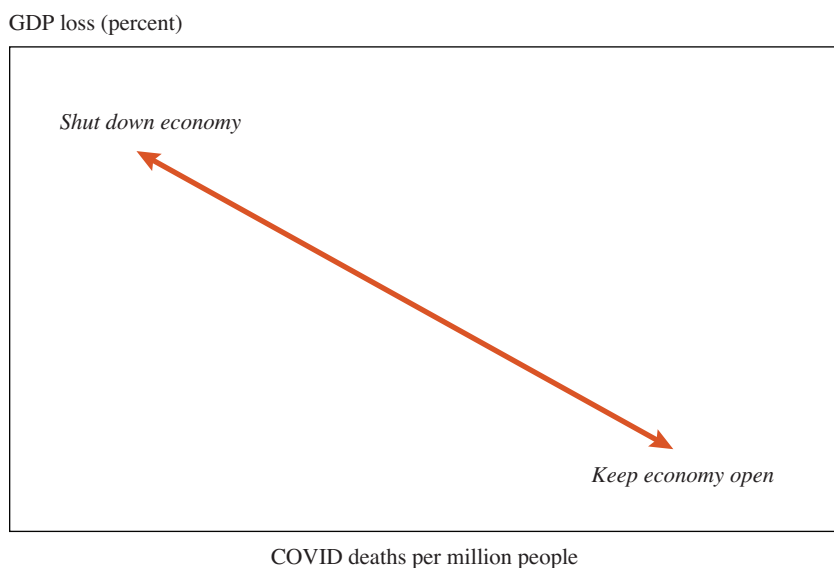
I. Framework

We focus on two outcomes in this paper: the loss in economic activity, as captured by reduced GDP or increased unemployment, and the number of deaths from COVID-19 per million people.³ Even with just these simple outcome measures, it is easy to illustrate the subtle interactions that occur in the pandemic.

To begin, figure 2 illustrates a simple trade-off between economic activity and deaths from the pandemic. In the short term, economic policy can shut the economy down sharply, which increases the economic losses

2. Google COVID-19 Community Mobility Reports, accessed October 9, 2020, <https://www.google.com/covid19/mobility/>.

3. There is a growing concern about the long-run health consequences for individuals who survived a COVID-19 infection. However, it is too early for any systematic international comparison of those long-run effects.

Figure 2. Economic Policy Trade-Off, Holding Health Policy and Luck Constant

Source: Authors' construction.

Note: Holding health policy and luck constant, economic policy implies a trade-off between economic activity and deaths from COVID-19.

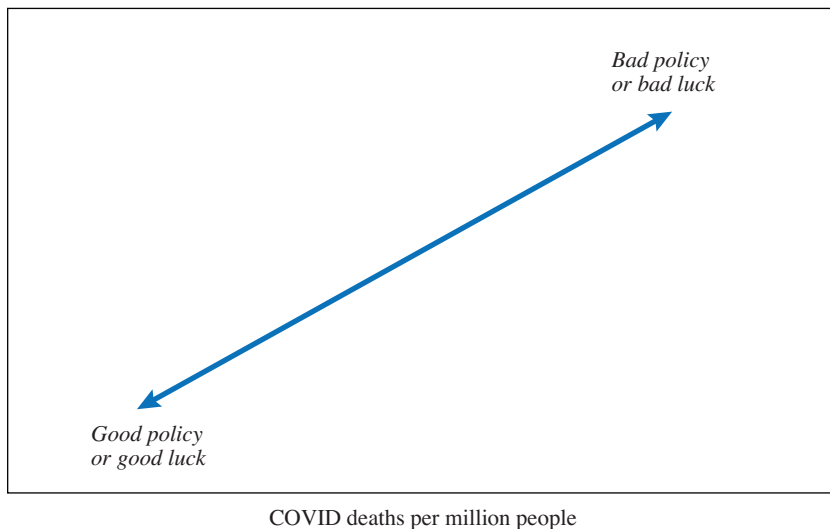
on the vertical axis but saves lives on the horizontal axis. Alternatively, policy could focus on keeping the economy active to minimize the loss in GDP at the expense of more deaths from the pandemic.

Figure 3 shows that the story is more complicated when health policy and luck are brought under consideration. There can be a positive correlation between economic losses and COVID-19 deaths. Good NPIs—for example, widespread use of masks, better indoor ventilation, protecting nursing homes, and targeted reductions in super-spreader events such as choirs, bars, nightclubs, and parties—can reduce the number of deaths with a limited impact on production. Furthermore, by reducing the death rate, such policies encourage economic activity by allowing people to return safely to work and the marketplace.

Similarly, luck plays an important but not yet fully understood role. Where does the coronavirus strike early versus late? Perhaps a country is in the lower-left corner in September 2020 with low deaths and little loss in GDP, but only because it has been lucky to avoid a severe outbreak. By early 2021, things may look different. Alternatively, was a region hit by a less infectious and deadly virus strain (see our next subsection)?

Figure 3. Health Policy Decisions and Luck Can Shift the Trade-Off

GDP loss (percent)



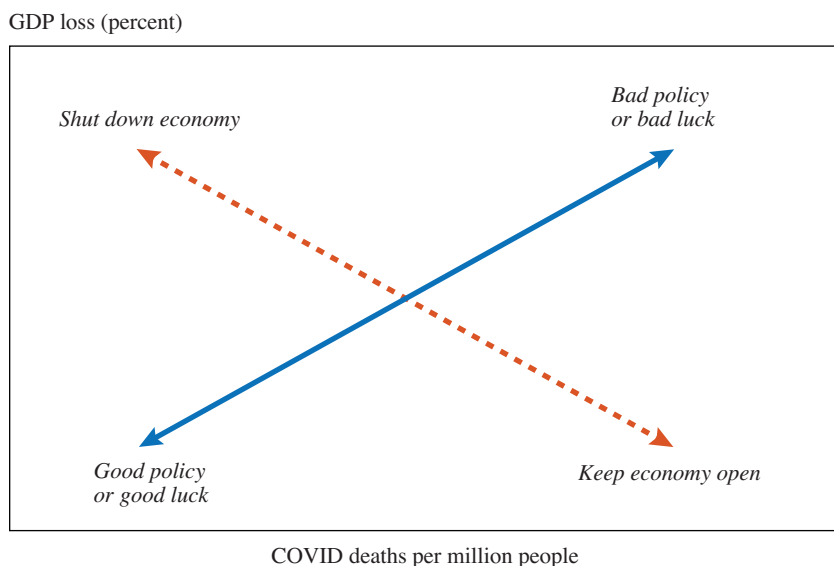
Source: Authors' construction.

Note: Health policy and luck can shift the trade-off between economic activity and deaths from COVID-19.

Given the steep age pattern of COVID-19 mortality rates, basic demographic differences influence the trade-off between deaths and GDP losses. This is another dimension of what we can call luck. COVID-19 has a steep age and obesity gradient. Younger and less-obese countries, many of them emerging market and developing economies, have experienced much better outcomes than one would have expected (Goldberg and Reed 2020).

To complicate matters, all of these forces play out over time, which gives rise to important dynamic considerations. For example, a community may keep the economy open in the short term, which may lead to a wave of deaths, and then be compelled to shut the economy down to prevent even more deaths. Two communities can end up with large economic losses, but very different mortality outcomes, because of these timing considerations. This can be thought of as being embodied in figure 3.

Figure 4 puts these mechanisms together in a single chart. It reveals that the correlation between economic losses and COVID-19 deaths that we see in the data is governed by a sophisticated collection of forces, both static and dynamic. When we see a cloud of data points in the empirical versions of this graph, we can think about how these various forces are playing out.

Figure 4. Economic Activity, COVID-19 Deaths, Health Policy, and Luck

Source: Authors' construction.

Note: Putting the two lines on the same chart explains why the data can be difficult to interpret.

1.A. Evidence on the Role of Mutation

We have mentioned that a simple mechanism behind luck is the strain of the virus that attacked a given location. From March to May 2020, a SARS-CoV-2 variant carrying the spike protein G614 which likely appeared in some moment in February replaced D614 as the dominant form of the virus globally (Korber and others 2020).

While the global transition to the G614 variant is a well-established fact, its practical consequences are still debated. Korber and others (2020) present experimental evidence that the G614 variant is associated with greater infectivity and clinical evidence that the new variant is linked with higher viral loads, although not with greater disease severity. Hu and others (2020), Ozono and others (2020), and Zhang and others (2020) report similar findings. However, these latter results regarding greater infectivity and higher viral load are not yet the consensus among scientists (Grubaugh, Hanage, and Rasmussen 2020).

In other words, there is some evidence—although far from conclusive—that the pandemic's timing may have played a role in determining the quadrant where each location falls in figure 1. If indeed the original D614

variant is less infectious, Asian countries (who were exposed more to this earlier form of the virus) faced a more straightforward trade-off between containing the epidemic and sustaining economic activity. Even within the United States, California, likely due to its closer ties to Asia, experienced a higher prevalence of lineages of D614 at the start of the health crisis than New York City, closer to Europe, and thus it had better initial outcomes regardless of the policies adopted.

II. Cumulative Deaths and Cumulative Economic Loss

This section shows the empirical versions of the trade-off graphs for various countries and US states using GDP and unemployment as measures of the economic outcomes.

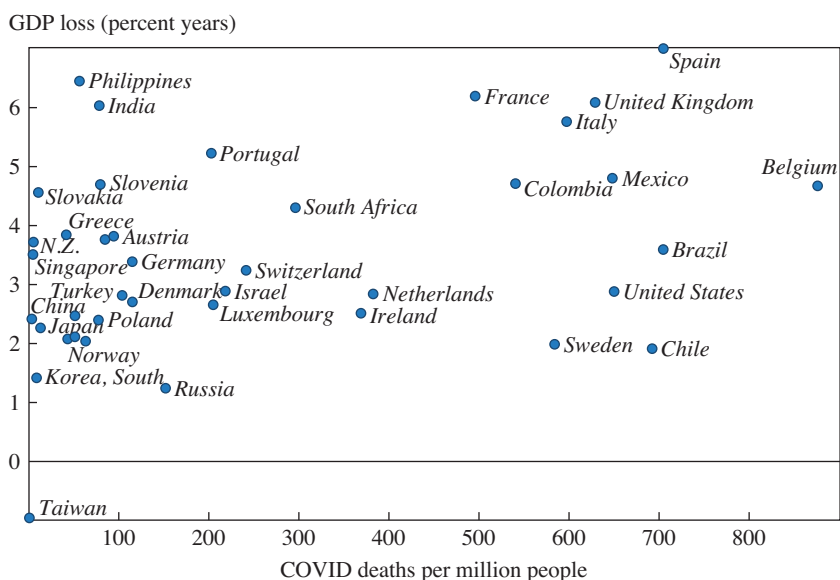
II.A. International Evidence

We use GDP data from the OECD and death data from Johns Hopkins University Center for Systems Science and Engineering (CSSE) to study the international evidence on COVID-19 deaths and GDP.⁴ Figure 5 plots the COVID-19 deaths per million population as of October 9 against the loss in GDP. GDP loss is the cumulative loss in GDP since the start of 2020 (data from Q1 and Q2) and is annualized. For example, a value of 6 means that the loss since the start of 2020 is equivalent to a 6 percent loss in annual GDP.

Before discussing our findings, some warnings are appropriate. First, we only have observations up to 2020:Q2. Second, the numbers released so far are likely to be revised substantially. Even in normal times, the revisions of GDP early releases are considerable (Aruoba 2008). The difficulties in data collection during the pandemic suggest that the revisions for 2020 are bound to be even larger.⁵ Third, GDP is only an imperfect measure of

4. OECD, Quarterly GDP, accessed October 1, 2020, <https://data.oecd.org/gdp/quarterly-gdp.htm>; Johns Hopkins University Center for Systems Science and Engineering, “2019 Novel Coronavirus COVID-19 (2019-nCoV) Data Repository,” accessed October 9, 2020, <https://github.com/CSSEGISandData/COVID-19/>.

5. Recall, for example, the note on the Coronavirus (COVID-19) Impact on June 2020 Establishment and Household Survey Data: “The collection rate for the establishment survey in June was 63 percent. This is lower than the average for the 12 months ending in February 2020, before data collection was impacted by the pandemic, and lower than May (69 percent). This rate was also lower than that for June 2019 (71 percent).” <https://www.bls.gov/cps/employment-situation-covid19-faq-june-2020.pdf>. A similar issue relates to the state unemployment rates that we will use later. These rates are a combination of survey measurement on small state-level samples and a pooled time series model run by the Bureau of Labor Statistics. During the last months, we have seen large revisions in these rates.

Figure 5. International COVID-19 Deaths and Lost GDP

Sources: Johns Hopkins University CSSE, OECD, and authors' calculations.

Note: "GDP loss" is the cumulative loss in GDP in the first two quarters of 2020 and is annualized. For example, a value of 6 means that the loss is as if the economy lost 6 percent of its annual GDP.

economic activity. There are reasons to believe that those imperfections are even more acute in 2020.

For instance, consider government consumption. This item is measured by the sum of employee compensation, consumption of fixed capital, and intermediate goods and services purchased. Many government services, from the local DMV to public schools, were not offered (or only offered under a very limited schedule) during the lockdowns. However, most government employees were still paid (furloughs were rare in OECD countries), and the consumption of fixed capital is imputed according to fixed depreciation tables. Thus, except for some reduction of intermediate goods and services purchased, government consumption remained unchanged from the perspective of GDP. Indeed, in the United States, real government consumption increased .6 percent in 2020:Q2 with respect to 2020:Q1 while GDP dropped 9.0 percent. While part of the increase can be attributed to the fiscal stimulus and the fight against COVID-19, a substantial part of government consumption operated well below normal levels during that quarter with little impact on measured GDP.

With these considerations in mind, figure 5 suggests that there has not been a simple trade-off between deaths and GDP. Rather, countries can be seen to fall into several groups.

First, we have countries with low deaths and moderate GDP losses: Taiwan (with positive GDP growth!), South Korea, Indonesia, Norway, Japan, China, and Germany. Such countries illustrate an important lesson from the crisis: it was possible to emerge with relatively good performance on both dimensions. Importantly, this group is heterogeneous. It includes countries in both Asia and Europe. It includes countries with large, densely populated cities. And it includes countries that are globally highly connected to the rest of the world, including Germany and China, the two major export powerhouses of the world economy. Other countries nearby in the diagram include Poland, Greece, and Estonia.

Presumably, both good policy and good luck play important roles here. For example, Greece, a dense country with a poor track record in terms of economic governance and a public health system starved of resources after a decade of budget cuts, has performed so far surprisingly well. Greece's government approved restrictive measures when the number of cases was minimal and directed a well-coordinated health strategy. At the same time, Greece is less well connected with the rest of the European Union and has a fragmented geography, which has slowed down the virus's spread. Uncovering the explanation for Greece's success could yield important lessons.

Next, in the graph's upper-right part, we have countries with high death rates and large GDP losses: France, Spain, Italy, the United Kingdom, and Belgium. Some combination of bad luck and imperfect policy led these countries to suffer on both dimensions during the pandemic. The United Kingdom, as an example, suffered from more than 600 deaths per million people and lost the equivalent of 6 percent of a year's GDP. Also, high COVID-19 incidence might trigger nonlinear effects on mortality. There is evidence that the Italian and Spanish health systems were overwhelmed in March 2020, leading to many deaths that could have been avoided. Ciminelli and Garcia-Mandicó (2020) show that mortality in those Italian municipalities that were far from an ICU was up to 50 percent higher, which they argue was due to the congestion of the emergency care system during those crucial weeks.

A few countries in figure 5 are harder to classify. India and the Philippines have experienced a considerable reduction in GDP but comparatively few deaths per million people. As we will see later, however, the situation in India is still evolving. The United States and Sweden also stand out, with

many COVID-19 deaths but smaller reductions in GDP than France, Italy, or Spain. As with India, however, the dynamic graphs we show later suggest that the position of the United States is still in flux.

The case of Sweden is particularly interesting because its government defied the consensus among other advanced economies and imposed much milder restrictions, explicitly aiming for herd immunity. Compared to the United Kingdom, Spain, or Italy, Sweden looks like a success story: it has a comparable number of deaths when normalized by population, but a significantly smaller loss in GDP. The shutdown in the United Kingdom, Spain, and Italy has already cost these economies the equivalent of 6 percent of their annual GDP, while the loss in Sweden has been just 2 percent of GDP.

On the other hand, with an alternative comparison, Sweden looks worse. In terms of deaths, Sweden has had around 575 deaths per million population vs. 50 in Norway, 60 in Finland, 115 in Denmark, and 115 in Germany. The other Nordic countries are a natural comparison group in terms of socioeconomic conditions, although differences in population distribution and mobility within this group should not be underestimated. Regarding economic outcomes, Norway and Sweden both report GDP losses of around 2 percent, while Denmark, Germany, and Austria are only slightly larger.

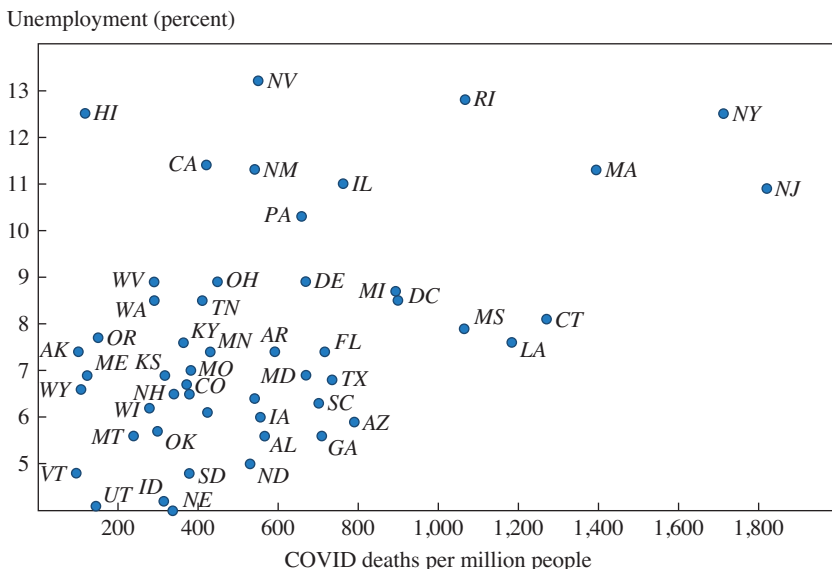
In the case of the United States, the current high levels of infection and deaths mean that the country is still moving to the right in figure 5. The rise in cases in Western Europe in August and September 2020 is at such an early stage that it is impossible to gauge whether these countries will also witness significant levels of additional deaths.

Finally, notice that figure 5 correlates COVID-19 deaths and GDP losses without controlling for additional variables (initial income per capita, industrial sectoral composition, density, demographics, etc.). We checked for the effects of possible controls, and we did not find any systematic pattern worth reporting.

II.B. US States and Unemployment

We now consider economic outcomes and deaths from COVID-19 across US states. In this case, our measure of economic activity is the unemployment rate. Figure 6 shows the unemployment rate for US states from August 2020 plotted against the number of deaths per million people as of October 9.

The heterogeneity in both the unemployment rate and in COVID-19 deaths is remarkable. States like New York, Massachusetts, and New Jersey have more than 1,200 deaths per million residents as well as unemployment

Figure 6. US States: COVID-19 Deaths and the Unemployment Rate

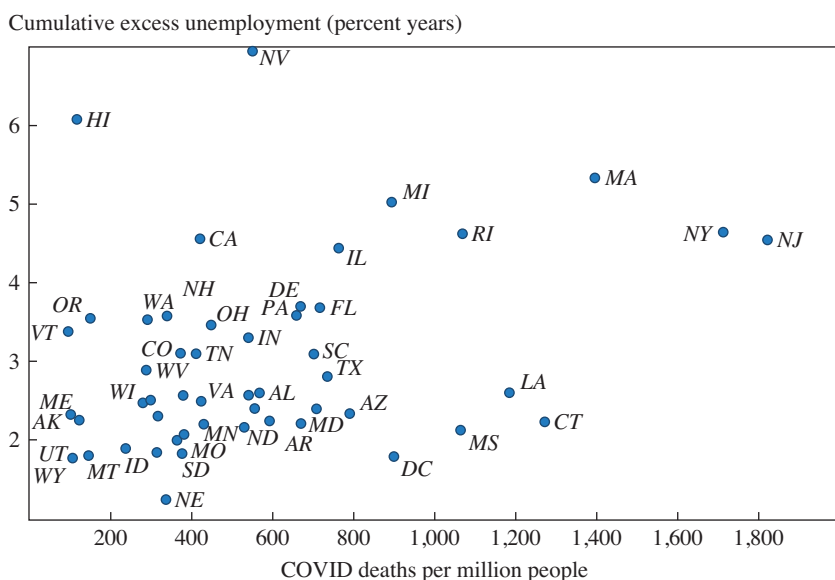
Sources: Johns Hopkins University CSSE, Bureau of Labor Statistics, and authors' calculations.

Note: The unemployment rate is from August 2020.

rates that, even after several months of recovery, exceed 10 percent. In contrast, states like Utah, Idaho, Montana, and Wyoming have very few deaths and unemployment rates between 4 and 7 percent.

Figure 7 cumulates the unemployment losses since February to create a more informative measure of the macroeconomic cost of the pandemic. In particular, we measure cumulative excess unemployment by summing the deviations from each state's February 2020 rate for each month and then dividing by twelve to annualize. In other words, a number like 6 in the graph implies that the loss to date is equivalent to having the unemployment rate be elevated by 6 percentage points for an entire year.

In this figure, it is interesting to compare New York, California, and Washington, DC. Both New York and California have had large declines in economic activity, the equivalent of having the unemployment rate be elevated by about 5 percentage points for an entire year. However, the number of deaths is very different in these two states. New York had around 1,700 deaths per million people, while California had around 400 as of October 9. What combination of luck and policy explains this outcome? Both states got hit relatively early by the coronavirus. Was California lucky

Figure 7. US States: COVID-19 Deaths and Cumulative Excess Unemployment

Sources: Johns Hopkins University CSSE, Bureau of Labor Statistics, and authors' calculations.

Note: Cumulative excess unemployment adds the deviations from each state's February 2020 rate for each month and then divides by 12 to annualize. In other words the loss to date is equivalent to having the unemployment rate be higher by a certain percentage for an entire year.

to get a strain from Asia that was less contagious and less deadly while New York got a strain from Europe that was more contagious and more deadly? Or did the policy differences between New York and California have enormous effects?

When compared to New York, California looks like a resounding success. On the other hand, one can also compare California to states like Washington and Minnesota, not to mention Montana and Nebraska. All of these other states had similar death rates but smaller employment losses. Did California shut down too much? Or were Nebraska and Minnesota lucky? Or did population density play an important role?

Finally, Washington, DC, stands out as a locale with relatively small employment losses—equivalent to an unemployment rate that is elevated by just 2 percentage points for a year—but substantial deaths. Washington, DC, looks somewhat like Sweden in this graph, but when we turn to the Google activity data below, the story will be a bit different: the prevalence of government jobs with stable employment may have limited the rise in the DC unemployment rate.

II.C. International Comparisons of Unemployment

Given our previous analysis, it would seem natural to compare the evolution of unemployment rates among the advanced economies. However, such a comparison is not especially informative in gauging the effects of COVID-19.

Many countries have passed generous government programs to induce firms to keep workers on the payroll even during lockdowns, count workers on furloughs with reduced pay as being employed, or classify workers who lost their jobs as out of the labor force if they are not searching for a new job due to the stay-at-home orders. Furthermore, severance costs make firing workers after a relatively transitory shock unattractive: firms might end up paying more in severance packages than the cost of just keeping their workers at home with pay for a few months. That means that the measured unemployment rate in some of the most severely hit countries has only increased by a few percentage points (from 13.6 percent in February 2020 to 15.6 percent in June 2020 in Spain) or even fallen (from 9.1 percent in February 2020 to 8.8 percent in June 2020 in Italy).⁶

The main exception is the United States, which features substantially different labor market regulations: unemployment jumped from 4.4 percent in March 2020 to 14.8 percent in April 2020 but then declined to 7.8 percent in September 2020.

III. Activity from the Google Mobility Report Data

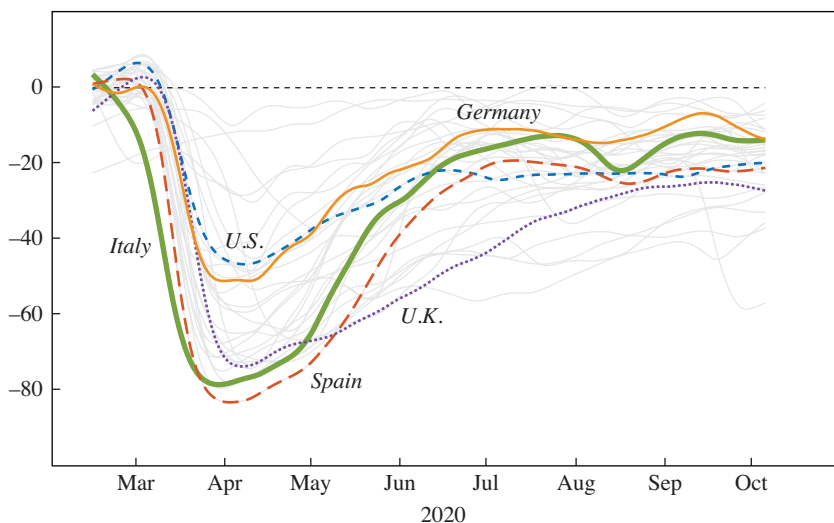
GDP and unemployment rates are standard macroeconomic indicators that are extremely useful. However, they also suffer from some limitations related to frequency and availability. In this section, we turn to another source of evidence: the COVID-19 Community Mobility Report data from Google for 2020. For shorthand, we will refer to this as the Google activity measure. These data show how daily location activity changes over time in a large number of countries and regions. The outcomes are grouped according to several destinations: retail and recreation, grocery and pharmacy, parks, transit stations, workplaces, and residences.

The Google activity measure has several key advantages relative to GDP or unemployment. First, it is available at a daily frequency, rather than quarterly or monthly. Second, it is reported with a very short lag of just a

6. Similar arguments would apply to a comparison of employment rates. The number of hours worked is reported by the OECD only at an annual frequency.

Figure 8. Google Activity: International Evidence

Percent change relative to baseline



Sources: Google COVID-19 Community Mobility Reports and authors' calculations.

Note: Google activity is the equally weighted average of the retail and entertainment and workplace categories. The data are smoothed with an HP filter with smoothing parameter 400.

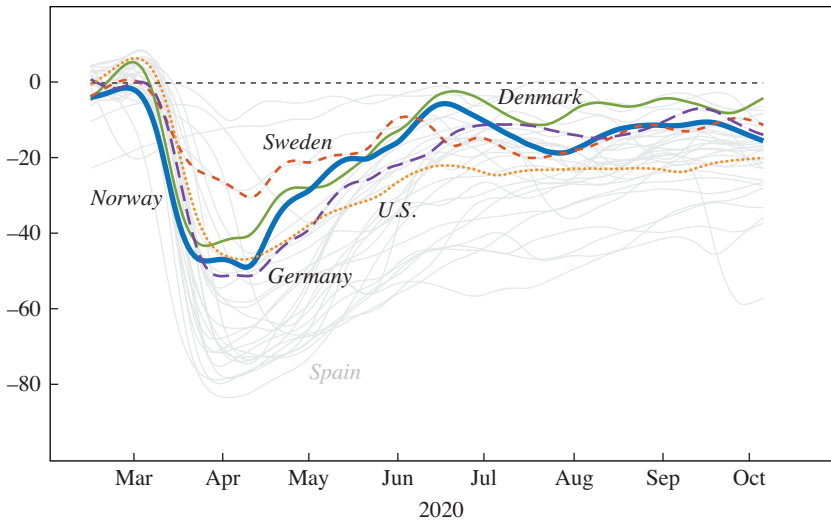
few days. By comparison, we only have 2020:Q2 GDP data for a handful of countries, and our latest unemployment rate data for US states are from September 2020. Finally, the Google data are also available at a very disaggregated geographic level, allowing us to look at cities as well as states and countries. In what follows, we focus on Google activity, defined as the equally weighted average of the retail and entertainment and workplace categories.

III.A. Google Activity over Time

Figure 8 shows the (smoothed) Google activity data over time for a large number of countries, highlighting a few. Italy and Spain show very sharp declines in activity starting quite early compared to the declines in the United States, the United Kingdom, and Germany. Activity recovers somewhat in May in Italy and Spain but only gradually in the United Kingdom. This appears to be a case of the United Kingdom being slow to get the pandemic under control, suffering from more deaths as a result, and being forced to keep its economy shut down for longer.

Figure 9. Google Activity: Northern Europe

Percent change relative to baseline



Sources: Google COVID-19 Community Mobility Reports and authors' calculations.

Note: Google activity is the equally weighted average of the retail and entertainment and workplace categories. The data are smoothed with an HP filter with smoothing parameter 400.

The United States and Germany are also interesting, in comparison. They have somewhat similar changes in activity but, as we've seen, very different COVID-19 outcomes. Among the highlighted countries, Germany had the smallest loss in economic activity and the fewest deaths.

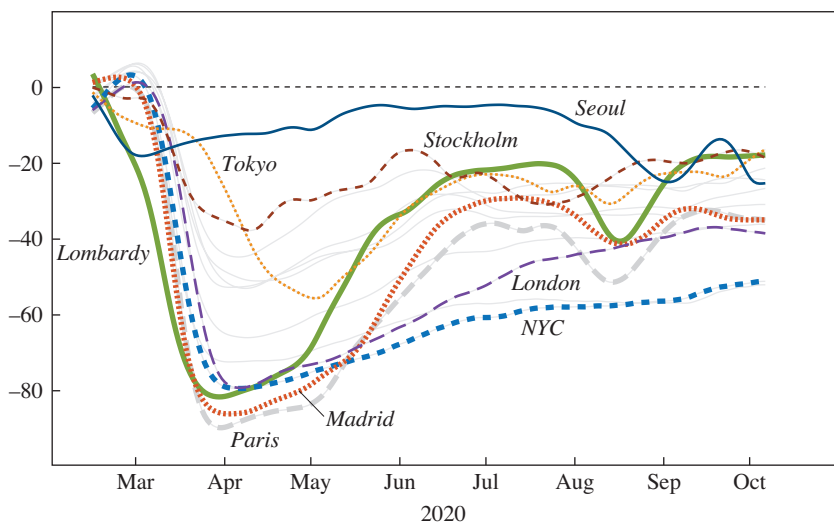
Next, consider figure 9 which highlights the Scandinavian countries. These countries have even milder shutdowns than Germany and the United States. Sweden's shutdown is initially the mildest but by June it looks similar to Germany, Denmark, and Norway.

GLOBAL CITIES Figure 10 shows the Google activity measure for fourteen key international cities or regions. Lombardy and Seoul have very early shutdowns with 20 percent declines in activity by the first of March. Madrid and Paris and then New York City and finally London follow them down, with all four seeing activity down by around 80 percent as of April 1. Seoul recovers very quickly, while Tokyo sees a slow decline. Stockholm also has mild losses according to the Google activity measure.

US STATES Figure 11 shows the Google activity data for US states. The heterogeneity of experience stands out, with some states close to normal by

Figure 10. Google Activity for Key Global Cities

Percent change relative to baseline

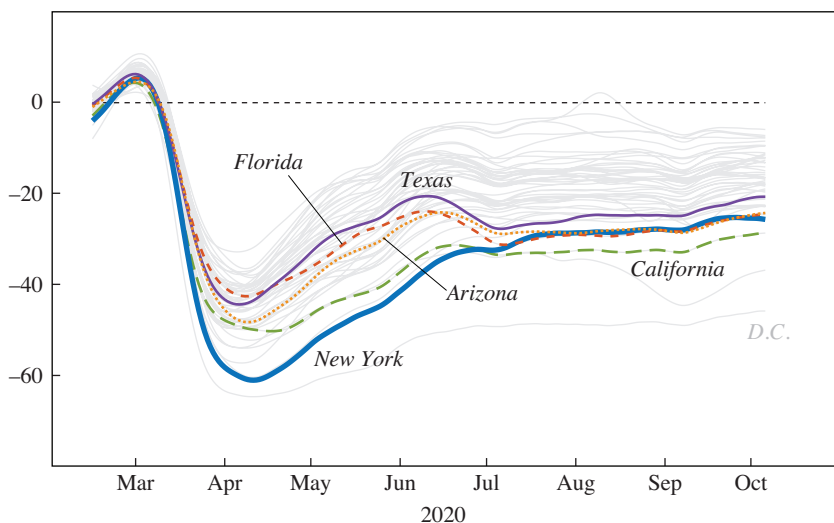


Sources: Google COVID-19 Community Mobility Reports and authors' calculations.

Note: Google activity is the equally weighted average of the retail and entertainment and workplace categories. The data are smoothed with an HP filter with smoothing parameter 400.

Figure 11. Google Activity for Key US States

Percent change relative to baseline

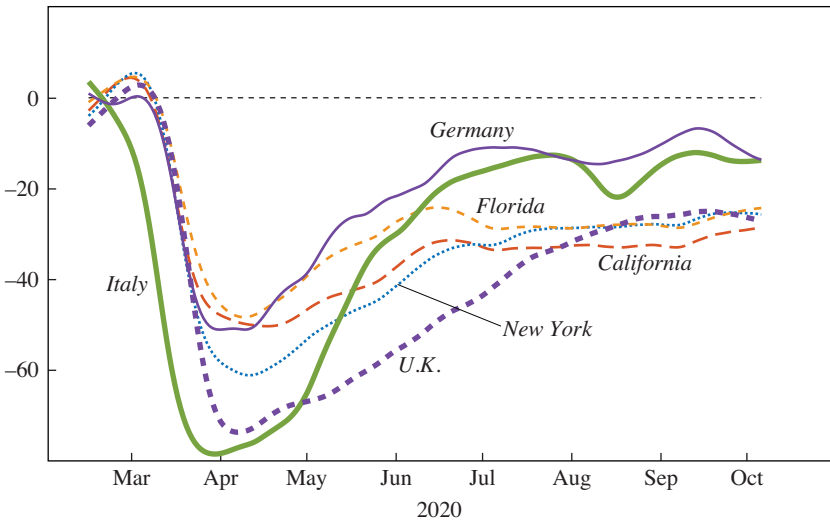


Sources: Google COVID-19 Community Mobility Reports and authors' calculations.

Note: Google activity is the equally weighted average of the retail and entertainment and workplace categories. The data are smoothed with an HP filter with smoothing parameter 400.

Figure 12. Google Activity for Key US States and Countries

Percent change relative to baseline

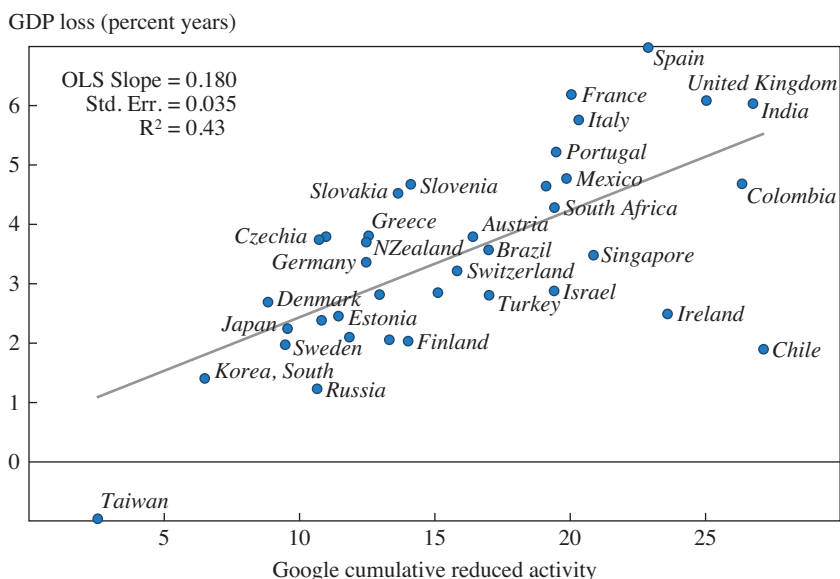


Sources: Google COVID-19 Community Mobility Reports and authors' calculations.

Note: Google activity is the equally weighted average of the retail and entertainment and workplace categories. The data are smoothed with an HP filter with smoothing parameter 400.

the summer while others remain 30 to 40 percent below baseline. Interestingly, Washington, DC, stands out: it has the largest decline of any state at virtually all dates, with activity more than 50 percent below baseline throughout the summer. Recall the contrast with the unemployment data shown earlier in figures 6 and 7. As the nation's capital, Washington, DC, is a special place: a large fraction of jobs are in the government sector and so therefore experienced small declines, while many employees are highly mobile, both nationally and internationally, resulting in large losses in Google activity.

Finally, figure 12 combines some of the key states and countries into a single graph for ease of comparison. The declines in Google activity in Italy and the United Kingdom are substantially larger than the declines in New York State and California, while Germany stands out as having even milder declines in activity than Florida. While the United Kingdom was slower than Italy (and slower than Spain and Germany—see figure 8) to shut down, it was as fast as New York and contracted economic activity more severely. New York had much worse outcomes in terms of deaths (1,700 versus 600), and this is true even if we compare New York City (2,800) versus London (650).

Figure 13. Cumulative Google Activity and Lost GDP

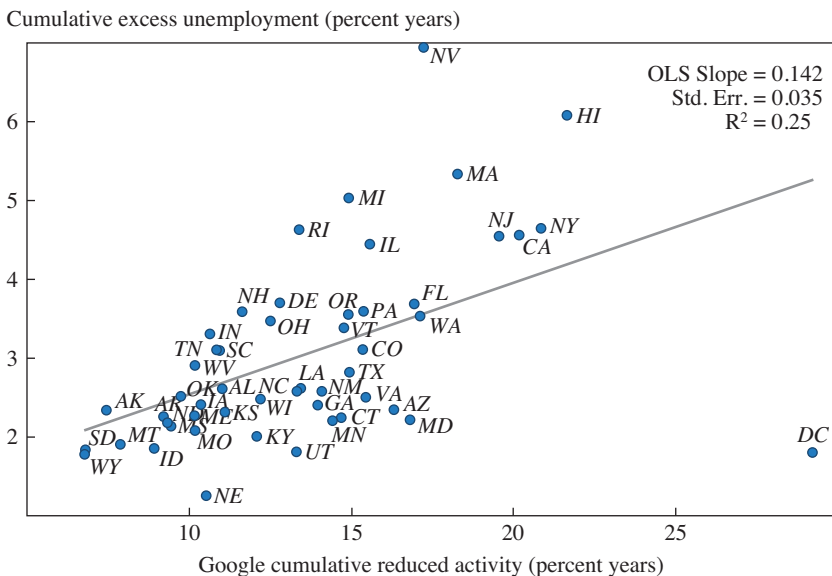
Sources: OECD, Google COVID-19 Community Mobility Reports, and authors' calculations.

Note: "GDP loss" reports the cumulative loss in GDP since the start of 2020 as a percentage of annual GDP. "Google cumulative reduced activity" measures the total amount of lost Google activity at an annual rate. The correlation in the graph is .65.

III.B. Correlating Economic Activity and Google Mobility

Before showing the trade-off graphs with the Google activity measure, we first demonstrate that this measure is correlated with the GDP loss and cumulative excess unemployment. The correlation with the GDP loss is shown in figure 13. Here and in what follows, we add up the areas in the Google activity graphs shown above to get a cumulative loss in Google activity. In particular, Google cumulative reduced activity measures the total amount of lost Google activity at an annual rate. A value of 20 indicates that, relative to baseline, it is as if activity at retail, entertainment, and workplace locations was reduced by 20 percent for an entire year. For example, a 40 percent reduction in activity each month for six months would deliver this value.

Figure 13 illustrates that the Google activity measure is a useful proxy for economic activity. The correlation between the loss in GDP and the cumulative reduction in activity is .65 (the square root of .43).

Figure 14. Cumulative Google Activity and Cumulative Excess Unemployment

Sources: Google COVID-19 Community Mobility Reports, Bureau of Labor Statistics, and authors' calculations.

Note: The correlation is 0.50; it rises to 0.69 if Washington, DC, is dropped.

Figure 14 shows this same kind of evidence for US states, only this time for cumulative excess unemployment. The correlation with Google activity is .50 if Washington, DC, is included, but the District of Columbia is an outlier, as has already been mentioned; the correlation rises to .69 if this outlier is dropped.

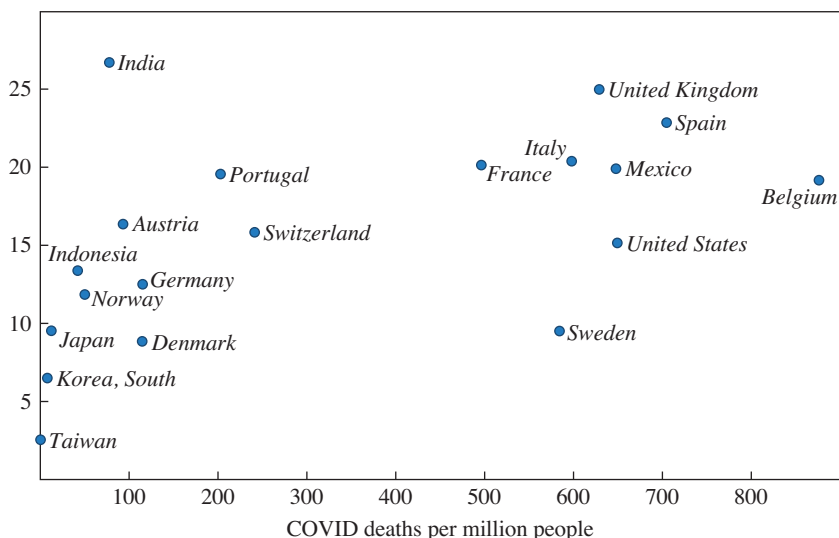
III.C. Cumulative Results

COUNTRIES Figure 15 shows the cumulative lost activity according to the Google mobility data as of October 9. The first thing to appreciate is that the graph looks very similar to the GDP loss graph in figure 5. This is of course just another way of saying that the GDP data and Google data are highly correlated.

The key takeaways from this figure are therefore also similar. Belgium, the United Kingdom, Spain, and Italy have both very high deaths and very large losses in macroeconomic activity. Taiwan, South Korea, and Japan, as well as Denmark, Norway, and Germany are in the lower left of the graph,

Figure 15. COVID-19 Deaths (Latest) and Cumulative Google Activity (September)

Cumulative reduced activity (percent years)



Sources: Google COVID-19 Community Mobility Reports, Johns Hopkins University CSSE, and authors' calculations.

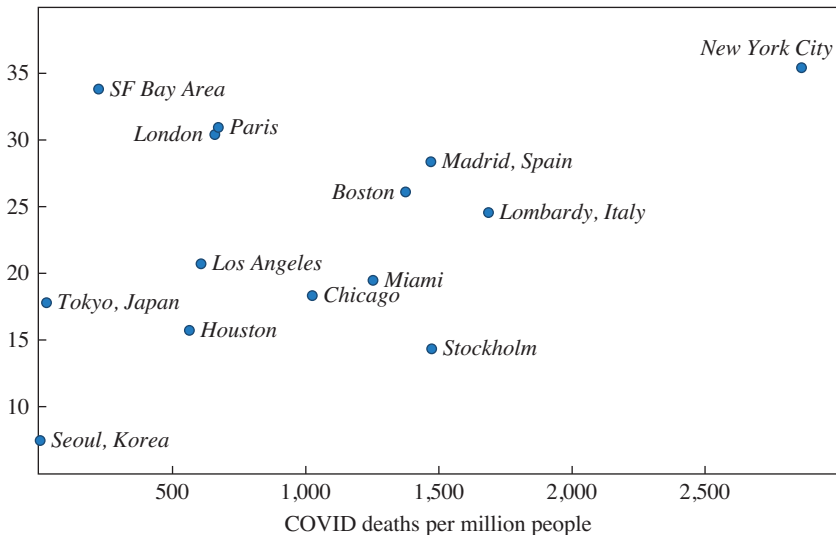
Note: Google activity is the equally weighted average of the retail and entertainment and workplace categories. "Cumulative" refers to the fact that we add up the losses for every month between February and September 2020.

with good performance on both dimensions. Sweden stands out. It looks successful compared to countries like the United Kingdom, Spain, and Italy, with similar deaths but much smaller losses in GDP. On the other hand, compared to Norway and Germany, Sweden looks much less successful, with similar losses in economic activity but far more deaths. The United States is a similar case in that it has fewer deaths and smaller losses in economic activity than the United Kingdom, Spain, and Italy, but it looks much worse than Norway and Germany. India stands out in the upper left quadrant of the graph, having large losses in economic activity with comparatively few deaths. The United States and India have the additional disadvantage that their situations were still rapidly evolving at the time of writing.

CITIES Figure 16 shows one of the advantages of the Google data by disaggregating to the city level for a collection of key cities around the world. Broadly speaking, we see the same types of outcomes for cities that we saw for countries and states using macroeconomic data. New York City has by far the highest death rate in the world at around 2,800 per million people.

Figure 16. Global Cities: COVID-19 Deaths and Cumulative Google Activity

Cumulative reduced activity (percent years)



Sources: Google COVID-19 Community Mobility Reports, Johns Hopkins University CSSE, and authors' calculations.

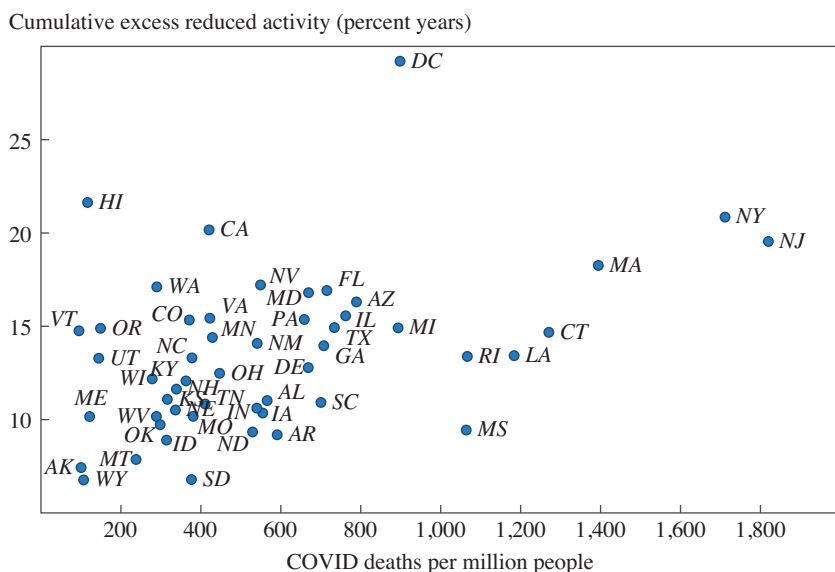
Interestingly, it also has the largest cumulative economic loss, equivalent to around 35 percent of a year's activity.

The economic loss is only slightly larger than losses in other cities such as London, Paris, and San Francisco. These cities have far fewer deaths than New York City, however, at around 650 per million for London and Paris and just 220 for the San Francisco Bay Area.

Madrid, Boston, and Lombardy stand out the way Spain and Italy did before, with a high death rate and large economic losses. In contrast, Seoul and Tokyo are much like South Korea and Japan. Stockholm also is positioned about the same as Sweden.

Finally, cities such as Los Angeles and Houston lie in the middle, with deaths somewhat similar to Paris and London, but with noticeably less cumulative loss in economic activity.

US STATES Figure 17 shows the Google activity data and deaths for US states. Apart from Washington, DC—where the large decline in activity contrasts with the small rise in the unemployment rate, as noted above—the pattern is quite similar to what we saw in the unemployment data in figure 7.

Figure 17. US States: COVID-19 Deaths and Cumulative Google Activity

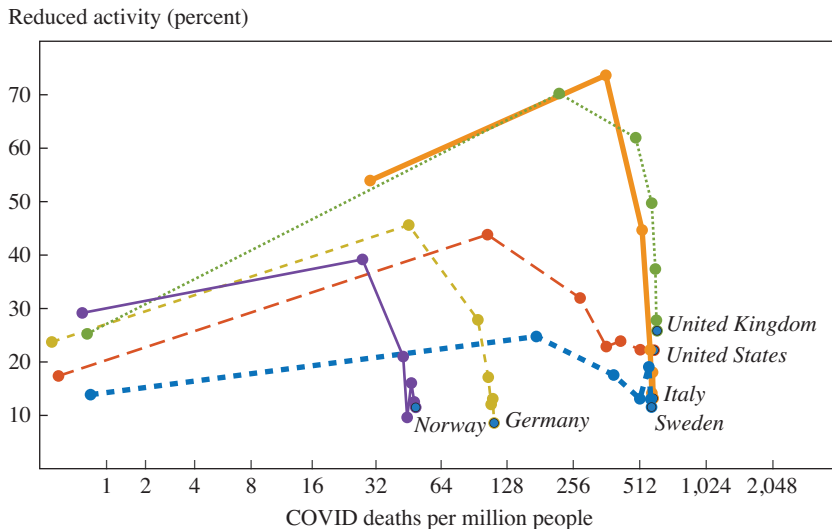
Sources: Google COVID-19 Community Mobility Reports, Johns Hopkins University CSSE, and authors' calculations.

IV. Dynamic Versions of the Trade-Off Graphs

We now take advantage of the high-frequency nature of both the Google activity data and the COVID-19 data to examine the dynamic evolution of our outcomes. In what follows, we show outcomes at the monthly frequency, from March through September. Each dot on the graph is a monthly observation, connected in order, for selected locations identified at the most recent observation point. After experimenting with different ways of showing these data, we focus on plots for the current (flow) Google activity measure instead of the cumulative loss in economic activity.

IV.A. Countries

Figure 18 shows the dynamics for the flow of Google activity for a small set of countries, focused on the United States and some key European economies. The general pattern is that between March and April, countries move sharply up and to the right, as COVID-19 deaths explode and the countries severely restrict economic activity. After April, countries break in two directions. Italy, Germany, Norway, and the United Kingdom see COVID-19

Figure 18. Monthly Evolution from March to September, 2020, for Key Economies

Sources: Google COVID-19 Community Mobility Reports, Johns Hopkins University CSSE, and authors' calculations.

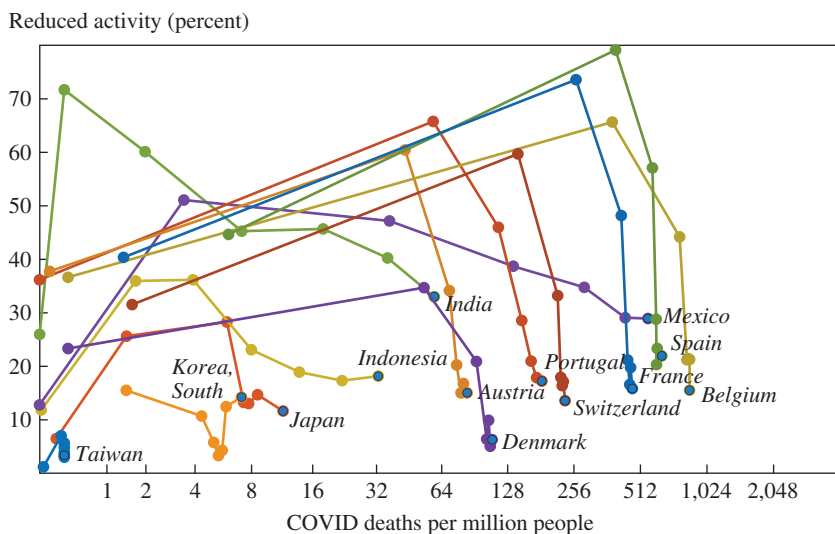
Note: The vertical axis is the current flow of Google activity, averaged for each month. The horizontal axis plots $\log(1 + \text{deaths})$ where deaths are as of the 15th of each month.

deaths stabilize by May or June, and economic activity starts to recover: the dynamics take the lines sharply downward. In Sweden and the United States, in contrast, deaths continue to increase and there is less economic recovery; the movement is more to the right instead of straight down.

Figure 19 shows this same kind of graph for an additional dozen countries, including Taiwan, South Korea, India, Japan, Mexico, France, and Spain. The same variation is seen among these countries. Most have a large sharp move up and to the right followed by a recovery in economic activity and a stabilization of deaths, illustrated by the vertical nature of the lines in the graph. In contrast, Mexico, India, and Indonesia experience a persistent move to the right as the pandemic continues and deaths have yet to stabilize.

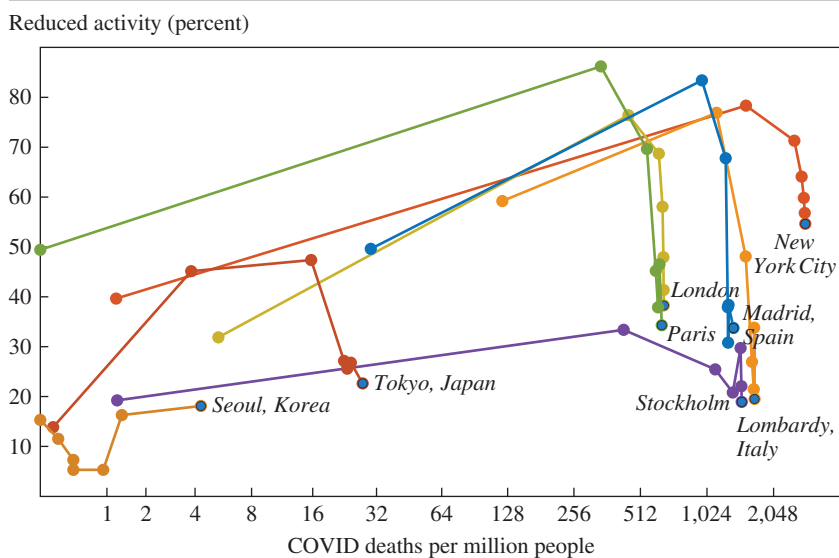
IV.B. Global Cities

Figure 20 shows similar dynamics for key cities or regions around the world. New York City, Lombardy, Madrid, London, and Paris all move sharply up and to the right with the onset of the pandemic. By May, however, the stabilization of deaths and the gradual reopening of the economies is apparent in the vertical portion of the curve.

Figure 19. Monthly Evolution from March to September, 2020, for Additional Countries

Sources: Google COVID-19 Community Mobility Reports and authors' calculations.

Note: The vertical axis is the current flow of Google activity, averaged for each month. The horizontal axis plots $\log(1 + \text{deaths})$ where deaths are as of the 15th of each month.

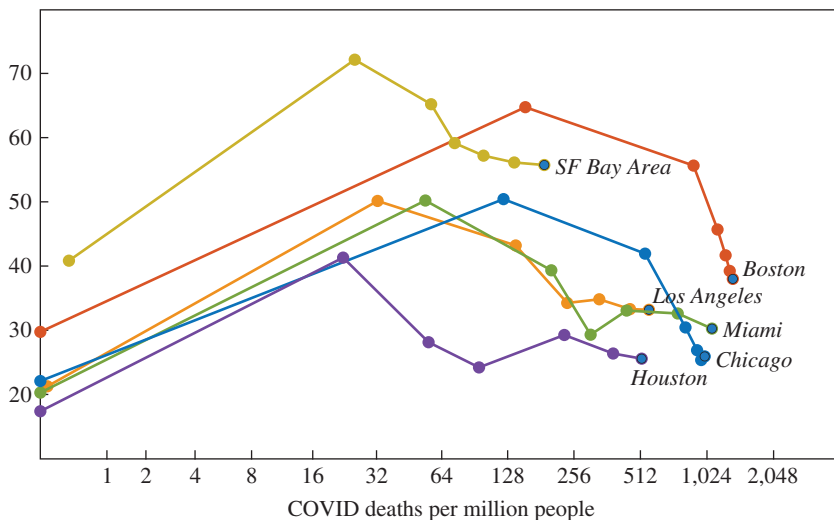
Figure 20. Global Cities: Monthly Evolution from March to September, 2020

Sources: Google COVID-19 Community Mobility Reports, Johns Hopkins University CSSE, and authors' calculations.

Note: The vertical axis is the current flow of Google activity, averaged for each month. The horizontal axis plots $\log(1 + \text{deaths})$ where deaths are as of the 15th of each month.

Figure 21. US Cities: Monthly Evolution from March to September, 2020

Reduced activity (percent)



Sources: Google COVID-19 Community Mobility Reports, Johns Hopkins University CSSE, and authors' calculations.

Note: The vertical axis is the current flow of Google activity, averaged for each month. The horizontal axis plots $\log(1 + \text{deaths})$ where deaths are as of the 15th of each month.

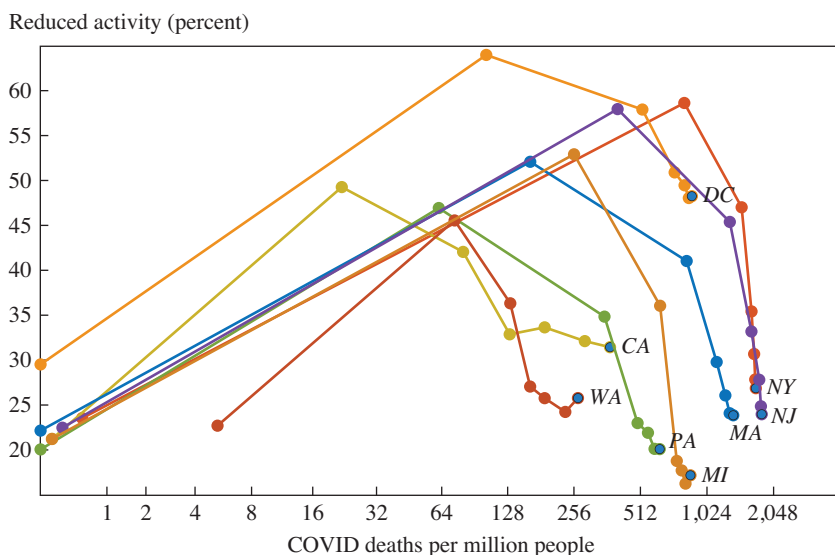
Stockholm is an interesting contrast in that Google activity declines by only about 20 to 30 percent for the entire spring, far less than in many other cities. On the other hand, the rightward move continues for longer, resulting in appreciably more deaths.

Finally, Tokyo and Seoul are interesting to compare. Tokyo had a much larger decline in economic activity peaking at around 45 percent in April and May. By comparison, Seoul saw reductions of 20 percent or less each month. While both cities end with enviably low deaths, the death rate in Seoul is about 4 per million versus six times larger at 24 per million in Tokyo.

Figure 21 shows a similar graph for cities in the United States. Here the continued rightward trends in Houston, Miami, Los Angeles, and San Francisco are evidence that the pandemic was not yet under control.

IV.C. US States

The next two figures show the dynamics for US states, confirming the two types of patterns we've seen in countries and cities. Figure 22 shows that in states like New York, New Jersey, Massachusetts, Michigan, and

Figure 22. US States: Monthly Evolution from March to September, 2020

Sources: Google COVID-19 Community Mobility Reports, Johns Hopkins University CSSE, and authors' calculations.

Note: The vertical axis is the current flow of Google activity, averaged for each month. The horizontal axis plots $\log(1 + \text{deaths})$ where deaths are as of the 15th of each month.

Pennsylvania, deaths have stabilized. By contrast, figure 23 shows many states where this is not true. The continued movement to the right documents the continued rise in deaths from COVID-19.

V. Conclusion

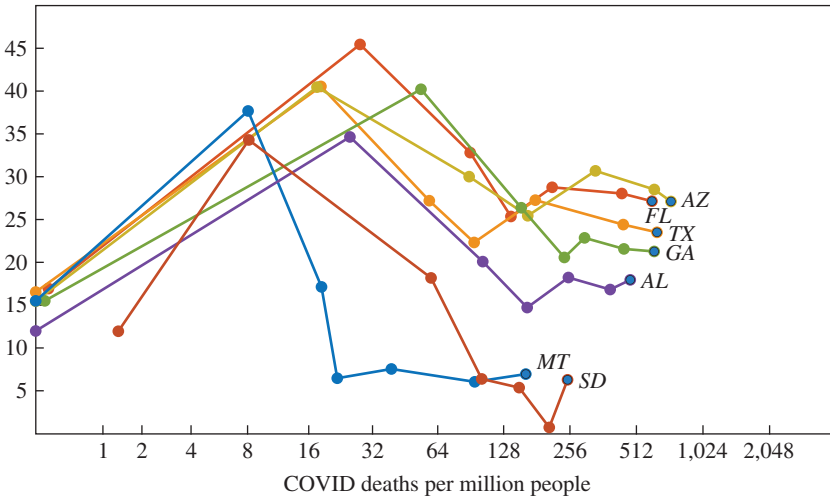
We have combined data on GDP, unemployment, and Google's COVID-19 Community Mobility Reports with data on deaths from COVID-19 to study the pandemic's macroeconomic outcomes.

Our main finding is that most countries, regions, or cities fall in either of two groups: large GDP losses and high fatality rates (New York City, Lombardy, United Kingdom) or low GDP losses and low fatality rates (Germany, Norway, Kentucky). Only a few exceptions, mainly California and Sweden, depart from this pattern.

This correlation has a simple explanation at a mechanical level. Through some combination of government mandates and voluntary changes in behavior, those areas that suffered high mortality reduced economic activity dramatically to lower social contacts and slow down the pandemic's spread.

Figure 23. Other US States: Monthly Evolution from March to September, 2020

Reduced activity (percent)



Sources: Google COVID-19 Community Mobility Reports, Johns Hopkins University CSSE, and authors' calculations.

Note: The vertical axis is the current flow of Google activity, averaged for each month. The horizontal axis plots $\log(1 + \text{deaths})$ where deaths are as of the 15th of each month.

In comparison, those locations that were able to control the virus from the beginning could maintain economic activity and suffer fewer deaths.

This observation suggests that controlling the epidemic is vital to mitigating GDP losses. It is easy to be sympathetic with this view, as it avoids the classic trade-offs in economics between alternative ends. With COVID-19, the evidence suggests that it is possible to be successful on both dimensions, minimizing deaths as well as other economic losses.

Nonetheless, it is challenging given our current data to gauge the extent to which a low death toll was the product of good luck versus good policy. Taiwan, South Korea, and Germany have been praised for their early and aggressive testing programs and intensive use of contact tracing, and several papers have highlighted the effectiveness of non-pharmaceutical interventions. But Taiwan and South Korea might have been hit by a less contagious form of the virus and might have benefited from prior experience with SARS and MERS. More of the circulation of SARS-CoV-2 in Germany might have occurred among younger cohorts than in other European countries. Further research will be required to separate the roles of luck from policy and to determine which policies were especially effective.

These arguments also work in reverse when we analyze the two main outliers in our data set: California and Sweden. California seems to have lost too much GDP given the severity of the health crisis it faced. Sweden could have reduced its mortality without too much GDP loss, at least as suggested by its Nordic neighbors' performance. But again, California was hit early by the first form of virus, perhaps less contagious. From the perspective of California's policymakers, the decisions taken *ex ante* in March might be fully justified even if too tight *ex post*. Sweden might have suffered from higher density in Stockholm, worse demographics, and other social differences with its neighbors.

Finally, we should notice that COVID-19 has policy spillovers, both in terms of health and economic outcomes. Had Italy controlled its epidemic earlier, France and Germany might have suffered a milder crisis. And if China had not undertaken draconian measures in Wuhan, South Korea might look very different today. Before rushing to judgment regarding the effect of different policies, these spillover effects must be analyzed in more detail. Regarding economic outcomes, a fall in global economic activity has dire consequences even for countries that have been able to control the virus. For example, Goldberg and Reed (2020) document that emerging market and developing economies have suffered from massive capital outflows and large price declines for certain commodities, especially oil and nonprecious metals.

Our conclusions are subject to a fundamental consideration. Health professionals in China started to suspect the presence of a new respiratory disease in the last week of December 2019. The first public message regarding the pandemic occurred on December 31, 2019, and was reported as a minor news item by a few Western media outlets. Only ten months have passed since that news.

Furthermore, the pandemic continues. Even in the best-case scenario in which effective vaccines and rapid tests become widely available by early 2021, we will still face, at the very least, a difficult first two quarters of 2021. There are already some indications that an additional wave of the pandemic may crest in the autumn of 2020 and winter of 2021. All the graphs that we report may look quite different by mid-2021. By then, it may be much more apparent how much the divergence in outcomes is driven by luck and by policy.

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Comment and Discussion

COMMENT BY

ANDREW ATKESON The paper by Fernández-Villaverde and Jones is a useful summary of the patterns of lost economic activity and COVID-19 deaths that have been seen to date across a wide range of locations, both countries and states of the United States. This paper is part of a rapidly growing body of literature that looks to estimate the relationship between pandemic deaths and lost economic output, both in current data and in data from the 1918–1919 Spanish influenza.

My comment is focused on the question of how should we interpret empirical findings on the cross-country or cross-regional relationship between cumulative deaths and lost economic activity from COVID-19 or the Spanish influenza such as those presented in this paper. What should we expect to see in the cross-sectional relationship across countries or US states between cumulative deaths and cumulative lost activity from this pandemic? Should we expect to see higher cumulative deaths associated with higher cumulative lost activity as one might expect if some regions were simply more susceptible to the pandemic than others? Or should we expect the reverse: higher cumulative deaths associated with lower cumulative lost activity as one might expect if one envisioned a trade-off for behavior and policy between disease control and economic output? This question is central to our establishing an empirical framework to determine to what extent does this cross-sectional heterogeneity in activity and deaths result from inherent differences across countries and regions versus reflecting the impact of heterogeneous private and public policy responses to the pandemic.

In their paper, Fernández-Villaverde and Jones point to luck and policy as two factors that might vary across locations and thus play a role in shaping the observed differences in outcomes. In my comment, I take a small

step toward giving the terms “luck” and “policy” structural interpretations within the context of a simple epidemiological model that incorporates in a very reduced-form way elements of an endogenous response of behavior, and hence economic activity, to the state of the disease in the population. I refer to this model as a behavioral SIR model.¹

This behavioral SIR model extends the standard epidemiological SIR model with two equations. One equation relates the level of human activity to the transmission rate of the disease. The higher the level of human activity, the more frequently infected and susceptible people meet and transmit the disease from one to the other. The other equation relates the level of daily deaths to the level of human activity. The higher the level of deaths from the disease, the greater is the level of fear in the population and hence the lower is the level of human activity. In this model, with these two equations, I interpret luck as factors determined in advance of the pandemic that alter the rate of disease transmission in a given location, holding fixed the level of human activity in that location. These factors might include population density, average temperature and humidity, predetermined cultural differences regarding physical contact (kissing and shaking hands, etc.), and the demographic structure of households. I interpret policy as factors that alter the strength of the endogenous response of activity to the current state of the disease. These factors might include true policy differences regarding the speed and severity of lockdowns in response to rising deaths from COVID-19 as well as heterogeneity across locations in the semielasticity of the decentralized response of individuals in choosing to avoid contact with others based on the current state of the epidemic in their location.

My main finding with this simple behavioral SIR model is that the slope of the relationship in the cross section across regions between cumulative deaths and cumulative lost activity depends on whether it is differences in luck or policy that are driving the heterogeneity in outcomes across locations. I establish this finding with two illustrative numerical experiments solving for the equilibrium paths of activity and COVID-19 deaths implied by this model for locations that differ either in terms of their luck or their policy.

In the first experiment, regions differ in the level of disease transmission holding fixed activity but are identical in terms of the semielasticity of the relationship between agents’ choice of activity and the current level

1. The model is derived from one first presented by Gianluca Violante at the NBER Economic Fluctuations and Growth Summer 2020 meeting, July 11, on Zoom; slides available at <http://conference.nber.org/confer/2020/EFGs20/Violante.pdf>.

of daily deaths. This heterogeneity implies that regions with higher basic reproduction numbers (transmission rates at the start of the epidemic) experience both higher cumulative deaths and higher cumulative lost activity. As we shall see, the outcomes in the hypothetical regions considered in this model experiment resemble those shown in figure 3 of the paper by Fernández-Villaverde and Jones. Because these differences in disease transmission rates across regions are assumed to have been determined prior to the start of the pandemic, it would not be correct to interpret differences in outcomes across regions in this experiment as resulting from policy differences. Instead, it would seem reasonable to say that these differences across locations are driven by luck.

In the second experiment, regions differ in the semielasticity of agents' endogenous response of activity to daily deaths but are identical in terms of the level of transmission holding fixed activity. Equivalently, one can interpret the heterogeneity across locations in this experiment as being driven by differences in the semielasticity of policy-induced restrictions on human activity in response to rising daily deaths. In this experiment, in contrast to what we found in the first experiment, regions with agents (or policies) that are highly responsive in terms of reducing activity as daily deaths rise end up with lower cumulative deaths and higher cumulative lost activity. As we shall see, the outcomes in the hypothetical regions considered in the model experiment resemble those shown in figure 2 of the paper by Fernández-Villaverde and Jones. In this case, there appears to be a trade-off between economic outcomes and cumulative deaths from the disease, where this trade-off can be interpreted as a trade-off for policy between disease control and economic outcomes.

Finally, in a third experiment, I show how by allowing both for heterogeneity in the disease transmission rate given activity and in the semielasticity of the response of activity to the level of daily deaths, one might find a region in each quadrant of figure 1 in the paper. This experiment simply highlights that to interpret the cross-country and cross-state data on cumulative deaths and cumulative lost economic activity in this pandemic (or in 1918–1919) one must be careful to disentangle which sources of heterogeneity are driving the differing outcomes across regions.

The remainder of my comment is organized as follows. First I present the behavioral SIR model that I use in my experiments. Then I briefly discuss how this model is capable of reproducing salient features of the data on the transmission of COVID-19 seen across most countries and regions of the world. In this part of my discussion, I make reference to work I have done with Karen Kopecky and Tao Zha documenting four stylized

facts about COVID-19 over the past six months (Atkeson, Kopecky, and Zha 2020). I then conduct my numerical experiments and conclude.

A BEHAVIORAL SIR MODEL Consider the following specification of a behavioral SIR model. I apply the model either to countries or to states of the United States. I normalize the population to one in each region that I consider. Thus, the model's implications for daily and cumulative deaths and activity in a region should be interpreted on a per capita basis.

At any point in time, the state vector for the model is the distribution of the individuals in the population across four compartments S , I , R , or D for susceptible, infected, recovered, or dead, respectively.

The dynamics of the population in region i across these disease compartments are given by the following equations:

$$(1) \quad \dot{S}_i(t) = -\beta_i(t)S_i(t)I_i(t),$$

$$(2) \quad \dot{I}_i(t) = [\beta_i(t)S_i(t) - \gamma]I_i(t),$$

$$(3) \quad \dot{R}_i(t) = \gamma(1 - \nu)I_i(t), \text{ and}$$

$$(4) \quad \dot{D}_i(t) = \gamma\nu I_i(t).$$

Here a dot over a variable (on the left side of these equations) indicates the time derivative of that variable.

Note that the parameter γ is the recovery rate from the disease, and the parameter ν is the fatality rate (the fraction of those that cease being infectious because they died). For simplicity, I assume that these parameters are common across regions and constant over time.²

I assume that the transmission rate of the disease at time t in region i , denoted by $\beta_i(t)$, is a function of activity in the region $Y_i(t)$ at that date:

$$(5) \quad \beta_i(t) = \bar{\beta}_i Y_i(t)^\alpha \exp(\nu_i(t)).$$

2. Clearly, in a full empirical study one would want to consider the possibility that these parameters might vary across regions or over time. Variation across regions or over time in the parameter γ governing the length of time that an infected individual may meet and infect a susceptible individual may reflect different policies for identifying and isolating infected individuals. Variation in the fatality rate ν across regions over time may reflect different age compositions of the population getting infected or different regimes for treating those with infections.

Here activity $Y_i(t)$ is measured using cell phone or similar data or, alternatively, data on economic activity. The parameter $\bar{\beta}_i$ in equation (5) is a fixed coefficient that captures features of the population of region i determined prior to the epidemic that might have an impact on transmission. Factors considered in the literature include population density, modes of transportation (subway versus car, etc.), household and demographic structure, cultural norms (bowing versus shaking hands or kissing), temperature and humidity, and so on. This is the parameter that I interpret as corresponding to luck.

The parameter α captures the elasticity of transmission with respect to activity. For simplicity, we assume that this parameter is common across regions.

The parameter $v_i(t)$ represents a potentially time-varying shock to the region-specific relationship between activity and transmission that may represent the impact of policy or natural variation in the transmission of the virus over time. I normalize $v_i(0) = 0$. When interpreting variation in $v_i(t)$ as representing the impact of policies, here I am thinking about policies such as mask wearing, ventilation, physical distancing, redesign of work spaces, or other measures implemented after the start of the epidemic that reduce transmission given a fixed level of activity.

I normalize the level of activity at the start of the pandemic to $Y_i(0) = 1$. Given this normalization, the parameter $\bar{\beta}_i$ sets the transmission rate of the virus in region i at the start of the epidemic. Specifically, $\bar{\beta}_i/\gamma$ corresponds to the basic reproduction number of the epidemic in region i , denoted by $\mathcal{R}_i(0)$. For this reason, I identify variation in $\bar{\beta}_i$ across regions as predetermined, or luck, while variation over time in $v_i(t)$ would correspond to changes in policy or personal behavior made after the start of the epidemic.³

Next I introduce the behavioral component of the model. I assume that individuals' decisions to engage in activity in region i at time t , $Y_i(t)$, are a declining function of the time derivative of cumulative deaths, $\dot{D}_i(t)$, which I refer to as the current level of daily deaths. I specify this function describing behavior as

$$(6) \quad Y_i(t) = \exp(-\sigma_i \dot{D}_i(t) + u_i(t)).$$

3. Note that constant shifts in the level of $\exp(v_i(t))$ have an equivalent impact on the relationship between activity and disease transmission in equation (5) to changes in the parameter $\bar{\beta}_i$. Thus fixed differences in policies of this kind are not distinguishable from fixed differences in the basic reproduction number in terms of their impact on model outcomes.

Here, $\sigma_i > 0$ represents the semielasticity of activity $Y_i(t)$ with respect to daily deaths. Note that we allow the semielasticity σ_i to vary by region.

The variable $u_i(t)$ in equation (6) represents a time-varying shock to the region-specific relationship between deaths and activity. I interpret $u_i(t)$ as reflecting policies such as lockdowns or closures that would reduce activity below what agents might choose in a decentralized fashion. Note that if such policies are imposed conditional on the state of the disease, with restrictions on activity becoming more severe as the level of daily deaths rises—as in $u_i(t) = -\eta_i \dot{D}_i(t)$ with $\eta_i > 0$ —then this dimension of policy heterogeneity across regions would also be a reason for why the semielasticity of activity with respect to daily deaths would vary across regions. Thus, I interpret differences in the semielasticity of activity with respect to daily deaths as due to either private behavior or public policy. Together I interpret these differences as policy.

I compute the cumulative loss in activity using the equation

$$(7) \quad \dot{CY}_i(t) = 1 - Y_i(t),$$

with initial condition $CY_i(t) = 0$. Note that a large value of this variable corresponds to more lost cumulative activity relative to the prepandemic level of $Y_i(0) = 1$.

Observe that by substituting equation (6) into equation (5) we get a reduced-form relationship between the current level of daily deaths and the transmission rate given by

$$(8) \quad \beta_i(t) = \bar{\beta}_i \exp(-\alpha \sigma_i \dot{D}_i(t) + \alpha u_i(t) + v_i(t)).$$

To solve this model for a particular region i , I specify initial conditions $S_i(0)$, $I_i(0)$, $R_i(0)$, $D_i(0)$, and $CY_i(0)$; parameters γ , v , $\bar{\beta}_i$, α , and σ_i ; and time paths for shocks $v_i(t)$ and $u_i(t)$. I solve for the implied evolution of the disease using equations (1) to (4) and the reduced form for transmission in equation (8). I then solve for activity from equation (6) and cumulative activity from equation (7).

Parameter Values. In what follows I perform several computational experiments with this model in which I examine the course of the epidemic and activity in hypothetical regions that differ in terms of their parameters $\bar{\beta}_i$ and σ_i .

In all of the computational experiments, I solve the model for 180 days and I start from identical initial conditions of $R_i(0) = D_i(0)$, $I_i(0) = 0.0001$, $S_i(0) = 1 - I_i(0)$, and $CY_i(0) = 0$. I set $\gamma = 1/5$, $v = 0.005$, and $\alpha = 2$ in

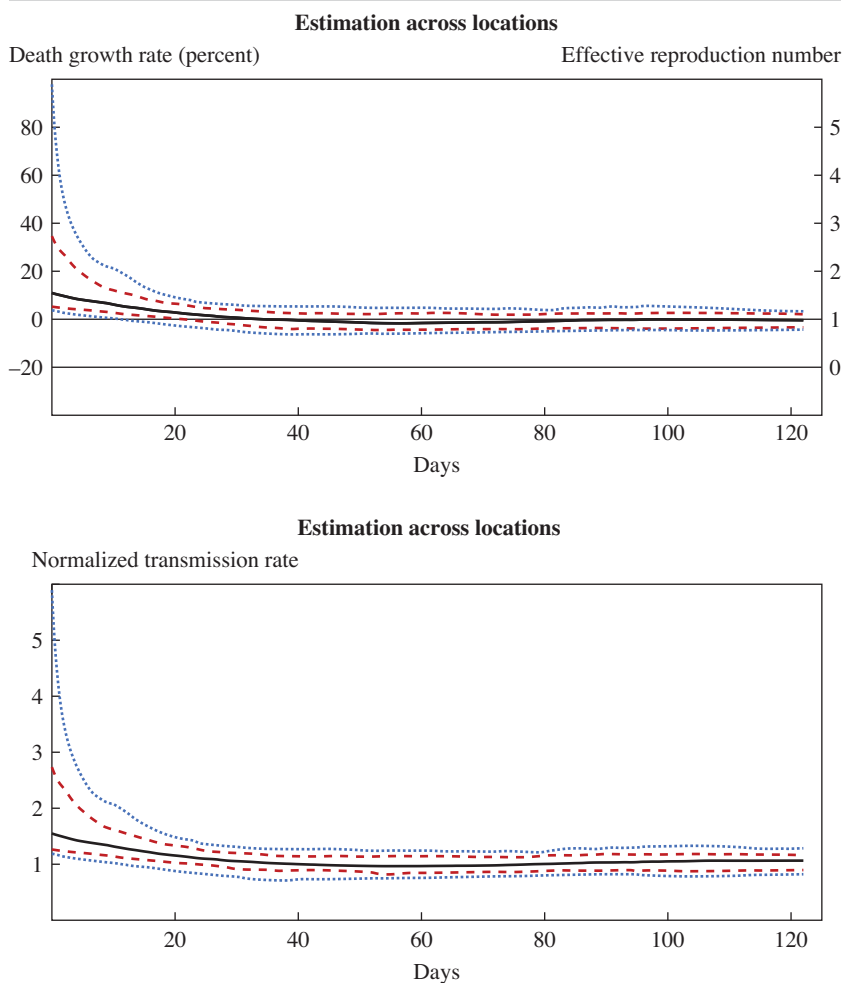
all experiments. (Note that some argue for $\alpha = 2$ on the grounds that an increase in activity by the representative agent results in an increase in meetings equal to the square of the increase in activity.) In these computational experiments, I set all shocks $u_i(t) = v_i(t) = 0$ for all t . I leave consideration of the impact of such shocks on model-implied outcomes to future research.

STYLIZED FACTS ON COVID-19 TRANSMISSION In this comment, I address this question regarding our expected cross-sectional relationship between cumulative activity and cumulative deaths using a simple behavioral SIR model of the first 180 days of the epidemic. I chose this model because of its ability to reproduce salient features of the data on the transmission of COVID-19 (as captured by the time path of the parameter $\beta_i(t)$ and the corresponding effective reproduction number $\mathcal{R}_i(t) \equiv \beta_i(t)S_i(t)/\gamma$ in the model above) seen across most countries and regions of the world. More specifically, in recent work with Kopecky and Zha (Atkeson, Kopecky, and Zha 2020), we document four salient facts about the dynamics of the COVID-19 epidemic observed so far. I show an updated presentation of these four facts using data through September 9 in figure 1 of this discussion. In this updated presentation, we estimate the dynamics of the COVID-19 epidemic in fifty-one countries and thirty-one states of the United States. We show the dynamics of the distribution of growth rates of daily deaths across these locations starting from the date at which cumulative deaths reached twenty-five in each location on the left axis of this figure. On the right axis of this figure, we show the dynamics of the distribution of effective reproduction numbers across these locations implied by our SIR model above.

The first three facts that we document in figure 1 are as follows: First, across all countries and US states that we have studied, the growth rates of daily deaths from COVID-19 fell from a wide range of initially high and highly dispersed levels to levels close to zero within twenty to thirty days after each region experienced twenty-five cumulative deaths. Second, after this initial period, growth rates of daily deaths have hovered around zero or below everywhere in the world. Third, the cross-sectional standard deviation of growth rates of daily deaths across locations fell very rapidly in the first ten days of the epidemic and has remained at a relatively low level since then.

These three facts can be seen in the first panel of figure 1. The left-hand scale in that plot shows the distribution of estimated growth rate of daily deaths across fifty-one countries and thirty-one US states, with the start of the data in each location taken from the first date at which cumulative

Figure 1. Dynamics of the Distribution of Growth Rates of Daily Deaths, Effective Reproduction Numbers, and Transmission Rates with Location and Sampling Uncertainty



Source: Author's calculations.

Notes: The solid line in both charts represents the median posterior estimate of these variables across fifty-one countries and thirty-one states of the United States. The two dashed lines in both charts contain two-thirds of the posterior probability at each point in time, and the two dotted lines .90 of the posterior probability. The growth rates of death are estimated according to the fitted mixture of modified log-logistic densities. Effective reproduction numbers and normalized transmission rates are based on the SIR model.

deaths reached twenty-five. The solid line is the median estimate of the growth rate. The dashed lines contain two-thirds of the posterior probabilities (considering both sampling and regional variation), and the dotted lines contain 90 percent of the posterior probabilities of estimated growth rates. In this figure, we see high and highly dispersed initial growth rates, with the distribution of growth rates of deaths falling to around zero with much less dispersion after twenty to thirty days. We see that this distribution of growth rates of daily deaths has stayed centered roughly around zero with a low cross-sectional variation relative to the cross-sectional variation observed in the initial phase of the epidemic.

The fourth fact we identify is as follows. When interpreted through a range of epidemiological models, these first three facts about the growth rate of COVID-19 deaths imply that both the effective reproduction numbers and transmission rates of COVID-19 fell from widely dispersed initial levels and the effective reproduction number has hovered around one after the first thirty days of the epidemic virtually everywhere in the world. This fact can be seen on the right-hand scale of the first panel of figure 1 and in the second panel of that figure, which shows the dynamics of the distribution of disease transmission rates across locations. Note that in a simple SIR model, the effective reproduction number is a linear transformation of the growth rate of daily deaths. Thus, the model-implied reproduction numbers ($\mathcal{R}_i(t) \equiv \beta_i(t)S_i(t)/\gamma$) for our locations can be read off the right-hand axis in the first panel of figure 1. We see, as with the growth rates of daily deaths, that the effective reproduction numbers across locations fell from high and highly dispersed initial levels close to one rather rapidly and have remained close to this level since. The transmission rates $\beta_i(t)/\gamma$ are calculated from the effective reproduction numbers after backing out an estimate of the pool of susceptible individuals $S_i(t)$ in each location.

The dynamics of the growth rates of deaths and the transmission rates of COVID-19 shown in figure 1 stand in sharp contrast to those patterns that would be predicted by a standard SIR model in which the transmission rate $\beta_i(t)$ is assumed to stay constant at a fixed value over time.⁴ In such a model, absent policy intervention, the growth rates of daily deaths and the corresponding effective reproduction numbers of the disease would have remained high and highly dispersed for quite a long time.

Many economic models of the COVID-19 epidemic that build on a standard SIR model are based, at least qualitatively, on a structure that

4. Such a model is equivalent to one in which the semielasticity of activity with respect to daily deaths— σ_i in equation (6)—is equal to zero.

incorporates analogs of equations (5) and (6) resulting in a reduced-form relationship between the transmission rate and daily deaths shown in equation (8). As we shall see in the numerical experiments below, this simple behavioral SIR model implies an initial dispersion of growth rates of daily deaths (and effective reproduction numbers) across locations as determined by heterogeneity in the parameter $\bar{\beta}_i$ in equation (5) across locations. Likewise, we shall see that, for a wide range of parameters, the growth rate of daily deaths in each location falls rapidly toward zero, or more precisely, a bit below zero, with the speed of the decline determined by heterogeneity in the parameter σ_i in equation (6) across locations. Thus this simple model can produce a wide range of disease outcomes at least roughly consistent with the disease dynamics shown in figure 1. The corresponding implications of this model for activity are then derived from equations (6) and (7).

WHAT IS THE RELATIONSHIP BETWEEN DEATHS AND ACTIVITY? I now use computational experiments to make three points.

First, this model can reproduce qualitatively the dynamics of disease transmission and activity seen in many locations for a wide range of parameter values.

Second, in the cross section of locations, this model can generate a positive relationship between cumulative deaths and cumulative lost activity or a negative relationship between cumulative deaths and cumulative lost activity depending on whether it is the parameters $\bar{\beta}_i$ or elasticities σ_i that vary across locations.

Third, in the cross section of locations, if differences in both $\bar{\beta}_i$ and σ_i across locations are considered, the model can generate outcomes for cumulative deaths and cumulative lost activity located in all four quadrants of the diagram in figure 1 in the paper by Fernández-Villaverde and Jones.

Experiment 1: Differences in the basic reproduction number imply more cumulative deaths with more lost cumulative activity. In our first computational experiment, I consider three regions that differ in the parameter $\bar{\beta}_i$ having an impact on the level of the relationship between activity and transmission in equation (5). I interpret this experiment as showing the impact of predetermined features of the region that have an impact on the level of transmission given activity.

Recall that the ratio $\bar{\beta}_i/\gamma$ corresponds to the basic reproduction number of the disease in region i , that is, to the effective reproduction number of the disease at the beginning of the epidemic. Consistent with the range of estimates seen across regions in figure 1, I set this basic reproduction number to $\bar{\beta}_i/\gamma$ equal to 2.75, 2.25, and 1.75 in three locations. I assume that the semielasticities $\sigma_i = 125,000$ are the same in each region.

I show the results from this computational experiment in figure 2. Panel A shows the path of daily deaths per million residents in these three hypothetical locations. Panel B shows the time path of daily activity relative to the pre-epidemic level (normalized to one). Panel C shows the path of the effective reproduction number in each location. Panel D shows the cross-sectional relationship between cumulative deaths per million over a period of 180 days and the logarithm of cumulative lost activity over the same time period.

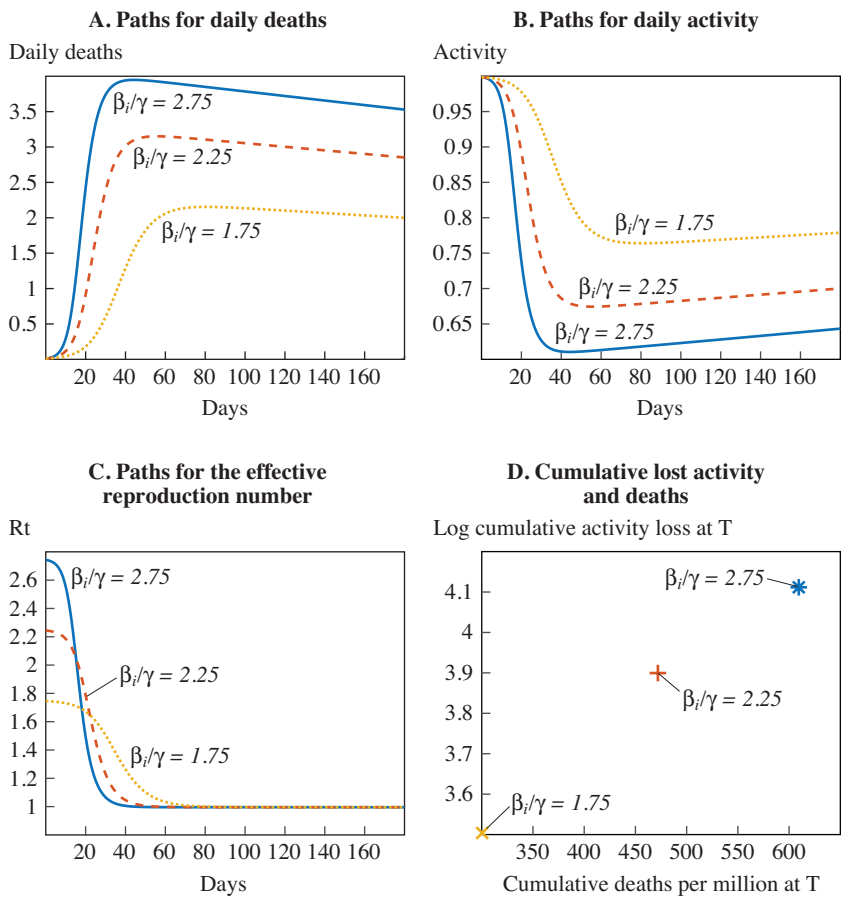
In this figure, we see a dramatic initial increase in daily deaths per million in each location, followed by a slow decline in the number of daily deaths. Activity declines abruptly, followed by a slow recovery. We see that the effective reproduction number in each location starts at initially dispersed levels and then falls relatively rapidly to slightly below one. This outcome is consistent with the data shown for a wide range of countries and US states in figure 1. Finally, in panel D, we see a positive slope in the relationship between cumulative deaths and the log cumulative lost activity—that is, more deaths are associated with more lost activity.

The intuition for this outcome is straightforward. These regions share the same parameters in equation (6) relating the level of daily deaths to current activity, but they differ in equation (5), relating the level of activity to transmission and, hence, the growth rate of daily deaths. Thus, we see that the region with the highest value of $\bar{\beta}_i$ has higher daily deaths, lower activity, and a higher effective reproduction number than the other regions, leading, after 180 days, to worse outcomes in terms of both cumulative deaths and lost economic activity. One might reasonably ascribe the difference in outcomes here to differences in luck.

Experiment 2: Differences in semielasticities of activity with respect to daily deaths imply more cumulative deaths with less lost cumulative activity. In our second computational experiment, I consider three regions that differ in the semielasticity σ_i governing the slope of the relationship between the level of daily deaths and activity in equation (6). I assume that these semielasticities are given by $\sigma_i = 40,000, 80,000$, and $160,000$. I assume that the parameter $\bar{\beta}_i$ having an impact on the level of the relationship between activity and transmission in this case does not vary across regions. I set this basic reproduction number to $\bar{\beta}_i/\gamma$ equal to 2.25 in all three locations.

In figure 3, I show the results from this computational experiment. As before, panel A shows the path of daily deaths per million residents in these three hypothetical locations. Panel B shows the time path of daily activity relative to the pre-epidemic level. Panel C shows the path of the

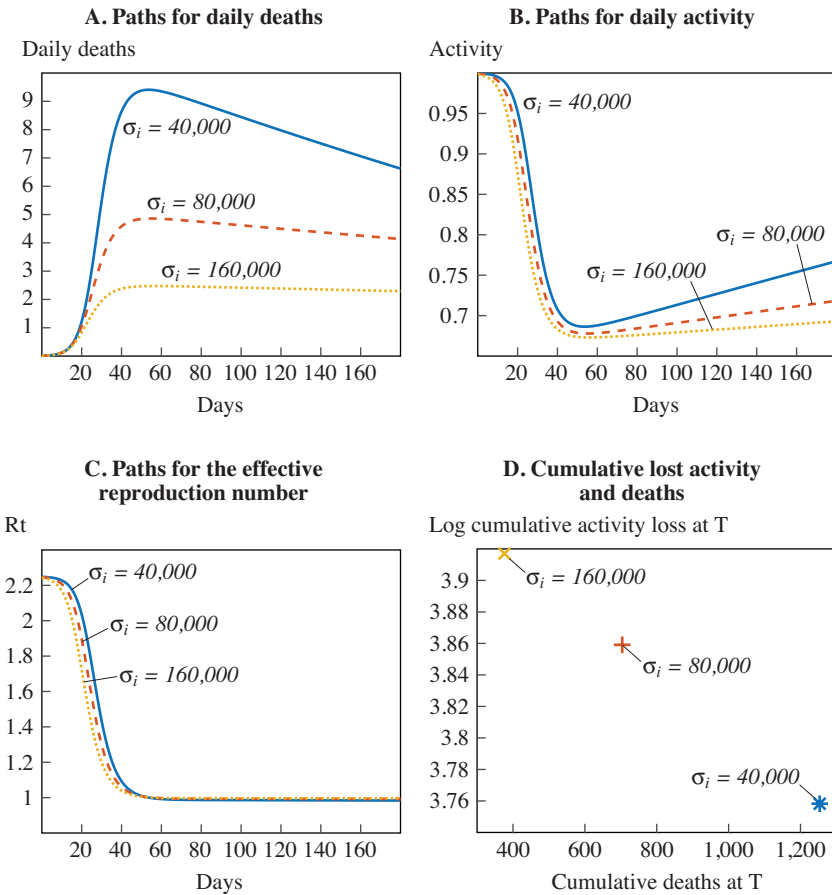
Figure 2. Implications of a Behavioral SIR Model corresponding to Alternative Values of the Basic Reproduction Number



Source: Author's calculations.

Notes: Experiment 1 addresses dynamics of the epidemic and activity in three regions that vary in the level of transmission given activity β_i . In panel D this heterogeneity across regions leads to an upward-sloping relationship between cumulative deaths and cumulative lost activity.

Figure 3. Implications of a Behavioral SIR Model corresponding to Alternative Values of the Semielasticity of Activity with Respect to Daily Deaths



Source: Author's calculations.

Notes: Experiment 2 addresses dynamics of the epidemic and activity in three regions that vary in the semielasticity of activity with respect to daily deaths σ_i . In panel D this heterogeneity across regions leads to a downward-sloping relationship between cumulative deaths and cumulative lost activity.

effective reproduction number in each location. Panel D shows the cross-sectional relationship between cumulative deaths per million over a period of 180 days and the logarithm of cumulative lost activity over the same time period.

In terms of their rough shapes, the dynamics of daily deaths, activity, and the effective reproduction number shown in figure 3 are similar to those dynamics shown in figure 2. In figure 3, panel D, however, we see a negative slope in the relationship between the log of cumulative deaths and the log cumulative lost activity—that is, more deaths are associated with less lost activity.

The intuition for this result is straightforward. Because these three regions share the same parameter $\bar{\beta}_i$ in equation (5), they all have the same transmission rate of the epidemic holding fixed the level of activity. Region 3, however, has the highest semielasticity of activity with respect to daily deaths, and hence activity and the effective reproduction number both fall more rapidly as daily deaths begin to rise. This elastic response of activity to daily deaths then leads to an apparent trade-off between cumulative deaths and cumulative lost activity.

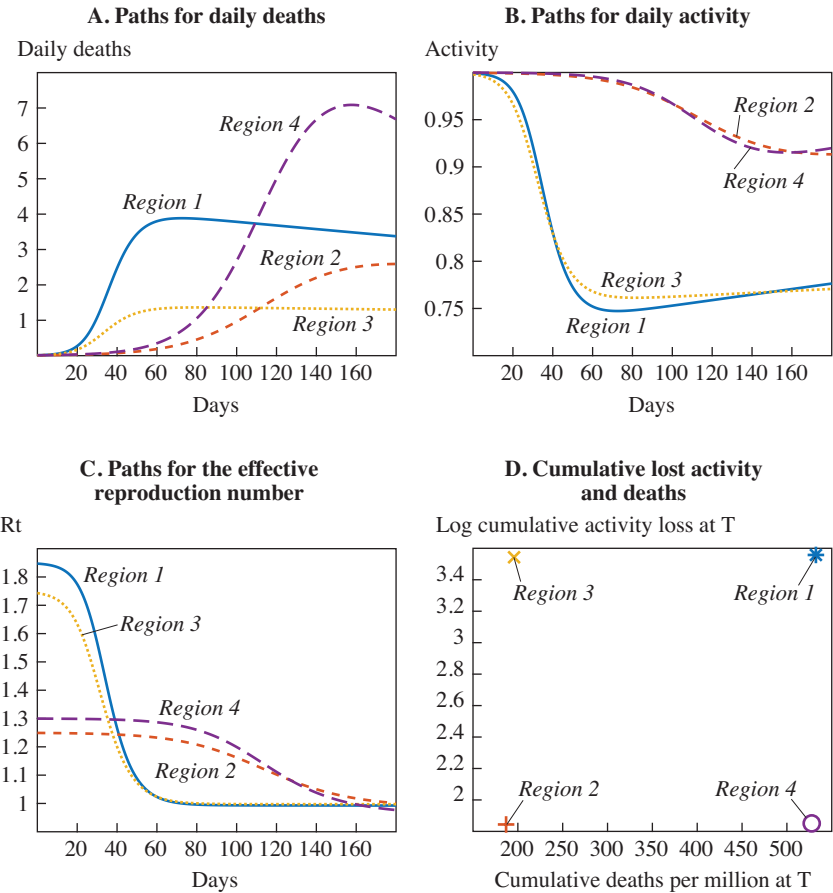
Experiment 3: Differences in both luck and policy lead to a cloud. In our third computational experiment, I consider four regions that differ both in the parameter $\bar{\beta}_i$ in equation (5) governing the transmission rate given the level of activity and in the semielasticity σ_i governing the slope of the relationship between the level of daily deaths and activity in equation (6). For the four regions that I consider, numbered 1, 2, 3, and 4 in figure 4, I set the basic reproduction numbers to $\bar{\beta}_i/\gamma = 1.85, 1.25, 1.75$, and 1.3 and the corresponding semielasticities to $\sigma_i = 75,000, 35,000, 200,000$, and $12,500$, respectively.

In figure 4, I show the results from this computational experiment. As before, panel A shows the path of daily deaths per million residents in these four hypothetical locations. Panel B shows the time path of daily activity relative to the pre-epidemic level. Panel C shows the path of the effective reproduction number in each location. Panel D shows the cross-sectional relationship between cumulative deaths per million over a period of 180 days and the logarithm of cumulative lost activity over the same time period.

Note that in panel D this heterogeneity across regions leads to regions with cumulative deaths and cumulative lost activity in all four corners of figure 1 in the paper by Fernández-Villaverde and Jones.

These simple computational experiments illustrate that the interpretation of the cross-sectional relationship between cumulative deaths and cumulative

Figure 4. Dynamics of the COVID-19 Epidemic in Four Regions



Source: Author's calculations.

Notes: Experiment 3 addresses dynamics of the epidemic and activity in four regions that vary both in the transmission rate given the level of activity β_i and in the semielasticity of activity with respect to daily deaths σ_i . In panel D this heterogeneity across regions leads to regions with cumulative deaths and cumulative lost activity in all four corners of figure 1 in the paper by Fernández-Villaverde and Jones.

lost activity is dependent on which cross-sectional heterogeneity in regional characteristics is generating the cross-sectional variation in the data. Which type of heterogeneity is driving the data now (or was driving the data in 1918–1919) is unknown and should be a subject for future research.

REFERENCE FOR THE ATKESON COMMENT

Atkeson, Andrew, Karen Kopecky, and Tao Zha. 2020. “Four Stylized Facts about Covid-19.” Working Paper 27719. Cambridge, Mass.: National Bureau of Economic Research. <https://www.nber.org/papers/w27719>.

GENERAL DISCUSSION Caroline Hoxby started the general discussion off by observing that the variation we see might be due to compliant versus noncompliant behavior. This is an important factor to economic activity because the variation in compliance will influence mobility and subsequent actions to reduce the spread of the virus. For example, Northern California (the San Francisco Bay area) and Southern California (Los Angeles) have the same level of regulations. “So what explains the difference?” she asked. It is most likely not attributable to density because San Francisco is denser than Los Angeles. But to her understanding, there is a difference in compliance between the two locations. Another example is Sweden versus the United States; Swedes are more likely to be compliant. She suggested finding data to use for this compliance measure, such as number of masks being purchased and other surveillance measures.

Martin Baily pointed out that the authors used the number of deaths as the outcome measure as opposed to deaths relative to the number of cases. Baily mentioned a recent study that found there were very wide cross-country differences in the ratio of deaths to confirmed cases.¹ This could be due to differences in reporting, but the gaps were large enough to suggest the findings reflect actual outcome differences. In the study, the United States had a very high number of cases per million persons, but the number of deaths per number of cases was much lower than most other OECD countries. France and the United Kingdom, for example, had many more deaths relative to the number of cases than did the United States. Fernández-

1. Ben Balmford, James D. Annan, Julia C. Hargreaves, Marina Altoè, and Ian J. Bateman, “Cross-Country Comparisons of Covid-19: Policy, Politics and the Price of Life,” *Environmental and Resource Economics*, August 4, 2020, 1–27, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7400753/>.

Villaverde and Jones look at number of deaths, which reflects not only how many people catch the disease but also the deaths per number of cases, which is affected by the quality of treatment given to those who become ill.

Ken Rogoff questioned to what extent the outcomes are affected by the commonness of nursing homes and their protocols. Nursing home protocols, he stated, are a big contributor to the variation in the United States. In addition, nursing homes are less common in developing economies, which is one hypothesis for why COVID-19 hasn't spread as fast in those countries. Furthermore, Rogoff commented that looking at other outcomes of health such as life expectancy and morbidity, as opposed to deaths alone, will be of interest in a few years.

Mervyn King noted that data on COVID-19 deaths internationally are difficult to compare because the definition of a COVID-19 death varies from one location to another. Because of this, many have looked instead at monthly excess deaths relative to a five-year moving average. An advantage of this comparison is that it offers a view of the period before the pandemic. Countries with low excess deaths in 2019 had higher excess deaths in 2020, now attributable to COVID-19. This factor might explain the difference between Sweden and the United Kingdom, in addition to the nursing home factor mentioned by Rogoff. King adds that it is also relevant to the comparison between Sweden and Norway. In 2019, Norway had high number of excess deaths while Sweden had fewer. In 2020, Sweden caught up due to COVID-19.

King added that this is relevant to Andrew Atkeson's discussion of luck. King stated that luck can also refer to the starting point and the prevalence of countries in terms of their vulnerability to an epidemic of an infectious disease as opposed to just policy issues. He concluded by praising the presentation and discussion thus far.

Jason Furman believed he had an explanation for the lack of correlation based on two factors. One, the bigger the prevalence of the virus the worse for the economy. Second, if the country is more averse to the virus, it takes bigger steps for any amount of the virus, which is also worse for its economy. For example, New Zealand had a lower prevalence of the virus but with very few cases confirmed the government engaged in extensive shutdowns. This might also explain some of the summer trends in the United States. Although Arizona, California, and Florida had higher numbers of virus cases, economic activity in those states was the same as in Connecticut, Maine, and Vermont, which had lower numbers of cases but were more averse. Furman concluded his remarks with this question: Is there an underlying parameter, where some places do more or less in

response to the same virus, that is inversely correlated with the virus? His hypothesis is this underlying parameter is why there isn't a strong correlation between the virus and economic activity.

Bob Hall pointed out the negative relationship between COVID-19 and tuberculosis. In countries like India, for example, tuberculosis is a pandemic but there are substantially lower COVID-19 death rates. There is some speculation that this is due to the treatment of and vaccinations for tuberculosis, which are widely practiced in third-world countries like India. This would indicate that those treatments have an effect against COVID-19.

Elaine Buckberg addressed the idea that trust in government has an effect on the results. She wonders if this question should be rephrased as rather a willingness to behave in the interest of the common good versus individualism. One way she suggested to measure this is by looking at fiscal variables such as the size of government budget or size of transfers. Although for some Asian countries, which have a historical behavior of wearing masks to protect others, it might not work well.

Tristan Reed recommended his paper with Pinelopi Goldberg presented at the Summer 2020 special edition of BPEA.² In this paper, the authors performed cross-country regressions and found a lot of explanatory power in health code variates, age distribution, obesity, and population density. He wondered how the addition of those variables would affect the analysis.

James Stock endorsed Reed's recommendation. He recognized that both this paper and the previous one focused on lost economic output versus lives in one way or another, either through mandated shutdowns or other outcomes as discussed here.³ He believes this is a reasonable framing for what happened in March and in April. But starting in May and including the present (September 2020), we know that there's more going on. He related this to the point Rogoff made about nursing home protocols. We now know more about how limiting the spread of the virus and protections for the elderly can contain the virus.

Other ways of containing the virus while not affecting the economy are masks, testing, and quarantine mandates, Stock added. The key lessons from these papers for policies moving forward are about adhering to and

2. Pinelopi Koujianou Goldberg and Tristan Reed, "The Effects of the Coronavirus Pandemic in Emerging Market and Developing Economies: An Optimistic Preliminary Account," *Brookings Papers on Economic Activity*, Summer (2020), xx–xx.

3. Alexander Armon, John Ricco, and Kent Smetters, "Epidemiological and Economic Effects of Lockdown," in the present volume of *Brookings Papers on Economic Activity*.

doing things that are good both for reducing deaths and preserving the economy. A common theme in the papers is that people would prefer to live than die and to work than not. The tragedy at the moment was that this is not the direction we had decided to go. He concluded that local officials have been given only one option, which is not a terrific option.

Jesús Fernández-Villaverde responded that if this presentation had been given two weeks earlier, he would have leaned toward luck. But given the second wave in Europe over the few weeks preceding the conference, he believes that policy makes a huge difference. One good example of this is Italy versus Spain. In Spain, ICU beds in Madrid were over 100 percent capacity on September 23. In Milan, Italy, they were not. He hypothesized that maybe the difference in some countries versus New York was due to luck in February. What was happening in Milan versus Madrid at that moment, he believes, was very clearly due to some policy decisions. In another six months or a year, these hypotheses and ideas would be much clearer.

Fernández-Villaverde continued by praising some of the suggested ideas thus far. In response to the comment made by King about using excess deaths, he responded that he and his coauthor have used this measurement in another paper that incorporates more econometrics. When using excess deaths, there is very little change in results. This is because there is an indication that countries with worse deaths scenarios, such as Spain or Italy, have also undercounted to a greater degree.

Fernández-Villaverde stated that it would be great to have good measures of compliance and social trust. Even within the United States there is variation across states, and states such as Vermont and Maine have done better than similar states. This could be attributable to differences in behavior and cultures of people across states. He hopes that in another year, there will be better measures and data on compliance. Currently there are some data on mask use, but it might not be credible. If we were in a totalitarian society like China, where everyone is recorded, we could actually check videos and take measurement of these topics.

Fernández-Villaverde concluded by stating he is in agreement with Stock and Rogoff about evaluating other outcomes and looking at long-term consequences. But it is difficult because at this time we do not have data. In five years, this will be an interesting topic to revisit.

Chad I. Jones added that there is luck involved with timing. If this paper had been written in May, for example, Arizona would have seemed great. Montana and South Dakota would have been seen as moving toward the right. There is luck involved in the timing and recording the analysis.

To echo Fernández-Villaverde's comments, in six months to a year we may see different outcomes on these graphs.

Andrew Atkeson concluded the discussion by responding to Furman's comments. He stated that the elasticity of the response of activity to infections is captured in New Zealand as they have responded aggressively to the disease. In the broader question of luck versus policy, an important case study comes from the Spanish flu. One of the biggest lessons from the Spanish flu is that some places were hit hard in the first wave while others were hit hard in the second wave. He notes that density is not a good proxy for luck and that something else is influencing how and when a location gets hit. The challenge is disentangling that factor from policy.

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Temporary Unemployment and Labor Market Dynamics during the COVID-19 Recession

ABSTRACT This paper develops a search-and-matching model that incorporates temporary unemployment and applies the model to study the labor market dynamics of the COVID-19 recession in the United States. We calibrate the model using panel data from the Current Population Survey for 2001–2019, and we find that the model-based job-finding rates match observed job-finding rates during the entire sample period and out of sample up through July 2020. We also find that the Beveridge curve is well behaved and that there is little change in market tightness in 2020 once we use the calibrated model to adjust for changes in the composition of the unemployed. We then use the model to project the path of unemployment over the next eighteen months. Under a range of assumptions about job losses and labor demand, our model predicts a more rapid recovery compared to a model that does not distinguish between temporary and permanent unemployment and compared to professional and academic forecasts. In order to rationalize the professional forecasts of the unemployment rate, some combination of the vacancy rate, the job-separation rate, and the recall rate of workers on temporary layoff must deteriorate substantially in the next several months.

In the aftermath of the 1991–1992 recession, economist Benjamin Friedman discussed the “Tolstoian notion that while expanding economies are all alike, every contracting economy is contracting in its own way” (1993, 196).

Conflict of Interest Disclosure: The authors did not receive financial support from any firm or person for this paper or from any firm or person with a financial or political interest in this paper. They are currently not officers, directors, or board members of any organization with an interest in this paper.

The notion of course is an exaggeration (in fact, Friedman wrote that the early 1990s contraction “was pretty much like other contractions”), but some recessions are unusual, and the COVID-19 recession is one of the most unusual recessions in a very long time.

What makes the COVID-19 recession unique is the nature of the initial shock. While past recessions have been primarily caused by economic or financial shocks, the adverse shock to the labor market in 2020 was biological in nature, triggered by a novel virus that forced millions of employees into temporary unemployment by the second quarter of 2020. The record-level rise in temporary unemployment contrasts starkly with past recessions that typically start with an increase in permanent layoffs (Elsby, Hobijn, and Şahin 2010). The path of job vacancies has also been unusual: while vacancies fell throughout the first half of 2020, the drop was much less pronounced than is typical in most recessions. In fact, vacancies at their lowest level were equal to the level that prevailed in 2015, a time typically considered to be a tight labor market. Thus, while the Beveridge curve—the negative relationship between vacancies and unemployment—typically loops around during and after a recession, in the early months of the COVID-19 recession, the increase in the unemployment rate was much larger than the corresponding drop in job vacancies.¹

The unusual nature of the COVID-19 recession makes it difficult to draw on experiences from past recessions to project how the labor market will evolve in the months ahead. For example, during the Great Recession, the initial wave of layoffs was subsequently followed by a prolonged period of lower job-finding rates (Elsby, Hobijn, and Şahin 2010; Elsby and others 2011). This led to a significant increase in the long-term unemployment share, which in turn prolonged the recession through negative duration dependence (Kroft and others 2016; Krueger, Cramer, and Cho 2014). Currently available data suggest that the dynamics of the COVID-19 recession may play out differently. In particular, vacancies continue to be elevated, and job-finding rates have not decreased substantially—both the recall rates for the temporary unemployed and the job-finding rates for workers who have been permanently laid off remain fairly high.

In this paper, we develop a “flows-based approach” to shed light on the key economic forces affecting the labor market. While the typical approach to studying labor market flows considers three states—employment,

1. Journalist Catherine Rampell colorfully commented on Twitter (June 9, 2020) that the “Beveridge Curve is drunk.”

unemployment, and nonparticipation—our model further divides unemployment into temporary unemployment and permanent unemployment. The importance of temporary unemployment for the current downturn has been widely commented on and also features in work by Chodorow-Reich and Coglianesi (2020). Similarly, Forsythe and others (2020b) emphasize this distinction for understanding current trends in the labor market and observed levels of market tightness. In particular, Forsythe and others (2020b) point out that it is necessary to separate the temporary unemployed from those searching for jobs when considering the performance of the matching market.

To be very clear at the outset, by “permanent unemployment” we do not mean to imply that individuals in this state are permanently unemployed; rather, individuals in this state have been permanently separated from their former employer. Similarly, by “temporary unemployment,” we mean individuals who expect to be recalled by their former employer after having been temporarily separated.²

It is crucial to distinguish between temporary and permanent unemployment for understanding the dynamics of the COVID-19 recession for two reasons. First, the temporary unemployed historically find jobs at much higher rates than the permanent unemployed. Second, we argue that the temporary unemployed who are waiting to be recalled do not affect the tightness of the labor market in the same way as those who have been permanently separated and are actively searching for work. In particular, individuals who are actively searching for a job reduce the chance that other job seekers are employed, as they compete for the same job openings. In this sense, job search congests the labor market, and our model captures this distinction between temporary and permanent unemployment by allowing for the job-finding rates of active searchers to depend on market tightness. In our model, the group of temporary unemployed is composed of some who are waiting to be recalled and not searching for a job and others who are actively searching just like unemployed workers who have been permanently laid off.

2. According to these definitions, temporary unemployed individuals can become permanently unemployed if they are not recalled and are eventually laid off permanently, and our model allows for this possibility. We settled on this language because it matches the wording of the questions in the Current Population Survey, and it is consistent with previous work studying temporary layoffs. Following the presentation of this paper, Bob Hall suggested alternative language that we are happy to endorse and encourage the Census Bureau to adopt: “recall unemployment” and “jobless unemployment,” instead of temporary and permanent unemployment.

The key building blocks of our model are the transitions between labor market states, some of which we take to be exogenous (job-separation rates, vacancies, transition rates between the different nonemployment categories, and the recall rate of workers who are temporarily unemployed and not actively looking for work) and some of which we model endogenously (job-finding rates of the permanent unemployed, of those not in the labor force, and of temporarily unemployed individuals who are actively looking for work). Of course, the transition rates we take as exogenous are surely endogenous to deeper economic forces. Conditional on rates we take as exogenous, however, our model can be used to simulate the flows between labor market states as the economy recovers.

Our model allows for negative duration dependence, whereby job-finding probabilities decline with unemployment duration. Formally, duration dependence enters into the model in two ways. First, job-finding probabilities for both temporary and permanent unemployed individuals will vary with unemployment duration. Second, the model permits individuals to transition from temporary unemployment to permanent unemployment (and vice versa) over time, which implies that the overall job-finding rate from unemployment can exhibit negative duration dependence due to compositional effects.

We calibrate our model using panel data from the Current Population Survey for 2001–2019. We find that our calibrated model closely matches job-finding rates for both the temporary unemployed and permanent unemployed during the entire sample period, and it also matches job-finding rates out-of-sample up through July 2020. By contrast, the model in Kroft and others (2016), which does not distinguish between temporary and permanent unemployment, performs much worse out-of-sample in 2020. In particular, the “off-the-shelf” model substantially underpredicts the overall job-finding rates of the unemployed starting in April 2020. This is because of two reasons related to temporary unemployment. First, the Kroft and others (2016) model does not account for the high rate of recall for workers on temporary layoff; unemployed workers can only find jobs through job search. Second, that model implies that those in temporary unemployment congest the matching market and thus substantially reduce market tightness, even if the temporary unemployed are waiting rather than searching for work.

Since the calibrated model fits well out-of-sample during the first several months of the COVID-19 recession, we use it to shed light on several economic phenomena. First, we study the Beveridge curve in 2020, and we adjust the Beveridge curve to account for changes in the composition

of unemployment. We find that the Beveridge curve is stable in 2020 after adjusting for composition.³ We thus conclude that temporary unemployment is key to understanding the apparently puzzling movement in the Beveridge curve this year. Through the lens of our calibrated model, the temporary unemployed include many individuals not actively searching, which means they do not contribute very much to labor market tightness.

Second, we simulate the model for the next eighteen months to predict changes in the unemployment rate. We consider a range of paths for the exogenous forcing variables such as separation rates, job vacancies, and recall rates for the temporary unemployed who are waiting (and not actively searching). In our baseline scenario, we assume that the forcing variables steadily converge to their normal values over the next twenty-four months. Our calibrated model predicts a more rapid recovery compared to the model by Kroft and others (2016), which does not distinguish between temporary and permanent employment and predicts a more rapid recovery than professional forecasts. We find an increase in long-term unemployment, but to levels much lower than the levels that prevailed during the Great Recession. We then look at additional scenarios and conclude that in order to rationalize existing professional forecasts of the unemployment rate, the paths of the exogenous forcing variables would have to deteriorate substantially relative to current trends. For example, job-separation rates would have to increase by over 50 percent over the coming months. Deterioration in job vacancies or the recall rate would also prolong the downturn, although we find that the labor market impact coming from these channels is less pronounced than the impact coming from a rise in job separations.

Overall, we conclude that our model provides some rigorous support for focusing somewhat less on the headline unemployment rate as a measure of labor market slack during the COVID-19 recession. Instead, our preferred measure of slack takes into account the composition of the unemployed: the distinction between temporary and permanent unemployment, the share of the temporary unemployed who are actively searching, and the distinction between short-term and long-term unemployment. Importantly, each group imposes a different degree of congestion on the labor market. Along with standard measures of labor demand, such as job vacancies and the separation rate, our model provides a relatively complete picture of the health of the labor market and can provide useful guidance to forecasting

3. See also Forsythe and others (2020b), who redraw the Beveridge curve excluding the temporary unemployed; this has a similar effect as our model-based adjustment.

labor market dynamics in the aftermath of the COVID-19 recession. This will be a useful guide to policymakers who are continuing to debate appropriate stimulus policies, such as the Paycheck Protection Program (PPP) and supplemental unemployment insurance payments.

The remainder of this paper proceeds as follows: Section I provides a brief review of the related literature on temporary unemployment and the recall expectations of unemployed workers, and it also discusses broadly related recent work studying the COVID-19 recession. Section II discusses the data and measurement and presents figures that motivate the model-based analysis. Section III describes our new search-and-matching model with temporary unemployment and goes through the calibration of the model. Section IV describes how we use the calibrated model to adjust for changes in the composition of the unemployed and how this results in a well-behaved Beveridge curve that displays little change in market tightness throughout 2020. Section V presents the counterfactual simulations that predict the unemployment rate and other labor market statistics over the next eighteen months under different scenarios. Section VI concludes.

I. Related Work

The sharp downturn in the labor market starting in 2008 and the long slow recovery that followed motivated a series of papers on the flows across labor force states and how they contributed to the slow recovery in the aftermath of the Great Recession. This paper builds on this literature, which we selectively describe in this section.

In two contributions to the *Brookings Papers on Economic Activity*, Elsby, Hobijn, and Şahin (2010) and Elsby and others (2011) characterize the dynamics of recessions, including the Great Recession, in terms of unemployment inflow and outflow rates. Elsby, Hobijn, and Şahin (2010) write: “In all recessions, inflows account for a substantial fraction of unemployment variation early on and then subside. In contrast the contribution of the outflow rate becomes more dominant as each recession progresses” (18–19). During the Great Recession, the decline in the outflow rate from unemployment was particularly sharp, leading the labor market to contract over a long time and long-term unemployment to increase to levels not seen during the postwar period.

In Kroft and others (2016), we responded to the increase in long-term unemployment by analyzing how duration dependence in job-finding rates and congestion from the unemployed and nonparticipants contributed to the buildup in long-term unemployment and the slow recovery of the

labor market during and after 2009. While the current paper owes much of its analytic structure to Kroft and others (2016), it also recognizes, as do Chodorow-Reich and Coglianesi (2020) and Forsythe and others (2020b), how important temporary unemployment is for the current downturn and thus augments the model to allow for temporary unemployment.⁴

The importance of accounting for temporary unemployment when modeling transition dynamics in the labor market was noted previously by Katz (1986), Katz and Meyer (1990), and Lilien (1980). More recently, Fujita and Moscarini (2017) reconsider the evidence on temporary unemployment and find that it is pervasive, even in normal times, since many individuals who began their unemployment spell in permanent unemployment eventually return to their former employers.

Additionally, our model allows for negative duration dependence in job-finding probabilities, consistent with empirical evidence from Katz (1986) and Fujita and Moscarini (2017).⁵ While we do not directly observe whether a worker is recalled by their former employer, we find—consistent with Katz and Meyer (1990)—that the temporary unemployed have higher reemployment rates, even if they do not report that they are actively searching for a job. Forsythe and others (2020b) find that the temporary unemployed (compared to the permanent unemployed) are more likely to work in the same industry following their unemployment spell, as expected if these individuals were recalled to their former employer at a higher rate than the permanently unemployed.

Our paper complements other recent research studying labor market dynamics during the COVID-19 recession. In particular, Chodorow-Reich and Coglianesi (2020) study unemployment durations using CPS data. Similar to our model, they also allow for temporary unemployment, but they also differentiate between layoffs and quits as well as labor market entrants among the unemployed. They take a factor-flows simulation approach and assume the overall unemployment rate is an observed factor, while we allow the unemployment rate to evolve endogenously using the structure of the matching model and a prespecified path of job vacancies and separations. Despite the differences in methodology, both papers find

4. Krueger, Cramer, and Cho (2014) and Kroft and others (2019) build on Kroft and others (2016) and calibrate similar search-and-matching models.

5. While these papers find negative duration dependence is mostly driven by the recall rates of the temporary unemployed, Nekoei and Weber (2015) find somewhat contradictory evidence that negative duration dependence only occurs when recalls are excluded from the unemployed pool.

little reason to expect long-term unemployment to come close to the levels observed during the Great Recession.⁶

Lastly, a large number of papers—which we can only selectively review here—study the recent economic turmoil during the COVID-19 recession. Bartik, Bertrand, Lin, and others (2020) and Forsythe and others (2020a) find that state variation in stay-at-home orders had little effect on economic activity.⁷ One interpretation is that rising concerns about public safety led to a sharp decrease in demand for in-person services, whether or not a stay-at-home order was in place. This interpretation is consistent with data on individual mobility in Goolsbee and Syverson (2020), who conclude that voluntary changes in behavior played a larger role than government policies. Bartik, Bertrand, Cullen, and others (2020) suggest that firms' liquidity played an important role in preventing business closures. Lastly, Barrero, Bloom, and Davis (2020) study job reallocation during the COVID-19 recession and document excess job reallocation using survey data on expected job gains across industries.

II. Data, Measurement, and Motivating Evidence

II.A. Data

We use the same data sources as Kroft and others (2016), updated to the most recent month available. The online appendix provides more details on the data used in our analysis, and some of the discussion below follows Kroft and others (2016).

CURRENT POPULATION SURVEY (CPS) We use CPS monthly data between January 2001 and August 2020, limiting the sample to individuals between

6. Additionally, our paper is broadly related to Gregory, Menzio, and Wiczer (2020), who develop an equilibrium model of job search allowing for unemployed workers to be recalled to their former employer. Their primary objective was to forecast the path of COVID-19 recession in response to the lockdown, based on information available in May 2020. We predict a more rapid recovery than they did, which we think is because observed rates of temporary unemployment and recall rates are significantly higher than those anticipated by Gregory, Menzio, and Wiczer (2020). Methodologically, our approach is more reduced form than the equilibrium model of Gregory, Menzio, and Wiczer (2020), and they rely on Longitudinal Employer-Household Dynamics (LEHD) and Survey of Income and Program Participation (SIPP) data, while we use CPS data, which allows us to measure the duration structure of unemployment and the breakdown between temporary and permanent unemployment.

7. We build on Forsythe and others (2020a) in determining how to classify the labor force across labor force states.

the age of 25 and 55.⁸ We use the CPS data in several ways. First, we use the repeated cross-sectional data to measure the stocks of each labor market state each month: employment, temporary unemployment, permanent unemployment, and nonparticipation. Second, we use the panel structure of the CPS to measure month-to-month transition rates between states, such as the job-finding rate or transition rates between temporary and permanent unemployment, for example.⁹ We also measure the duration of the unemployment spell, which allows us to estimate transition rates conditional on unemployment duration.

JOB OPENINGS AND LABOR TURNOVER SURVEY (JOLTS) We use the total number of vacancies from monthly JOLTS data between January 2001 and July 2020, and we use the vacancy data through December 2019 to calibrate the matching model described below. We then use the 2020 vacancy data as one of the exogenous forcing variables to assess how well the calibrated model fits out-of-sample during 2020.

II.B. Measurement

In recent months, common labor market indicators have at times moved in dramatic fashion. These movements occurred during a unique moment when many workers were asked to stay at home and others were afraid to go to work. The measurement framework of the Bureau of Labor Statistics (BLS) was not designed with such an event in mind but instead was meant to track the labor market across less unusual business cycles. In this section, we describe how we adapt the data from the CPS to confront the challenges of adequately differentiating between those who are waiting to be recalled by a former employer and those who are searching for a new employer. Our approach to mapping the CPS questions onto the categories of waiting and searching derives from Forsythe and others (2020b). We note at the outset that the CPS does not directly measure *ex post* recall—that is, whether an

8. Following Kroft and others (2016), we focus on prime-age men and women since this allows us to sidestep issues arising from delayed labor force entry of younger workers and changes in retirement patterns of older workers. Online appendix figure A16 shows that the headline unemployment rate from the Bureau of Labor Statistics very closely tracks our unemployment rate measure in this paper, which is based on the age 25–55 prime-age sample restriction and also includes individuals employed but absent from work for other reasons as part of the temporary unemployed, as we discuss in more detail below.

9. The CPS interviews households for two four-month spells spaced apart by eight months. To create panel data, we match individual observations across successive months, matching on household identifier, line number, age, gender, and race.

individual who transitions from temporary unemployment to employment returns to their former employer.

STOCKS We begin by discussing how we measure the distribution of the workforce across labor force states. The traditional way of defining temporary unemployment in the CPS does not fully capture the extent to which layoffs were temporary during the COVID-19 recession. Forsythe and others (2020b) propose using the more detailed questions on labor force participation in the CPS to classify respondents into whether they are waiting to be reemployed or whether they are actively searching for a job.

In addition to the typical categorization—employed, unemployed, out of the labor force—Forsythe and others (2020b) introduce a category of those waiting to return to their former workplace. This group includes those who are temporarily unemployed but not searching for work and those who report being absent from work without pay.¹⁰ Forsythe and others (2020b) base these decisions on the wording of the CPS and on guidance provided by the BLS during the pandemic. Additionally, they are guided by job-finding patterns among “April separators”—that is, respondents who were employed in February and March and those not employed in April.

We follow Forsythe and others (2020b) in our approach to classifying individuals, except for separately considering the temporary unemployed who are actively searching. There are specific groups that require attention. Throughout, we rely on their evidence of whether April separators return to the same industry to motivate our data choices.

The first group to consider are those who report that they are employed but are absent from work. Roughly 1.5–2 percent of the population normally falls into this category. The CPS asks these individuals to provide specific reasons for their absence, such as vacation time, child care, or training, with a residual category for “unspecified reasons.” During normal times, less than 0.2 percent of the population are absent for unspecified reasons. Between February and April 2020, however, the share absent from work for unspecified reasons ballooned to 2.4 percent of the population. The BLS has reported that “analysis of the underlying data suggests that this group includes workers affected by the pandemic who should be classified as unemployed on temporary layoff.”¹¹ The data on April separators

10. Forsythe and others (2020b) call this group the “Waiting Room” and distinguish this group from the “Open Market,” which consists of those actively searching, whether or not they report being on temporary unemployment.

11. “Impact of the Coronavirus (COVID-19) Pandemic on the Employment Situation for September 2020,” BLS, <https://www.bls.gov/covid19/employment-situation-covid19-faq-september-2020.htm>, item 4.

(see Forsythe and others 2020b) also show that roughly nineteen out of every twenty people in this group return to their former industry, suggesting that individuals in this group are very likely to return to work at their former workplace. For these reasons, we assign the entire group of those employed but absent for other reasons and unpaid to the temporary unemployed in all of our analyses.

During spring 2020, we also observe an unusual rise in the number of those not in the labor force who are neither retired nor disabled. Between February and April, their share in the population rose from 13.2 to 16.5 percent. We speculate that some of this increase is due to the fluid boundary between nonparticipation and unemployment during the beginning of the COVID-19 recession. In particular, the data indicate increased churning between nonparticipation and temporary unemployment during the pandemic.

Additionally, the share of those recalled to their industry among April separators who are not in the labor force (and want a job and are not searching) mirrors that of the temporary unemployed. Thus, it seems plausible that some of the individuals transitioning from employment to being not in the labor force are really temporarily unemployed but do not report it that way. Allocating the entire group to temporary unemployment due to the increase of 3 percentage points, however, would also mean allocating the roughly 13 percent that form the base of this group even outside of pandemic times to temporary unemployment. It is therefore not possible for us to get a time-consistent way of classifying these individuals that relies only on current responses in the CPS. As a result, we retain this group among those not in the labor force but flag that in April and May 2020 this population consists (to an unusual degree) of individuals closely attached to the labor market and who are expecting to return to work shortly.¹²

Next, we divide the temporary unemployed based on whether they say they are actively searching for a new job while on temporary unemployment. We believe that those actively searching for a job contribute to congestion in the search labor market, while those who are not actively searching are instead waiting to return to work and thus do not contribute to congestion. Empirically, the job-finding rates between these two groups

12. This has consequences for interpreting transition rates involving those not in the labor force during the COVID-19 recession and should be kept in mind when interpreting the counterfactual scenarios which make assumptions about how quickly these transition rates involving nonparticipants return to normal.

Table 1. Labor Force Status, by Month, 2020

<i>Month</i>	<i>Employed/ population</i>	<i>Temporary unemployed and not searching/ population</i>	<i>Temporary unemployed and searching/ population</i>	<i>Permanent unemployed/ population</i>	<i>Out of labor force/ population</i>
January	0.784	0.006	0.001	0.023	0.170
February	0.782	0.006	0.001	0.022	0.171
March	0.766	0.015	0.002	0.022	0.175
April	0.653	0.100	0.009	0.021	0.202
May	0.681	0.076	0.011	0.022	0.196
June	0.698	0.046	0.011	0.030	0.188
July	0.692	0.039	0.012	0.030	0.188

Source: CPS monthly data.

Note: This table reports share of adults age 25–55 in each of the five labor force states for each month of 2020. See the online appendix for more details.

of the temporary unemployed differ, and so this distinction is potentially important.

Interestingly, during the pandemic, those on temporary unemployment and not actively searching return to work at a higher rate than both those actively searching while on temporary layoff and those who have been permanently separated. They are also more likely to rejoin their former industry than those actively searching, suggesting that while both groups describe themselves as awaiting recall, the ones not searching are more likely to be recalled. We capture this in our model by allowing for a higher recall rate for the temporary unemployed who are not searching, as compared to the temporary unemployed who are actively searching.

Ultimately, we allow for five labor market states in our model and empirical analysis: employed (E), temporary unemployed and not actively searching (or waiting, T^w), temporary unemployed and actively searching (T^a), permanent unemployed (P), and not in the labor force (N). The overall unemployment rate combines all unemployed workers ($U = T^a + T^w + P$) and divides by the labor force ($U + E$). The monthly distribution of the prime-age adult population across these five groups in 2020 is shown in table 1. For some of our measurements below, we will combine the two groups of temporary unemployed into a single group ($T = T^a + T^w$).

MEASURING TRANSITION RATES We rely on the CPS matched panel data to estimate transition rates. This section briefly describes how we estimate transition rates between employment, temporary unemployment, permanent unemployment, and nonparticipation (E , T , P , N), and we discuss

below how we measure transition rates for the two types of temporary unemployed (the actively searching and the waiting).

Unfortunately, the transition rates directly estimated using the panel are not consistent with the time series of labor forces states obtained from the monthly cross sections. As discussed in detail in Kroft and others (2016), respondents are more likely to report not being in the labor force when interviewed in later months in the sample, a phenomenon known as rotation group bias.¹³ Left unaddressed, this bias compounds over time in simulated data, with the simulated distributions diverging rapidly from the stocks observed in the cross-sectional data.

To address this inconsistency in the data, we estimate the transition rates in the population in a way that forces consistency with the time series of stocks. To do this, we adapt the approach in Kroft and others (2016) and Kroft and others (2019). We sketch this approach here and provide the exact algorithm in the online appendix.¹⁴

First, we fit the observed labor force distribution across the four states in each month. This results in three restrictions, since we normalize the population to be one each month to abstract from population growth (i.e., $E + T + P + N = 1$). Second, the observed fraction of those on permanent or temporary unemployment with duration ($d = 0$) provides us with two additional restrictions on the job loss rates. We thus require seven ($12 - 5$) additional restrictions to estimate the transition rates. Next, we let $\lambda_t^{X \rightarrow Y}$ and $\lambda_t^{W \rightarrow Z}$ denote the transition rates from state X to state Y and from state W to state Z in period t . We then estimate the ratio $\widehat{\lambda_t^{X \rightarrow Y}} / \widehat{\lambda_t^{W \rightarrow Z}}$ using estimates of each transition rate, and we assume that this ratio of the estimated transition rates is a valid estimate of the ratio of the true transition rates, $\lambda_t^{X \rightarrow Y} / \lambda_t^{W \rightarrow Z}$. We do this for each of the following seven ratios of transition rates:

$$\frac{\lambda_t^{N \rightarrow P}}{\lambda_t^{N \rightarrow E}}, \frac{\lambda_t^{E \rightarrow N}}{\lambda_t^{E \rightarrow P}}, \frac{\lambda_t^{P \rightarrow N}}{\lambda_t^{P \rightarrow E}}, \frac{\lambda_t^{E \rightarrow R}}{\lambda_t^{N \rightarrow R}}, \frac{\lambda_t^{P \rightarrow R}}{\lambda_t^{N \rightarrow R}}, \frac{\lambda_t^{R \rightarrow P}}{\lambda_t^{R \rightarrow N}}, \frac{\lambda_t^{R \rightarrow E}}{\lambda_t^{R \rightarrow N}}$$

This delivers the final seven restrictions needed to identify and estimate the twelve unknown transition rates using a system of twelve linear equations (see the online appendix for the equations). The key assumption is

13. See Krueger, Mas, and Niu (2017) and Ahn and Hamilton (2020) for more detailed discussion of rotation group bias in the CPS.

14. Ahn and Hamilton (2020) discuss an alternative approach to address rotation group bias; their approach, however, requires data on all eight of the months in the sample for each respondent. Clearly, we do not have the ability to use that approach to estimate transition rates in recent months; we follow our approach instead so that we can see how transition rates are changing in the first few months of the COVID-19 recession.

that the biases in the estimated transition rates need to cancel out when we take ratios (i.e., the biases that cause the inconsistencies are proportional across each of the pairs of labor market states above). The resulting adjusted transition rates are thus estimated to impose consistency in stocks from month to month, and we use these adjusted transition rates throughout our analysis. In the next section, we present these transition rates as motivating evidence for our model setup and calibration.

II.C. Motivating Figures

This section presents several figures which show how unique the COVID-19 recession has been, especially with respect to temporary unemployment.

We begin with figure 1, which shows in panel A how the (seasonally adjusted) monthly unemployment rate evolved since 2000 and focuses in on the last twelve months in panel B. (All of the figures in this section will follow this same format.) Between March and April 2020 the unemployment rate spiked by 10 percentage points to just over 15 percent. This is dramatic even when compared with the Great Recession.¹⁵ By July 2020, the economy clawed back about half of this increase, and the unemployment rate stood at just under 10 percent.

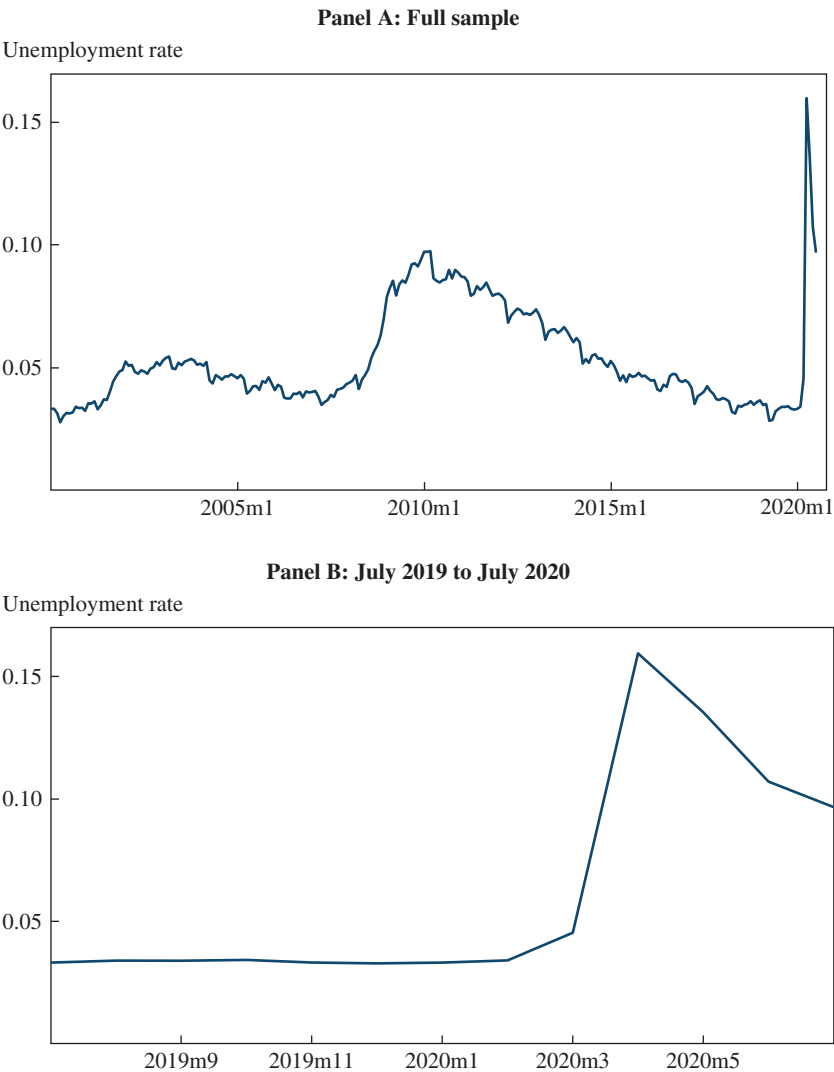
Figure 2 plots the seasonally adjusted number of vacancies from JOLTS. Although there is a clear drop in vacancies in March and April 2020, the drop is far less pronounced than the rise in unemployment. Notably, even at the depth of the crisis, the number of vacancies is comparable to 2015—a period typically acknowledged as being a fairly tight labor market. Similar to the unemployment rate, we start to see evidence of a rebound in May 2020, and by July 2020 more than half of the drop has been reversed.¹⁶

Figure 3 shows the important role of temporary unemployment during the COVID-19 recession. The figure plots the separation rates for three groups: all employed workers flowing into unemployment, into temporary

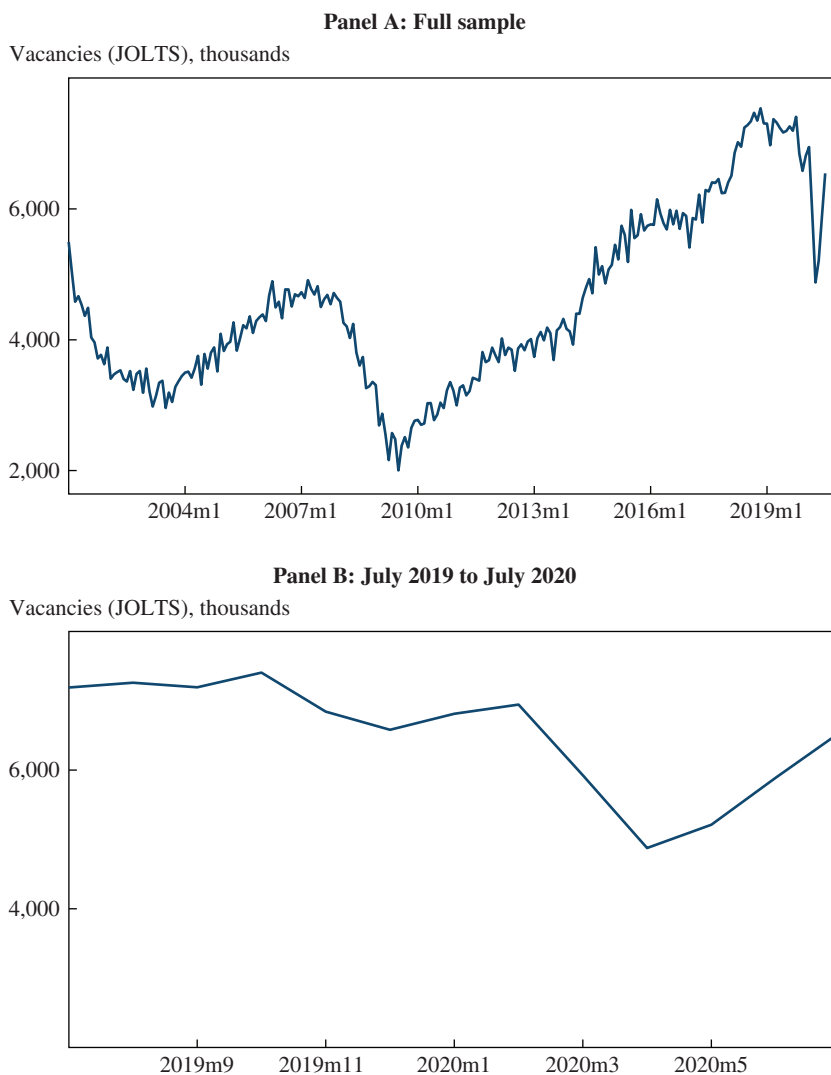
15. As mentioned above, it is worth noting that the BLS believes that the initial spike in the unemployment rate would have been even larger if its survey procedures had been followed correctly. For more details on the measurement of unemployment during the initial months of the COVID-19 recession, see “Impact of the Coronavirus (COVID-19) Pandemic on the Employment Situation for September 2020,” BLS, <https://www.bls.gov/covid19/employment-situation-covid19-faq-september-2020.htm>.

16. Online appendix figure A2 reports the vacancies series alongside the JOLTS quits series and shows a similar rebound for voluntary job quits, as well.

Figure 1. Unemployment Rate, 2000–2020



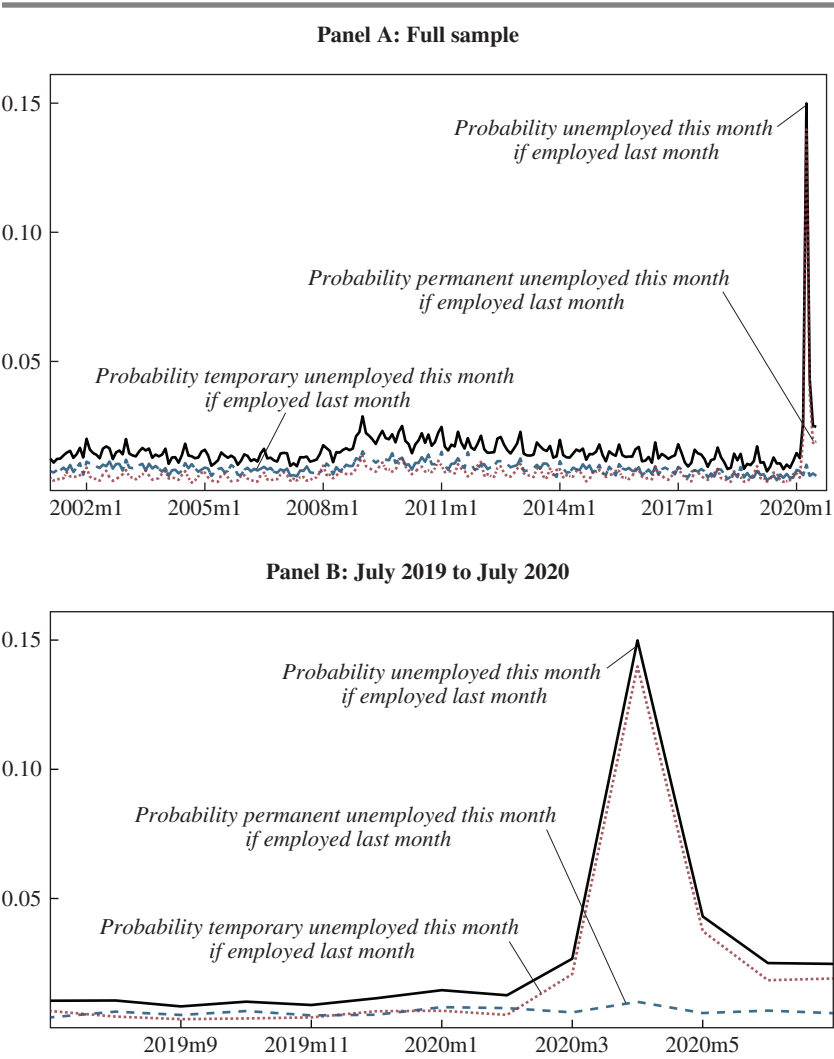
Source: CPS monthly data.
Note: The data are seasonally adjusted by regressing the full time series on month fixed effects that are constrained to be mean zero.

Figure 2. Job Vacancies, 2000–2020

Source: Job Openings and Labor Turnover Survey (JOLTS) vacancy series.

Note: The data are seasonally adjusted by regressing the full time series on month fixed effects that are constrained to be mean zero.

Figure 3. Separation Rates, 2000–2020



Source: CPS monthly data.
Note: This figure reports the adjusted transition rates from employment to unemployment measured using matched panel CPS data.

unemployment, and into permanent unemployment, respectively.¹⁷ This figure shows quite clearly what makes the COVID-19 recession unique: the role of temporary layoffs. Unlike separations for workers who have been permanently laid off—which shows little change during the initial months of the COVID-19 recession—separation rates into temporary unemployment rose dramatically to roughly 15 percent between March and April 2020, explaining virtually all of the increase in job separations overall. By June 2020, separation rates are down to 2–3 percent, but this is still elevated relative to the pre-2020 average, which is less than 1 percent.

With such a huge inflow of temporary unemployed workers into unemployment, we would of course expect the share of the unemployed who are on temporary layoff to rise drastically, and this pattern is shown in figure 4. In normal economic times (and even during the Great Recession), the share of the unemployed on temporary layoff hovers around 20 percent. In April 2020, this share reached 80 percent. By July 2020, the share had fallen to around 60 percent, which is still historically high.

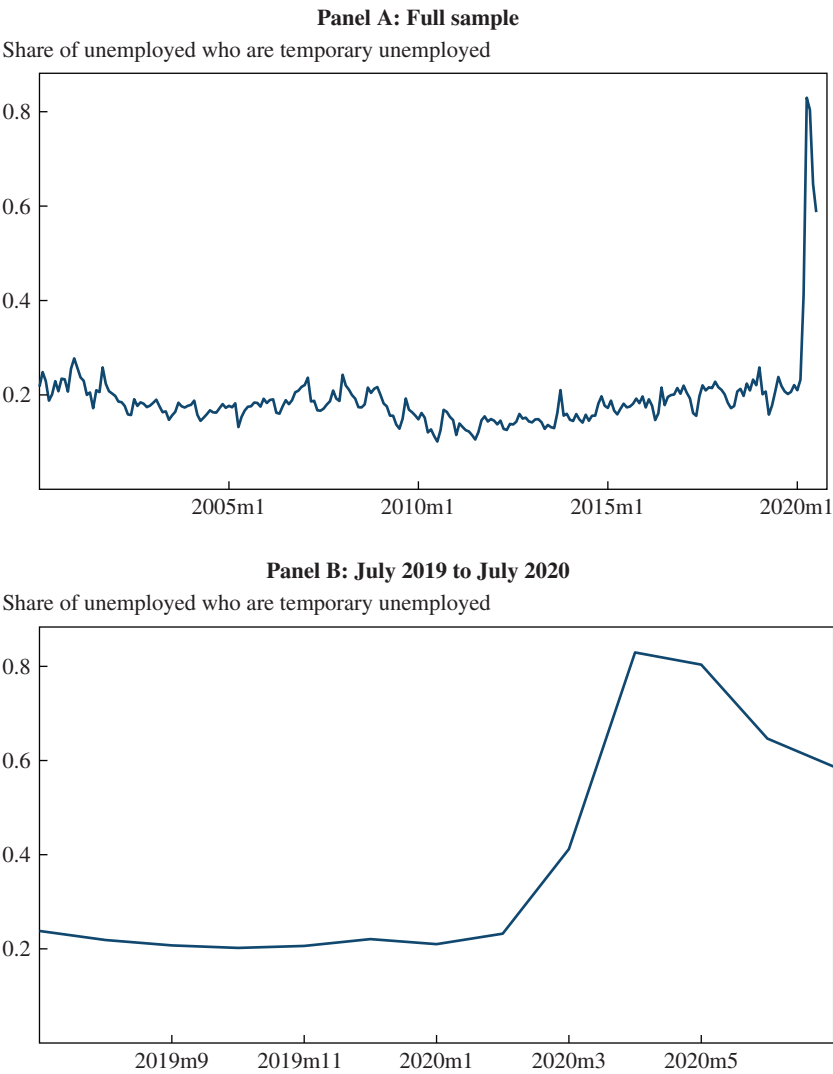
Figure 5 plots the probability of employment in a given month if the worker was unemployed in the prior month (either temporarily or permanently). This is the measure of job-finding rates that we use throughout the paper.¹⁸ Overall, the temporary unemployed have much higher job-finding rates than the permanent unemployed. This fact combined with the sizeable increase in the number of temporary layoffs in April 2020 explains—at least in an accounting sense—the increase in the overall job-finding rate for unemployed workers in May and June 2020.¹⁹ The elevated job-finding rate also explains why the unemployment rate dropped by about 5 percentage points in May and June as many unemployed individuals were recalled to their former jobs.

17. In the online appendix, we present the separation rates for the temporary unemployed, splitting them into two groups: regular temporary layoffs as classified by the BLS and individuals who are “employed but absent for other reasons and unpaid,” which we have reclassified as temporary unemployed in this paper. Here we see that the transition rates for the former group increase quite substantially, while the transition rates for the latter group also increase, but to a lesser extent.

18. In the online appendix, we show that the regular temporary unemployed workers and those employed but absent from work for other reasons and unpaid have very similar job finding rates. This suggests that classifying the latter group as temporarily unemployed is appropriate during the last few months. This approach of classifying workers based on their job-finding rates follows Jones and Riddell (1999).

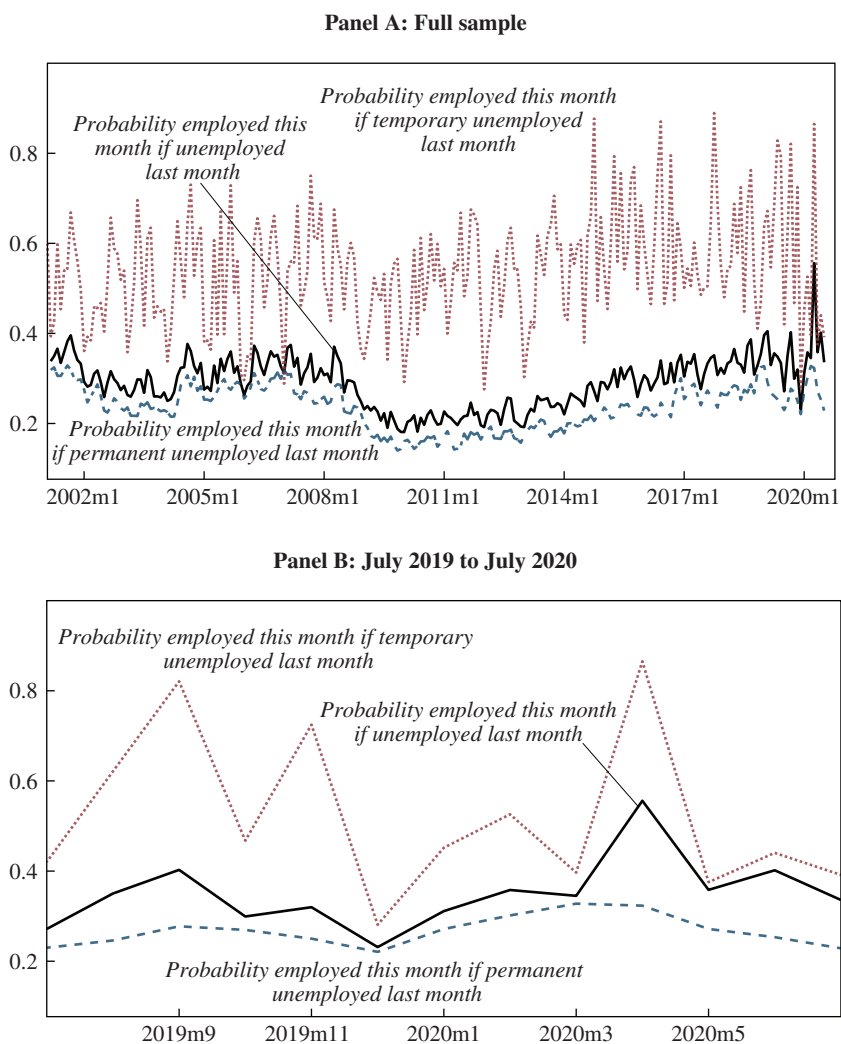
19. Note there is a one-month lag since they enter into unemployment in April and thus the job-finding rate for these individuals is based on employment status in May and June.

Figure 4. Share of Unemployed on Temporary Layoff



Source: CPS monthly data.

Note: This figure reports the seasonally adjusted share of the unemployed on temporary layoff. The data are seasonally adjusted by regressing the full time series on month fixed effects that are constrained to be mean zero.

Figure 5. Job-Finding Rates for the Temporary and Permanent Unemployed

Source: CPS monthly data.

Note: This figure reports the adjusted transition rates from unemployment to employment measured using matched panel CPS data. Transitions into employment require the individual to report being employed for two consecutive months (i.e., they are UEE transitions in the CPS).

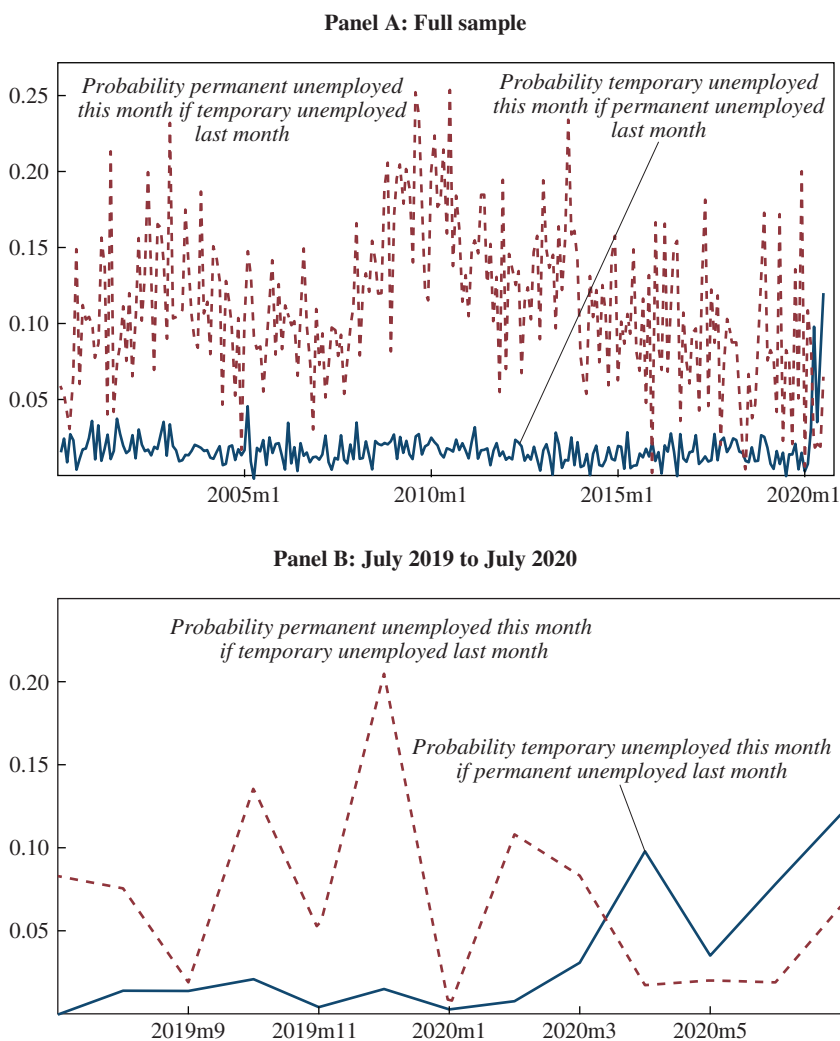
Conditional on type of unemployed, we do not see much evidence that job-finding rates declined substantially for either temporarily or permanently unemployed individuals during the COVID-19 recession. During the Great Recession, declines in the outflows from unemployment played a large role in leading the labor market into a prolonged slump. By contrast, the COVID-19 downturn is characterized by a rapid, unprecedented increase in the inflows into temporary unemployment, with relatively muted overall changes in the outflow rate conditional on type of unemployment. What has led to a change in job-finding rates is the compositional shift toward temporary unemployment which increased outflows from unemployment over the pandemic period.

An important concern about temporary layoffs is that they can become permanent layoffs as the COVID-19 recession worsens, as emphasized in Katz (1986) and Katz and Meyer (1990). Figure 6 plots the average probability that a temporary unemployed worker becomes permanently unemployed as well as the probability of the reverse event. The chance of transitioning from P to T is much smaller than the probability of a transition in the opposite direction. In recent months, however, there has been an extremely sharp rise in the $\lambda_t^{P \rightarrow T}$ transition rate and also increases in the transition rates between nonparticipation and temporary unemployment. It does seem as if the boundaries between the different states of nonemployment are particularly fluid during the pandemic.

During normal times, about 10 percent of temporary unemployed transition to permanent unemployment. This rate was slightly lower during the initial months of the COVID-19 recession with an uptick in July.²⁰ According to the most recent data available at the time of writing, some workers who were initially expecting to be recalled when their unemployment spell began have been permanently laid off, transitioning from temporary to permanent unemployment. Given the continued elevated number of temporarily unemployed workers, it is possible that flows from temporary to permanent unemployment begin to increase the stock of permanent unemployed. We assess this possibility below using predictions from our calibrated model.

At this point, we capture only the first few months after layoff for many workers who are currently unemployed. It is possible that more workers

20. Prior to the COVID-19 recession there were relatively few workers in temporary unemployment. As a result, our estimates of monthly transition rates are very noisy pre-2020. Estimated rates are much smoother since March 2020 when there are many more temporary unemployed workers.

Figure 6. Transition Rates between Temporary and Permanent Unemployment

Source: CPS monthly data.

Note: This figure reports the seasonally adjusted transition rates between temporary and permanent unemployment using the matched panel CPS monthly data covering the period 2000–2020. The data are seasonally adjusted by regressing the full time series on month fixed effects that are constrained to be mean zero. The temporary unemployed includes individuals waiting to be recalled as well as those actively searching and also includes individuals who report being employed but were unpaid and absent from work for other reasons.

transition from temporary to permanent unemployment as the recession continues and unemployment durations lengthen. Online appendix figure A3 shows that the probability of transitioning from temporary to permanent unemployment increases with the duration of the unemployment spell, starting from around 10 percent in the initial month of unemployment and reaching 15–20 percent about six to eight months later. This figure suggests that as the COVID-19 recession continues, more workers might move into permanent unemployment due to this particular kind of duration dependence—the longer a temporary unemployed individual is unemployed, the more likely the individual is to transition into permanent unemployment.

III. Search-and-Matching Model with Temporary Unemployment

The previous section described trends in unemployment and vacancies, and highlighted the importance of temporary unemployment in recent months. Using these figures as motivation, we now develop a search-and-matching model with temporary unemployment that builds on and extends our model in Kroft and others (2016). We begin with the basic setup, and then we discuss the “forcing variables” that we treat as exogenous in the model. We then describe the (endogenous) job-finding rates that are determined by the matching model. Lastly, we describe our approach to estimation and calibration, report our estimated model parameters, and assess the fit of the model in sample and in recent months.

III.A. Model Setup

We allow for four labor force states that display persistence. The persistent states are E , N , P , and T . The states E and N refer to employment and nonparticipation (not in the labor force); permanent unemployment (P) refers to unemployed workers who have been permanently laid off and are actively searching, and T refers to unemployed workers who are on temporary layoff. For all unemployed workers (P and T), we measure the ongoing duration of their unemployment spell, which we index by d .

In addition to these four primary labor force states, we also distinguish among the temporary unemployed between those who are “actively searching for work” (T^A) and those waiting to be recalled (T^W), so that $T = T^A + T^W$. The states T^A and T^W are transitory in that we assume that at the beginning of a period, individuals who are temporarily unemployed are randomly assigned to either T^A or T^W with probability $q_t = Pr(T^A|T)$.

Conditional on being in labor force state T , this probability is independent of all other past variables, and it is directly estimated as the share of those in temporary unemployment who respond that they are actively searching for work. As this share q_t changes over time it captures variation in how many individuals on temporary unemployment contribute to congestion in the matching process.

The transitory identity of the temporary unemployed (T^A or T^W) only affects job-finding rates, and we describe how we model these job-finding rates in section III.C below. Both types of temporary unemployed individuals have the same transition rates to (N, P) and from (E, P, N) . One key advantage of this setup is that we can estimate transition rates from the larger group of all temporary unemployed workers prior to the COVID-19 recession, which allows for more precise and stable estimates. More importantly, by making the two temporary unemployment states transitory, we ensure that we do not have to account for the unemployment duration dynamics in each state separately. This modeling compromise is primarily motivated by the relatively small number of temporary unemployed workers in the pre-2020 period, and by our desire to calibrate the model entirely on pre-2020 data.²¹ Empirically, we do observe some persistence in these states, but our approach can still capture the congestion effect from increased search as the temporary unemployed move from waiting to searching.

Given this setup, we need to keep track of transitions between the four primary states $(E, T(d), P(d), N)$, and we index the unemployment states by d to emphasize that transition rates may vary by duration. We use $\lambda_t^{X \rightarrow Y}$ to denote the transition rate from state X to state Y in time t .²² For those on temporary unemployment, we separately model the job-finding rates $\lambda_t^{T^W(d) \rightarrow E}$ and $\lambda_t^{T^A(d) \rightarrow E}$ for those waiting and actively searching.

21. If we instead had allowed for persistence in A and W , then we would also need to account for the different duration structure within these groups and would have to model transition rates conditional on these durations separately.

22. Our notation allows for nonzero transitions between d and d' even when $d' \neq d + 1$, which does occur fairly frequently in the CPS panel, where transitions occur across the entire duration distribution. This needs to be accounted for, otherwise the dynamics of the duration structure evolve erratically in the counterfactual simulations. As in Kroft and others (2016), we estimate the empirical distributions of unemployment durations that individuals transition into, and we use these distributions in our counterfactual scenarios for transitions $\lambda_t^{X \rightarrow Y(d)}$ where $X \in \{E, N\}$ and $Y \in \{T, P\}$, and we also estimate $\lambda_t^{T(d) \rightarrow P(d)}$ and $\lambda_t^{P(d) \rightarrow T(d)}$ empirically, as well. This estimation approach is described in more detail in the online appendix.

III.B. Forcing Variables

Our forcing variables are the vacancy rate, the job-finding rate (denoted $\lambda_t^{T^W \rightarrow E}$) for those on temporary unemployment who are not actively searching (and thus waiting to be recalled), and all transition rates that do not involve flows into employment. The latter include the job-separation rates $\lambda_t^{E \rightarrow Y}$ for $Y \in (T(d), P(d), N)$ and the transition rates between the different nonemployment categories ($\lambda_t^{X \rightarrow Y}$, for $X \in (T(d), P(d), N)$ and $Y \in (T(d), P(d), N)$). Unlike the permanent unemployed and the temporary unemployed who are actively searching, we do not allow for duration dependence in the job-finding rates for the temporary unemployed not actively searching (i.e., the job-finding rate is allowed to vary over time but does not vary with d). This assumption is broadly supported by the evidence in online appendix figure A1, which shows a clearer pattern of negative duration dependence for the temporary unemployed who are actively searching, compared to the temporary unemployed who are not actively searching.

The transition rates involving the temporary unemployed (other than the job-finding rates) are assumed to be the same for those waiting and for those actively searching; that is, $\lambda_t^{E \rightarrow T^W(d)} = \lambda_t^{E \rightarrow T^A(d)} = \lambda_t^{E \rightarrow T(d)}$.

We measure these exogenous forcing variables from the data directly. When we explore counterfactual simulations, we assume different time paths for these forcing variables and explore what they imply for job-finding rates and the endogenous distributions of labor market states.

III.C. Job-Finding Rates

The main endogenous objects are the job-finding rates, which depend on market tightness and on search effort exerted by the different types of nonemployed. Market tightness is defined as the ratio between vacancies and aggregate search across all nonemployed. Aggregate search S_t includes the search effort by N , $P(d)$, and $T(d)$ workers.

The total number of matches in time t is determined by the following $M(S_t, V_t)$ function:

$$(1) \quad M(S_t, V_t) = m_0 (S_t^\alpha V_t^{1-\alpha}).$$

The match rate per unit of search effort is given by

$$\frac{M(S_t, V_t)}{S_t} = m_0 x_t^{1-\alpha},$$

where $x_t = \frac{V_t}{S_t}$ is market tightness (the ratio of vacancies to total search effort). The job-finding rate for each type is equal to the group-specific search effort times the match rate.

JOB-FINDING RATES FOR THE PERMANENT UNEMPLOYED AND THOSE NOT IN THE LABOR FORCE Search effort of the permanent unemployed with duration $d = 0$ is normalized to one, and the search effort of all other groups is measured relative to this group. Search among the permanent unemployed with duration d is given by the declining, always positive function $A(d)$, with $A(0) = 1$. Consequently, the job-finding rate at time t for the permanent unemployed with duration d is:

$$(2) \quad \lambda_t^{P(d) \rightarrow E} = \text{Prob}(E_t | P_{t-1}(d)) = A(d) m_0 x_t^{1-\alpha}.$$

Those out of the labor force (N) search with intensity $s \in [0,1]$, which is estimated within the model and is fixed over time. Consequently, their job-finding rate is:

$$(3) \quad \lambda_t^{N \rightarrow E} = \text{Prob}(E_t | N_{t-1}) = s m_0 x_t^{1-\alpha}.$$

These expressions are similar to those Kroft and others (2016).

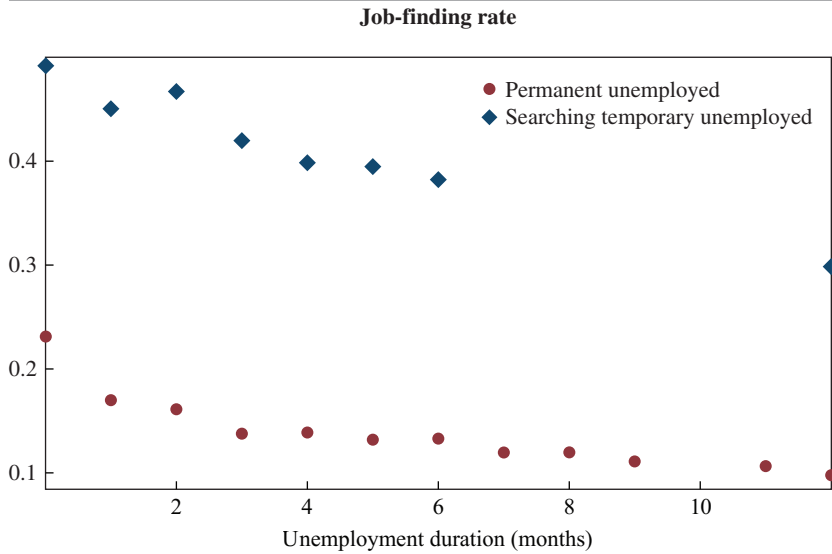
JOB-FINDING RATES FOR THE TEMPORARY UNEMPLOYED In our model, the waiting temporary unemployed ($T^w(d)$) do not congest the labor market, and their job-finding rate is given by the exogenous forcing variable $\lambda_t^{T^w \rightarrow E}$.

The job-finding rates of the temporary unemployed who are actively searching are partially endogenous. In particular, each period the actively searching temporary unemployed are either directly recalled, rehired as a result of their search, or remain nonemployed.

We assume that those actively searching for work among the temporary unemployed are less likely to be recalled to their former employer, so that the recall rate for $T_t^A(d)$ is $\pi \lambda_t^{T^w \rightarrow E}$, where $0 < \pi < 1$.

The parameter π captures the notion that this group of individuals is actively searching precisely because they understand that they are less likely to be recalled this period. Note that π does not vary over time or with duration.

Conditional on not being recalled, the temporary unemployed actively searching search at the same rate as the permanent unemployed of the same duration $P_t(d)$, and so they consequently find new employment conditional on not being recalled at the same rate. Figure 7 shows (proportionally) similar negative duration dependence among the actively

Figure 7. Duration Dependence in Permanent and Temporary Unemployment

Source: CPS monthly data.

Note: This figure reports how the job-finding rate varies with unemployment duration for the permanent unemployed and the temporary unemployed (restricted to those who are actively searching for work). This figure reports the average monthly job-finding rate by unemployment duration, pooling data from the 2001–2019 sample period. We omit durations where there are fewer than 150 observations in the data.

searching temporary unemployed and the permanent unemployed, which supports this assumption.

Given this setup, the job-finding rate of T^A is given by the following expression:

$$(4) \quad \lambda_t^{T^A(d) \rightarrow E} = \pi \lambda_t^{T^W \rightarrow E} + (1 - \pi) \lambda_t^{T^P \rightarrow E}.$$

We estimate π by solving equation (4) for π each month using the observed job-finding rates, and then averaging across months using the pre-2020 data. This leads to the following estimate for π :

$$(5) \quad \hat{\pi} = \frac{1}{T} \sum \frac{\tilde{\lambda}_t^{T^A \rightarrow E} - \tilde{\lambda}_t^{P \rightarrow E}}{\tilde{\lambda}_t^{T^W \rightarrow E} (1 - \tilde{\lambda}_t^{P \rightarrow E})}.$$

The $\tilde{\lambda}$ notation indicates that we calculate each transition rate using a common duration distribution, which we implement by re-weighting each

of the transition rates to have the same duration distribution. We feel this approach is more robust because of the rapidly changing duration structure of temporary unemployment in 2020, and we calculate our estimate of π using this approach, since in principle π could also vary by unemployment duration.

LABOR MARKET TIGHTNESS Three groups contribute to labor market tightness in this model: P , T^A , and N , where the first two groups are composed of individuals with different unemployment durations.

As in Krueger, Cramer, and Cho (2014), unemployed individuals with different durations contribute to overall search in proportion to their job-finding rates. Define $\bar{P}_t$ as the following weighted average of the permanent unemployed in time t :

$$\bar{P}_t = \sum_{d=1}^D A(d) P_t(d)$$

The variable $\bar{P}_t$ accounts for how changes in the unemployment duration distribution affect total search effort. Intuitively, if the permanent unemployed are mostly long-term unemployed, then they have lower job-finding rates and contribute less to labor market tightness.²³

In our model, we extend this logic to the temporary unemployed. Since we assume the temporary unemployed are actively searching for jobs at the same rate as the permanent unemployed (conditional on duration and conditional on not being recalled), then we can define an analogous weighted average for the active temporary unemployed as follows:

$$\bar{T}_t^A = \sum_{d=1}^D A(d) T_t^A(d).$$

Now we are ready to obtain our expression for total search S_t :

$$(6) \quad S_t = \bar{P}_t + (1 - \pi \lambda_{t_i}^{T^W \rightarrow E}) \bar{T}_t^A + s N_t.$$

Together with equation (1) and vacancies V_t , we can calculate time-varying market tightness and the matching rates needed to determine the endogenous job-finding rates. The new term in equation (6) relative to Kroft and others (2016) and Krueger, Cramer, and Cho (2014) is the separate contribution of the temporary unemployed to market tightness, which is scaled by the probability that they are not recalled and end up actively searching for work.

23. As described by Krueger, Cramer, and Cho (2014), this is one way the long-term unemployed were “on the margins” of the labor market during the Great Recession.

III.D. Estimation and Calibration of Model Parameters

To calibrate the model, we broadly follow the procedure outlined in Kroft and others (2016), adapted to our model that allows for temporary unemployment. We briefly summarize the approach here and refer the reader to the online appendix and Kroft and others (2016) for more details.

First, we use the CPS to estimate stocks and transition rates of the labor market states, as described in section II.A above, and we assign flows from nonparticipation into unemployment using the pre-2020 average distribution of unemployment durations that nonparticipants transition into.

Next, we estimate the $A(d)$ function that characterizes how the job-finding rate varies with unemployment duration using the same functional form as Kroft and others (2016), $A(d) = (1 - a_1 - a_2) + a_1 \exp(-b_1 \times d) + a_2 \exp(-b_2 \times d)$. We pool the pre-2020 data on job-finding rates for the unemployed and report the nonlinear least squares estimates in table 2. We estimate the $A(d)$ function pooling together the temporary unemployed who are actively searching and the permanent unemployed, since figure 7 suggests that the job-finding rate declines proportionally for both groups.²⁴ For comparison, table 2 reports the parameter estimates from Kroft and others (2016), which are very similar to the $A(d)$ estimates based on the full 2001–2019 sample period. This suggests a fairly stable relationship between unemployment duration and the job-finding rate.

Lastly, we estimate the remaining model parameters by minimizing the distance between the observed job-finding rates of the unemployed and the model-implied job-finding rates over the entire pre-2020 sample period. We report these estimates in table 2 as well. We find fairly similar matching model parameter estimates for the full 2001–2019 period as we found in Kroft and others (2016) using only pre-2008 data, but with a slightly lower search intensity of nonparticipants.

III.E. Model Fit

To assess the fit of the model we compare the observed and predicted job-finding rates both in-sample (through the entire pre-2020 sample period) and out-of-sample throughout the first half of 2020. This exercise confirms the results in Kroft and others (2016) and Krueger, Cramer, and Cho (2014) that this kind of search-and-matching model (accounting for nonparticipation and long-term unemployment) can do a good accounting

24. When we estimate $A(d)$ separately for $T^A(d)$ and $P(d)$ we find similar parameter estimates, so we opted for a single $A(d)$ function for both groups for simplicity.

Table 2. Model Parameter Estimates

<i>Model</i>	<i>Full model with temporary unemployment</i>	<i>Model with no temporary unemployment^a</i>	
	2001–2019 (1)	2001–2019 (2)	2001–2007 (3)
<i>Sample period for model estimation</i>			
<i>Duration dependence parameters</i>			
a_1 (intercept parameter 1)	0.273	0.275	0.314
a_2 (intercept parameter 2)	0.426	0.431	0.393
b_1 (slope parameter 1)	1.658	1.027	1.085
b_2 (slope parameter 2)	0.065	0.099	0.055
where $A(d) = (1 - a_1 - a_2) + a_1 \exp(-b_1 \times d) + a_2 \exp(-b_2 \times d)$			
<i>Temporary unemployment parameter</i>			
π (recall rate of temporary unemployed who are actively searching relative to those who are waiting)	0.324	.	.
<i>Matching model parameters</i>			
α (exponent in matching function)	0.717	0.729	0.753
m_0 (scale parameter)	0.422	0.495	0.435
s (relative search intensity of nonparticipants)	0.265	0.220	0.218

Sources: Authors' calculations; Kroft and others (2016).

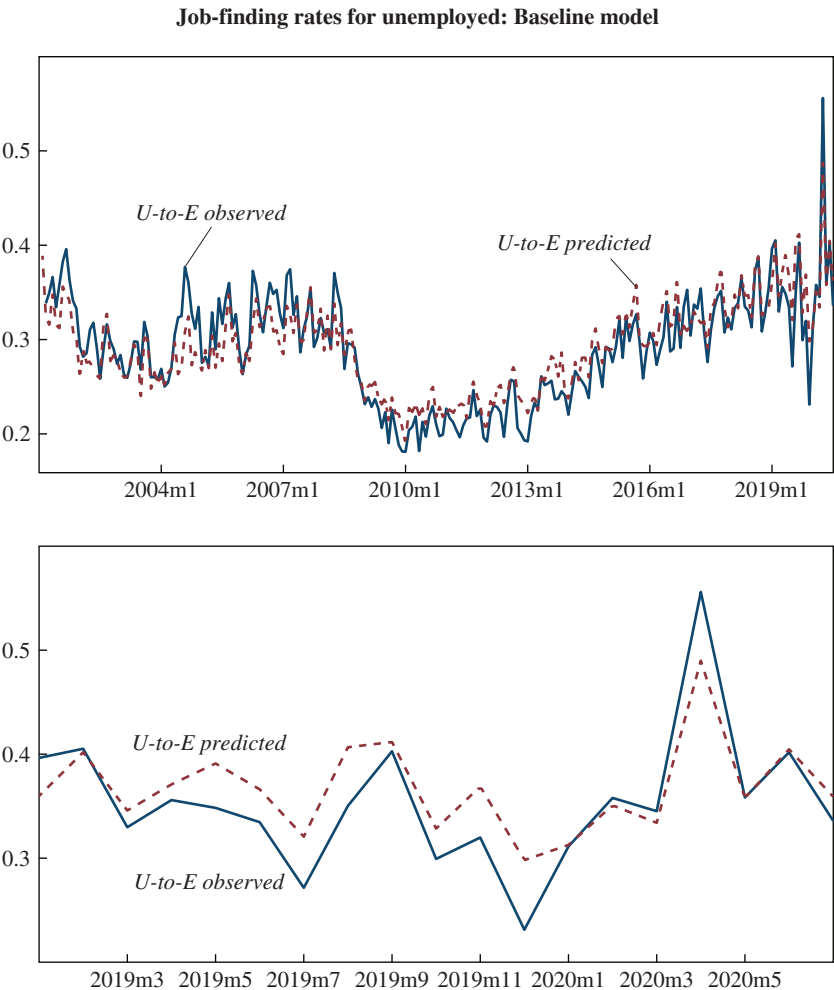
Note: This table reports parameter values from each step of the model calibration. The first set of estimates are the duration dependence parameters, which are estimated using nonlinear least squares and the job-finding rates from the matched CPS monthly data. The second set of estimates are the parameters for temporary unemployed, which are directly measured using the CPS data and are based on averages taken over the entire 2001–2019 sample period. The final set of estimates are the matching model parameters, which are estimated by minimizing the distance between the observed job-finding rates and the job-finding rates predicted by the model during the 2001–2019 period. Column 1 reports estimates for the baseline model in this paper that distinguish between temporary and permanent unemployment, while columns 2 and 3 report estimates for the model in Kroft and others (2016), which does not model temporary unemployment, using data for the 2001–2019 and 2001–2007 sample periods, respectively.

a. Kroft and others (2016).

for labor market dynamics during and after the Great Recession, and our results here show that the model continues to fit well all the way up through the end of 2019.

It is perhaps not surprising that the model fits well up through December 2019 since the distinction between permanent and temporary unemployment is relatively unimportant prior to 2020. However, the model also fits well in 2020 up through July. Figure 8 shows the in-sample and out-of-sample fit for all unemployed individuals, and figure 9 shows the fit of the job-finding rates separately for the permanent and temporary unemployed.

Figure 8. Assessing the In-Sample and Out-of-Sample Fit of the Baseline Model



Sources: CPS monthly data; authors' calculations.

Note: This figure reports the model-generated predicted job-finding rates for unemployed workers, where the predictions are based on model estimates calibrated to match the 2001–2019 time period. The overall job-finding rate of the unemployed is calculated by taking a weighted average of the job-finding rates of the temporary and permanent unemployed.

Figure 9. Further Assessing the In-sample and Out-of-Sample Fit of the Baseline Model

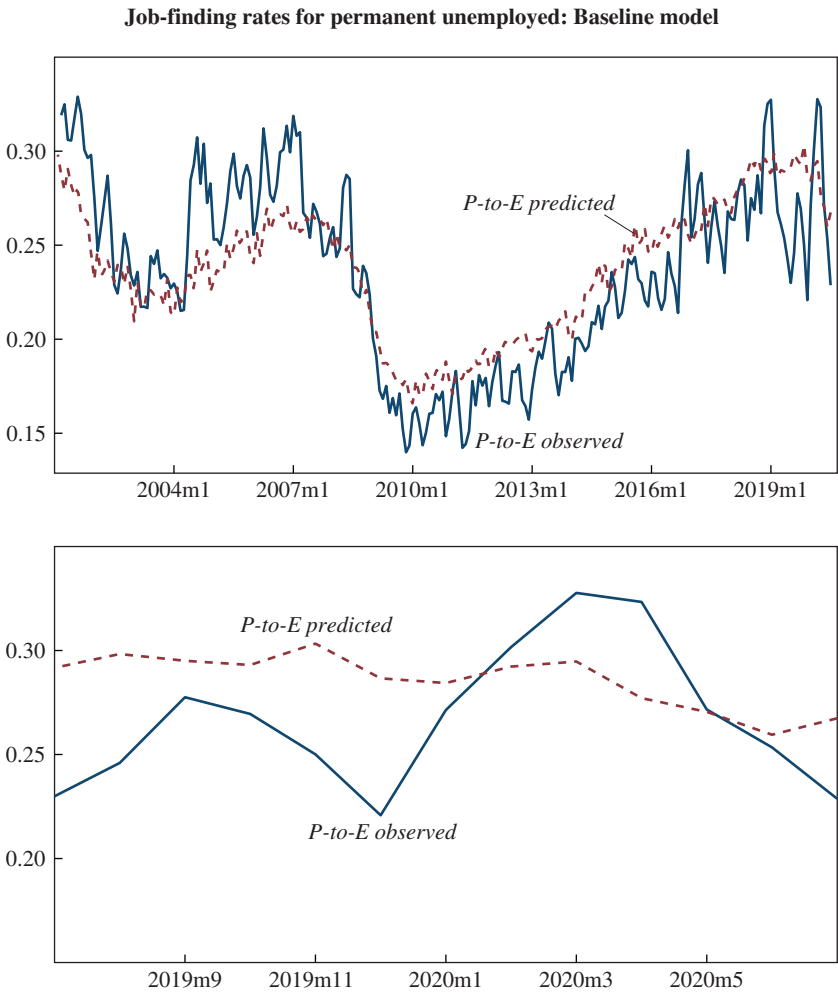
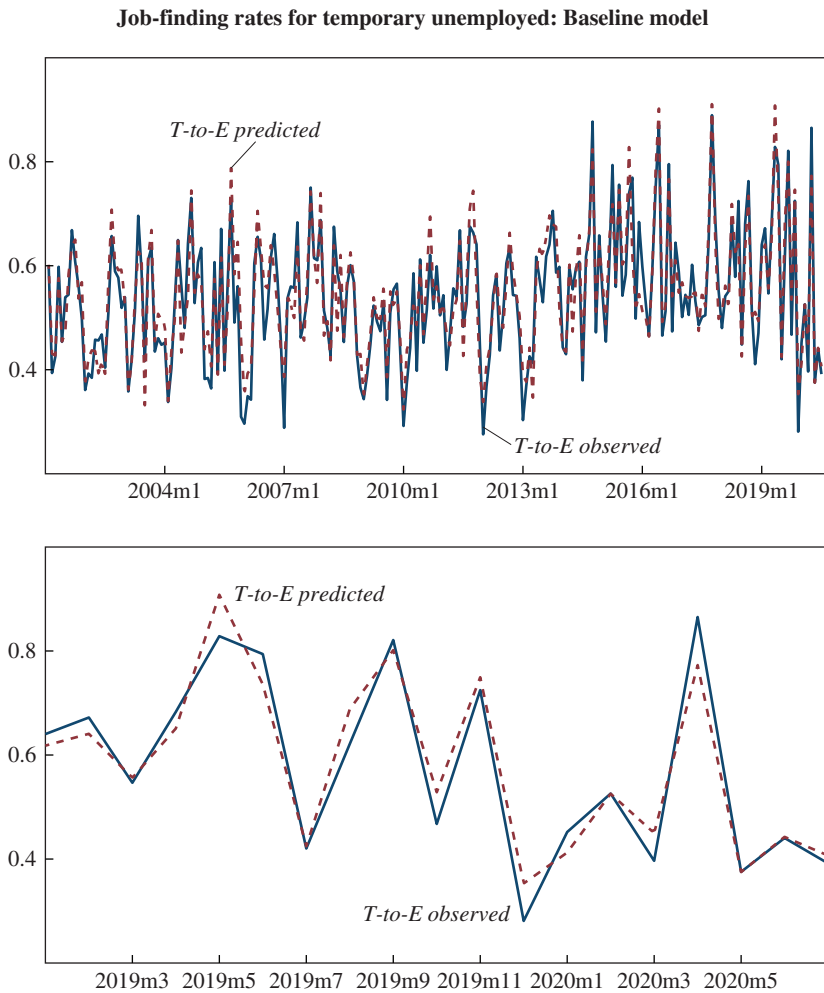


Figure 9. Further Assessing the In-sample and Out-of-Sample Fit of the Baseline Model
(Continued)

Sources: CPS monthly data; authors' calculations.

Note: These figures report the model-generated predicted job-finding rates for the permanent and temporary unemployed, where the predictions are based on model estimates calibrated to match the 2001–2019 time period. The predicted job-finding rate for the temporary unemployed is a weighted average of the job-finding rate of the actively searching, which is predicted by the model, and the observed job-finding rate of the waiting temporary unemployed. The observed job-finding rate of the permanent unemployed is seasonally adjusted and smoothed by taking a three-month moving average.

We note that we take the path of job finding among the waiting temporary unemployment as given, which surely helps in fitting the overall job-finding rate of the temporary unemployed.

Comparing the good fit of predicted and observed job-finding rates through July 2020 with those from a model that does not account for temporary unemployment leads us to conclude that including temporary unemployed is key to the good out-of-sample predictive power of the model. In particular, the model by Kroft and others (2016), estimated on data up to 2019, also fits well in-sample (see the top panel of figure 10). However, that model predicts much lower job-finding rates in 2020 than observed in the data.²⁵ Strikingly, observed job-finding rates *increase* in 2020. The model that does not distinguish between temporary and permanent unemployment predicts instead a steady drop in job-finding rates as shown in the bottom panel of figure 10.²⁶

Since the model proposed here fits well out-of-sample during the first several months of the COVID-19 recession, we use it to shed light on several economic phenomena. First, we use the model to understand movements in the Beveridge curve; second, we use the model to simulate changes in the unemployment rate through the end of 2021.

IV. Temporary Unemployment and the Beveridge Curve

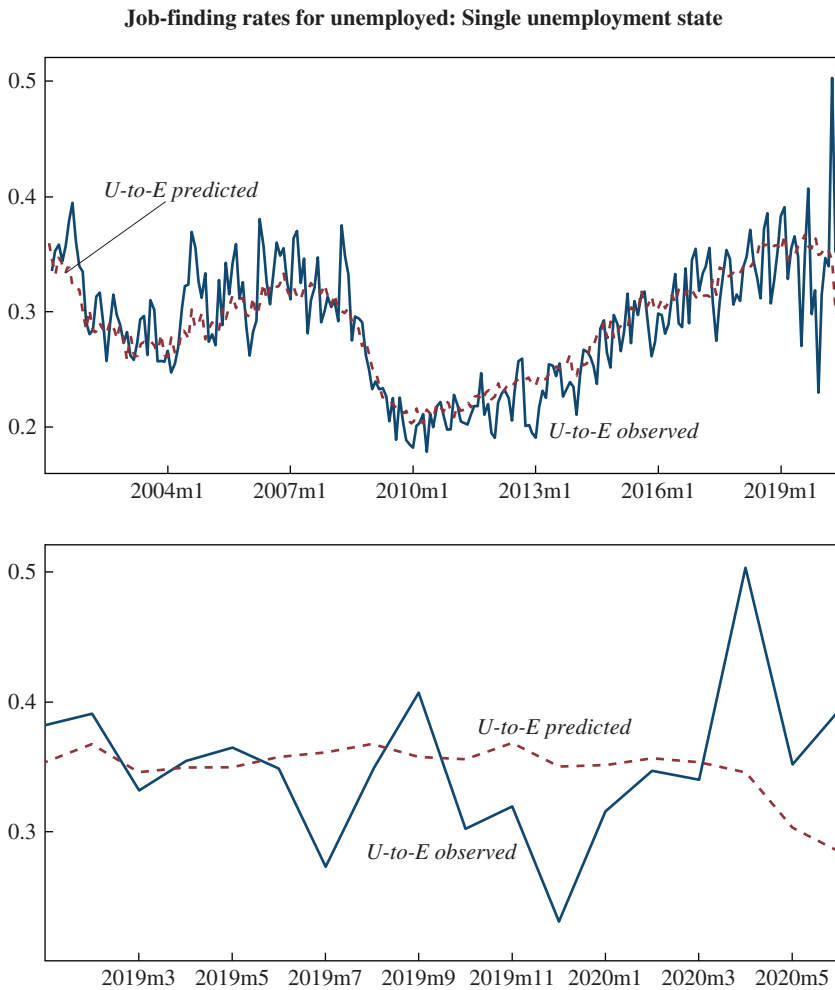
Our first use of the calibrated model is to understand movements along the Beveridge curve at the start of the COVID-19 recession. Panel A of figure 11 shows the dramatic movement of the Beveridge curve in recent months, with a substantial increase in unemployment without a correspondingly large decrease in job vacancies.²⁷ Typically, the Beveridge curve loops around counterclockwise during recessions, with vacancies falling while unemployment rises, and then during the economic recovery unemployment falls and vacancies rise, but along a curve that appears to have shifted

25. We obtain similar parameters estimating the model by Kroft and others (2016) using the data up to 2019 than we get using pre-2008 data (see column 2 of table 2), which confirms that the model by Kroft and others (2016) is well suited to model job-finding rates up to recent events.

26. It also is apparent that the overall in-sample fit is better allowing for temporary unemployment, but this is unsurprising since there are more parameters and more forcing variables used. What is striking to us is that the trend in job-finding rates carries the wrong sign in 2020 in the model by Kroft and others (2016) without temporary unemployment.

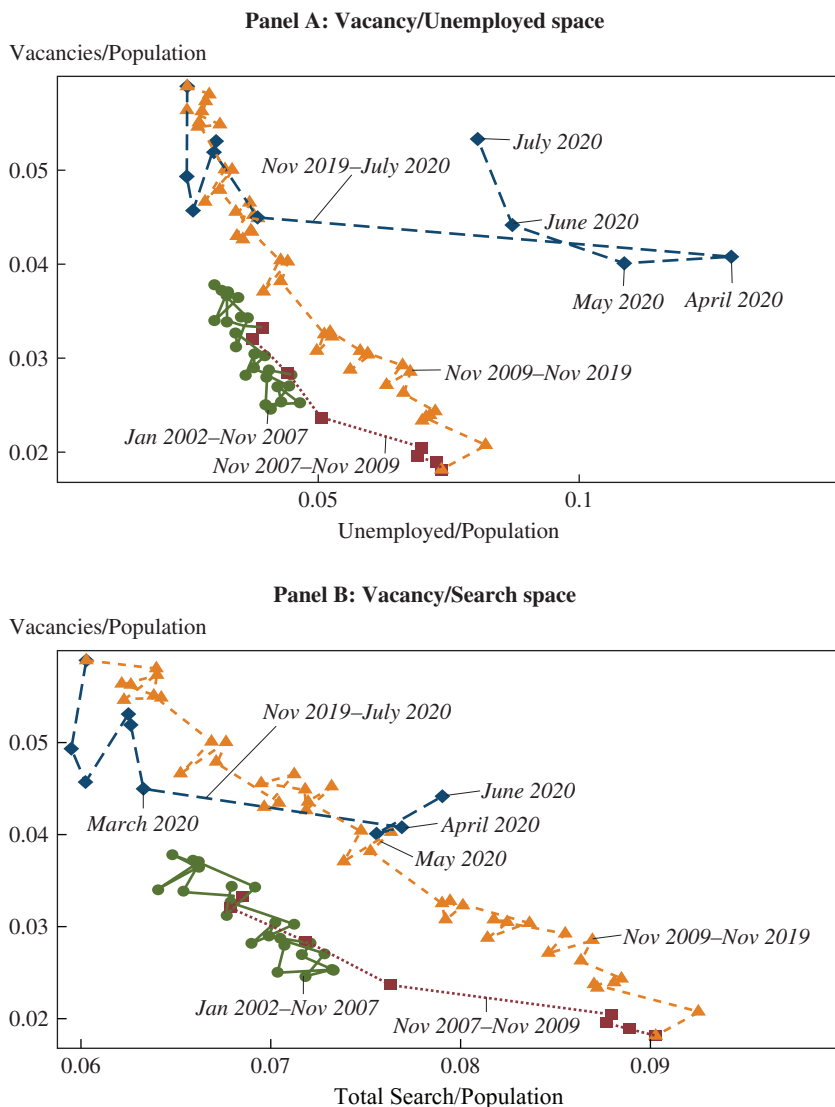
27. This matches the reduced form effort in Forsythe and others (2020b) to adjust the Beveridge curve for searching unemployment by just relying on those they classify as being in the “open market.”

Figure 10. Calibrated Model without Temporary Unemployment Has Poor Out-of-Sample Fit in 2020



Sources: CPS monthly data; authors' calculations.

Note: This figure reports the predicted job-finding rates for unemployed workers generated by the model in Kroft and others (2016) which does not distinguish between the temporary and permanent unemployed. The predictions are based on model estimates calibrated to match the 2001–2019 time period.

Figure 11. Beveridge Curves

Sources: JOLTS vacancy series; CPS monthly data; authors' calculations.

Note: Panel A reports the Beveridge curve relationship between vacancies and unemployment, scaling both measures by the total prime-age adult population. Panel B adjusts for the composition of the unemployed population using the calibrated model (normalizing each group relative to the search effort of a newly unemployed worker). This measures market tightness as the ratio of vacancies to the total search effort (V/S_t). Since temporary unemployment is very high in recent months and in the calibrated model the temporary unemployed search much less, this composition adjustment restores the shape of the Beveridge curve in recent months and leads to much less of an outward shift during the beginning of the COVID-19 recession.

outward somewhat. Kroft and others (2016) explain part of this apparent outward shift as resulting from duration dependence interacting with the historic increase in long-term unemployment during the Great Recession. In the language of the model above, total search effort was lower than would normally be indicated by the unemployment rate, since the share of unemployed who were long-term unemployed was very high.

Since unemployment surged so quickly and vacancies did not collapse in the middle of 2020, the ratio of unemployed workers to vacancies reached roughly 3:4, similar to the ratio observed during the depths of the Great Recession. Such a high ratio of U/V usually indicates substantial labor market slack, with many unemployed workers competing over scarce vacancies. In this situation, additional search by newly unemployed workers normally creates congestion in the matching process and reduces job-finding rates for everyone actively searching for a job.

This is in fact exactly what the calibrated model that ignores the distinction between temporary and permanent unemployment predicts. Without accounting for temporary unemployed, the model sees many newly unemployed workers searching over a small number of vacancies, and this causes job-finding rates to collapse (see figure 10). But this is not observed during the middle of 2020; instead, overall job-finding rates for the unemployed in May 2020 and June 2020 exceeded almost every other month during the entire 2001–2019 time period. We resolve this tension by distinguishing between the temporary unemployed (who are largely simply waiting to be recalled) and the permanent unemployed. Since the former are waiting and not searching, they do not affect the job-finding rate in the search market. Thus, we can account for record numbers of unemployed individuals with a fairly tight labor market and relatively high job-finding rates for all those who are actively searching.

What does this have to do with the Beveridge curve? In panel B of figure 11, we show a Beveridge curve with the search effort adjusted by scaling each type of nonemployed worker by their search effort. This corresponds exactly to the S_i term in the model described above. Quantitatively, this means that the contribution of the temporary unemployed to S_i is scaled down since some of them are waiting to be recalled, just like the long-term unemployed on permanent layoff are scaled down because they search less than newly unemployed workers who have been permanently laid off.

The resulting Beveridge curve is much more well-behaved during 2020. In fact, there is now little evidence of any outward shift, suggesting little change in matching efficiency or labor market tightness during the early months of the COVID-19 recession. In the online appendix, we show other

versions of the Beveridge curve looking at just the temporary unemployed and the permanent unemployed, similar to how Krueger, Cramer, and Cho (2014) report a Beveridge curve separately for the short-term and long-term unemployed. These figures support our interpretation that the temporary unemployed are key to understanding the puzzling movements in the Beveridge curve in 2020.

We conclude that the large number of workers on temporary layoff at the start of the COVID-19 recession led to much less of a change in market tightness than if all of these workers had been permanently laid off. As workers on temporary layoff transition to permanent layoff, however, our model predicts a greater contribution to market tightness, although the effect is still muted somewhat since both temporary unemployed and permanent unemployed experience negative duration dependence.

This analysis helps understand recent survey data from the Conference Board indicating that only 24 percent of workers say that jobs are hard to get.²⁸ This is much lower than the survey responses workers gave during the Great Recession, even though the official unemployment rate was higher in recent months than at any point during the Great Recession. In fact, the responses in recent months are fairly similar to 2015, when the unemployment rate was at 5.3 percent; this lines up well with our adjusted Beveridge curve in mid-2020, which hovers around the 2015 data points.

V. Counterfactual Simulations

We next use our calibrated model to forecast how the labor market will evolve in the next eighteen months. Key to our counterfactual experiments will be the evolution of the forcing variables, which include the job-separation rates, the job-finding rates for the temporary unemployed waiting to be recalled, and the vacancy rate. The endogenous variables are the job-finding rates for the permanent unemployed, the nonemployed, and the temporary unemployed who are actively searching. These job-finding rates feed back into the stocks of the unemployed of various types which allow the unemployment distribution to evolve endogenously.

The forcing variables are determined by economic forces that are beyond the scope of this paper. As an example, consider the recovery from a recession driven by a shortfall in demand. In such recoveries, the key driver is the path of demand: firms want to have enough workers to meet the

28. The Conference Board, "Consumer Confidence Survey," <https://conference-board.org/data/consumerconfidence.cfm>.

demand for their products, and they adjust their layoffs, recalls, and vacancies appropriately.

It is possible that the dynamics in the labor market are entirely driven by the economic forces that determine the forcing variables of our model. For this to be true, the short-run dynamics would have to play out very quickly. However, our prior work (Kroft and others 2016) and the work of Krueger, Cramer, and Cho (2014) indicate that this is not always the case. In particular, both papers found that during the Great Recession, failing to account for the distribution of unemployment durations caused the search-and-matching model to perform significantly worse than a richer model that allowed for both duration dependence and movements in and out of the labor market—in terms of matching the overall unemployment rate, the Beveridge curve, and the long-term unemployment share. Given this prior work, it is plausible a priori that search-and-matching frictions could be important factors in determining labor market dynamics during the COVID-19 recession as well.

We consider two scenarios. Our baseline scenario assumes that it will take the forcing variables—evaluated at their June 2020 values—twenty-four months to linearly converge back to the pre-period rates, taken to be the average rate of these forcing variables in the twelve months prior to March 2020. The second scenario is more pessimistic—imposing that the forcing variables remain at their June 2020 values indefinitely, meaning that there is no recovery in the vacancy rate or the separation rate over the next two years. Comparing these two scenarios informs whether a stalling of the recovery might lead to persistent scarring in the labor market.

Table 3 shows the values of the forcing variables for the twelve-month pre-period as well as each month since March 2020 (up to July 2020, the most recent data available). While E to T transition rates have dropped from their peak level in April, they still remain elevated in June 2020 at a level three to four times higher than the pre-period average. By contrast, the E to P and E to N rates have both returned to normal by June 2020. Most of the other forcing variables have returned to normal, with the exception of the N to T and N to P rates, which are higher than normal, the P to T rate (which is also higher than normal), and the recall rate for the waiting temporary unemployed, which is somewhat lower than normal.

We start by examining the predictions of our baseline scenario in figure 12. This figure shows the unemployment rate declining more rapidly than predicted by professional forecasts. By December 2020, our model predicts an unemployment rate of 6.7 percent, which is below the available professional forecasts—the CBO (10.5 percent in 2020:Q4) and the Federal

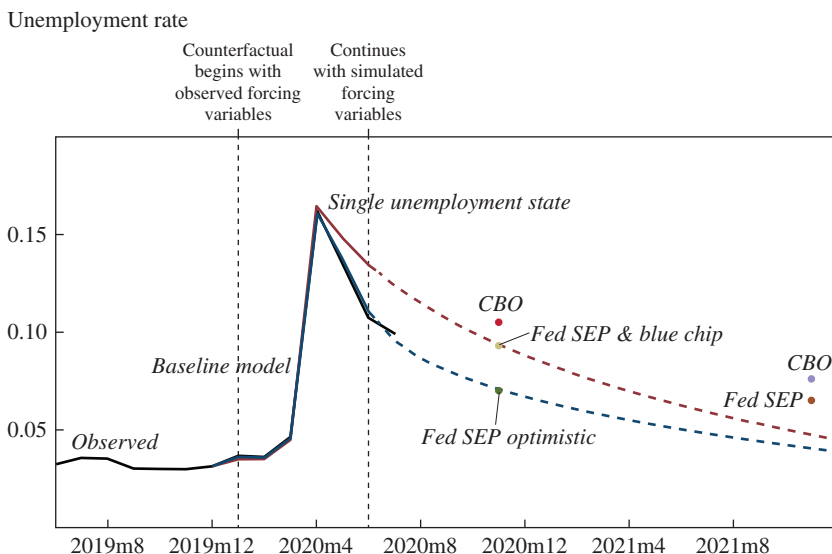
Table 3. Forcing Variables before and during the COVID-19 Recession

<i>Forcing variables</i>	<i>Mar 2019–Feb 2020 (average)</i>	<i>Mar 2020</i>	<i>Apr 2020</i>	<i>May 2020</i>	<i>Jun 2020</i>	<i>Jul 2020</i>
Vacancies	7,108,250	5,857,000	5,305,000	5,222,000	5,843,000	6,949,000
E to N transition rate	0.0229	0.0174	0.0527	0.0408	0.0237	0.0231
E to T transition rate	0.0049	0.0208	0.1398	0.0374	0.0184	0.0191
E to P transition rate	0.0057	0.0059	0.0100	0.0057	0.0066	0.0056
T to P transition rate	0.1119	0.3724	0.1477	0.0342	0.0504	0.0389
T to N transition rate	0.1806	0.5345	0.5708	0.1437	0.1287	0.1275
P to N transition rate	0.4028	0.3712	0.6359	0.4186	0.3207	0.2289
P to T transition rate	0.0167	0.0291	0.0881	0.0506	0.1213	0.1314
N to P transition rate	0.0545	0.0482	0.0464	0.0474	0.0735	0.0511
N to T transition rate	0.0036	0.0090	0.0321	0.0585	0.0467	0.0394
Share of temporary unemployed searching	0.1808	0.1082	0.0832	0.1236	0.1942	0.2340
Job-finding rate of waiting temporary unemployed	0.6418	0.4555	0.8048	0.3728	0.4510	0.4163

Source: CPS monthly data.

Note: This table reports each of the forcing variables used in the baseline model and shows values leading up to July 2020. Each of the transition rates is estimated using the CPS monthly data (both the CPS cross-sections and the matched panel). See online appendix for more details on the construction of the transition rates.

Figure 12. Comparing Forecasts between Baseline Scenario and Model without Temporary Unemployment

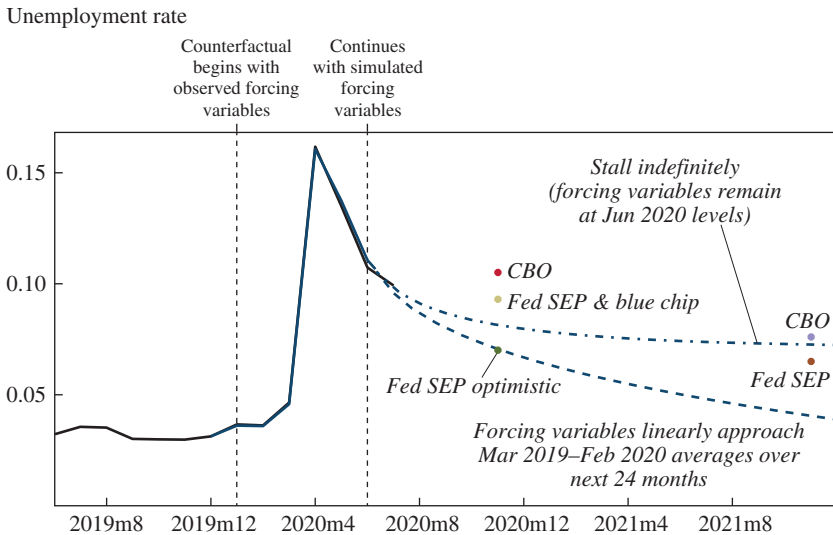


Sources: CBO Economic Outlook; Federal Reserve Summary of Economic Projections; authors' calculations.

Note: This figure reports the simulated unemployment rate from the baseline calibrated model and the model in Kroft and others (2016) ("Single Unemployment State"), which does not distinguish between permanent and temporary unemployment. The Congressional Budget Office (CBO) and Federal Reserve Summary of Economic Projections (Fed SEP) August 2020 forecasts of the unemployment rate in December 2020 and 2021 are presented for comparison.

Reserve Summary of Economic Projections Blue Chip (above 9 percent in 2020:Q4). Academic and business economists surveyed by the *Wall Street Journal* expect the unemployment rate to be 8.1 percent by the end of 2020 (although the experts surveyed just one month earlier, in August 2020, predicted an unemployment rate of 9 percent in December 2020). The figure also indicates that the baseline scenario continues to predict unemployment at a rate below the forecasts throughout 2021.

We next consider the role of temporary unemployment by comparing the baseline model to the model in Kroft and others (2016), which we call the "single unemployment state" model, since it does not distinguish between permanent and temporary unemployment. This model predicts a much higher unemployment rate over the next several months that is somewhat more in line with the professional forecasts. However, this model performs much worse in terms of its out-of-sample fit during the first half of 2020, and this model would have already overpredicted unemployment in June,

Figure 13. Comparing Baseline Scenario to Stalling Out Scenario

Sources: CBO Economic Outlook; Federal Reserve Summary of Economic Projections; authors' calculations.

Note: This figure reports the simulated unemployment rate from the baseline calibrated model under two different scenarios: a steady convergence and a stalling out. The Congressional Budget Office (CBO) and Federal Reserve Summary of Economic Projections (Fed SEP) August 2020 forecasts of the unemployment rate in December 2020 and 2021 are presented for comparison.

July, and August 2020. This was clear from the previous section which showed that this model also substantially underpredicts the overall job-finding rate of the unemployed. We also note that the distinction between temporary and permanent unemployment is relevant as of August 2020 when the temporary unemployed share was hovering around 50 percent. This suggests that the difference between the two models would still be present if one started the forecasts in August, rather than in June.

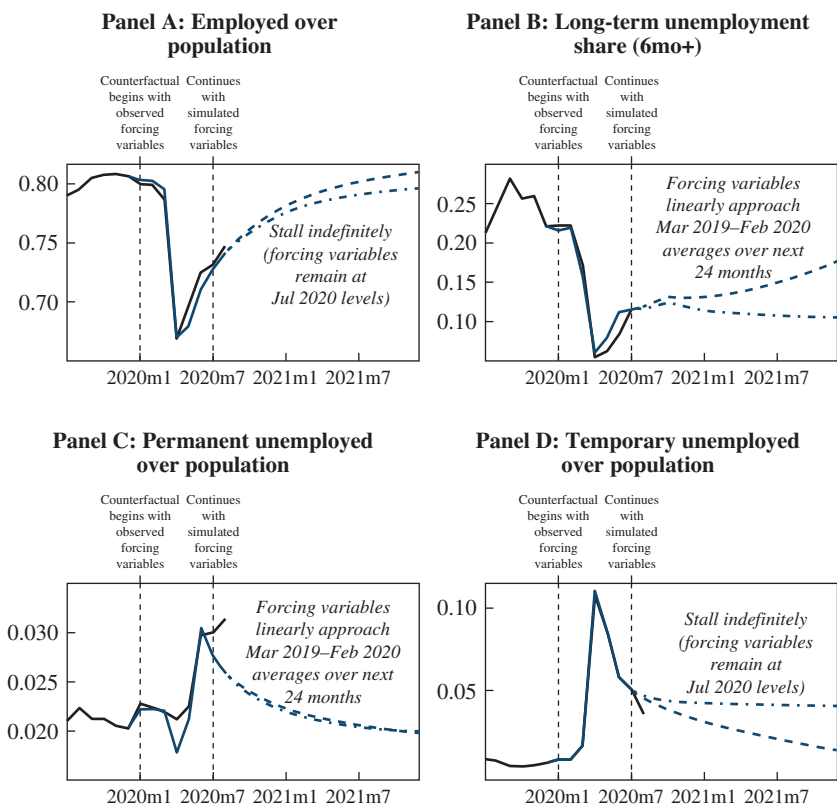
Figure 13 presents our next comparison, which compares our baseline scenario to the stalling scenario, where the forcing variables remain stuck at their June 2020 levels indefinitely. The main takeaway here is that the more pessimistic scenario projects values of unemployment that come closer overall to the CBO and the Federal Reserve Summary of Economic Projections forecasts over the next eighteen months. One interpretation of this figure is that for the professional forecasts to be correct, the labor market has to stall out for an extended period of time, with continued high flows from employment to temporary unemployment sustaining elevated unemployment rates, and labor demand remaining below prerecession

levels. We believe this scenario to be pessimistic and unlikely, since the trend in the forcing variables between May and June has mostly been positive: separations into temporary unemployment have been falling and vacancies have been rebounding. Recall rates have not been increasing substantially, but they still remain quite high and close to pre-period average levels. Thus, for the CBO and Federal Reserve Summary of Economic Projections forecasts to be correct, our model implies that there must be a deterioration in labor demand—not just a slow convergence, but a U-turn in current trends in job separations and job vacancies, or a deterioration in the recall rates of the waiting temporary unemployed.

To further understand the labor market dynamics of our calibrated model, figure 14 displays forecasts for the employment-to-population ratio, the long-term unemployment share, and the permanent and temporary unemployed share of the population. Panel A shows a steady increase in the employment-to-population ratio over the next eighteen months in both scenarios, with a somewhat slower increase in the stalling scenario. Panel B shows that both scenarios do not lead to a substantial increase in long-term unemployment, defined as the share of the unemployed out of work for six months or longer.

Panels C and D decompose the unemployed into permanent and temporary unemployment. Starting with permanent unemployment, we see that the model fits fairly well out-of-sample, although there is a slight divergence in August 2020 with permanent unemployment rising faster than the model predicts. The starting point for the two counterfactual series is 3 percent of the population in June 2020. This is about 40 percent higher than the rate observed in February 2020. The reason for the drop comes in part from the fact that inflows into permanent unemployment—while elevated in April 2020—have largely reverted back to trend by June 2020. Additionally, even though the rate of vacancy posting has declined by about 20 percent relative to the pre-period, the overall level of vacancies is still quite high. Thus, outflows from unemployment to employment have continued to remain fairly high. According to our model, as long as job vacancies hold up at the currently observed levels, the stock of the permanent unemployed will decline to something relatively close to the pre-period levels in the next twelve months.²⁹

29. The second reason why the stock of permanent unemployed is predicted to decline is because the transition rate from permanent to temporary unemployment is unusually elevated in recent months. As we have discussed above, it does seem as if the boundary between permanent unemployment and temporary unemployment is more fluid at this point, and we believe that this is unlikely to continue as the flow into temporary unemployment declines.

Figure 14. Decomposing Unemployment Rate Forecasts

Sources: CPS monthly data; authors' calculations.

Note: This figure reports the simulated ratios of the permanent unemployed, temporary unemployed, and employed to population and the share of long-term unemployment from the baseline calibrated model under two different scenarios: a steady convergence and a stalling out.

Turning next to temporary unemployment, panel D of figure 14 shows that since April 2020 there has been a pronounced drop in the temporary unemployment rate. This has been mostly responsible for the observed drop in the overall unemployment rate. Our projections indicate that this rate will continue to drop, though much more slowly for the more pessimistic scenario. The reason for the rapid drop in the temporary unemployment rate is that temporary unemployment, as its label indicates, is very much a transient state with monthly job-finding rates at or above 50 percent. Even though the recall rate has declined somewhat during the pandemic, it remains high. This is perhaps a bit surprising as one might have expected

the number of business closures during the pandemic to affect recall rates. Moreover, it also to some extent explains why we do not predict a building up of the stock of permanent unemployment through T to P transitions. Since recall rates have remained quite high, we do not see an elevated risk that individuals will transition from temporary to permanent unemployment. In fact, looking at table 3, T to P rates in June 2020 are actually *lower* than their normal (pre-2020) values.³⁰

While our baseline scenario is more optimistic than prominent existing forecasts, it is worth cautioning against this optimism for several reasons. It may indeed be the case that the labor market worsens and reverses its trend, and we explore this possibility in additional scenarios. The online appendix reports figures for all of these scenarios; here we summarize the conclusions for the unemployment rate forecasts. One reason the labor market could change course could be, for example, if the COVID-19 recession stimulus policies—such as the Paycheck Protection Program or the unemployment insurance supplemental payments—were keeping labor demand propped up during mid-2020, and so the end of these programs could lead to a sharp drop in labor demand.

We first consider a scenario where a decrease in labor demand leads to a 50 percent decline in the vacancy rate and the recall rates for the temporarily unemployed (relative to June 2020 values). This decline occurs during the second half of 2020 and then stalls out at these depressed levels for the next twelve months. Compared to our baseline model, we see higher unemployment rates that are more in line with the Federal Reserve Summary of Economic Projections forecasts, although even in this extremely pessimistic case the rates projected by the model still fall short of the CBO forecasts. We show in the online appendix that essentially all of the increase in unemployment is coming from the drop in recall rates, as opposed to the drop in job vacancies. The reason is that temporary workers dominate the unemployed pool and so the unemployment rate is much more sensitive to

30. Our discussion here has focused on permanent and temporary unemployment, but our model is also able to predict trends in nonparticipation. In the online appendix (figure A24), we report predictions for the nonparticipation rate, defined as the ratio of nonparticipants to the population. In both scenarios, we see that the model predicts a continuous drop in the share of nonparticipants; the decline, however, is more drastic in the more pessimistic scenario. The reason for this difference has to do with the elevated outflows from nonparticipation in June 2020. In particular, the rates of N to T and N to P flows are elevated. As a result, the scenario that holds these forcing variables for the next two years at their currently elevated levels leads to a more rapid outflow from nonparticipation and thus lower nonparticipation rates.

changes in labor demand for these workers than changes in labor demand for workers actively searching for a job.

While the previous counterfactual focused on outflow rates driven by firm hiring, the next counterfactual focuses on separation rates. Here we consider the scenario where all job separations (E to N , E to P , and E to T) increase by 50 percent over the next six months. In this case, we find a rise in unemployment that comes much closer to professional forecasts, including CBO forecasts. This demonstrates that, at least at the time of the forecast, inflows are relatively more important for the recovery of the labor market than the path of vacancies and recall rates. Nevertheless, this illustrates again that for the professional forecasts to be right there has to be a substantial deterioration in labor market flows. We think this scenario is also fairly unlikely, since this increase in job separations would bring separation rates up to the levels that prevailed during the Great Recession.

Overall, the counterfactual scenarios we consider do not suggest a very strong tendency for the wave of job loss that occurred in March–June 2020 to generate a stock of permanent unemployed, and the online appendix also shows that we do not see a surge in long-term unemployment as was seen during the Great Recession, consistent with the results in Chodorow-Reich and Coglianesi (2020). We know that other combinations of shocks can lead to the kind of hysteresis observed during the Great Recession (where negative duration dependence amplifies an initial adverse shock). By contrast, if we allow for duration dependence and transitions from temporary to permanent unemployment, we still predict a fairly rapid reduction in the unemployment rate, which we believe is largely driven by the relatively strong labor demand that is still observed in July 2020.

VI. Conclusion

This paper develops a search-and-matching framework that prominently features temporary unemployment alongside permanent unemployment and distinguishes between short-term and long-term unemployment. We show that accounting for this heterogeneity among the unemployed is crucial for understanding the dynamics of the COVID-19 recession up to July 2020. Ignoring this heterogeneity will lead to substantially overestimating unemployment.

We calibrate our extended search-and-matching model and use it to forecast unemployment under different assumptions on the path of the exogenous forcing variables, recognizing that these forcing variables may be potentially endogenous to broader economic forces that are beyond

the scope of this paper. Our main result is that the calibrated model projects an unemployment rate that is much lower compared to a model that ignores the distinction between temporary and permanent unemployment and compared to existing professional forecasts. In particular, we find that if we assume that it takes separation rates and vacancies two years to return to their prerecession levels, the unemployment rate is projected to fall rapidly.

What explains the difference between our model forecasts and the professional forecasts? One possibility is that the professional forecasts are based on the path of unemployment in historical recessions. As Elsby, Hobijn, and Şahin (2010) show, recessions are normally characterized by an initial period when inflows into unemployment rise as the rate of separation increases. This is then followed by a period of reduced job-finding rates as a result of lower labor demand and hence rising unemployment. The COVID-19 recession resembles the front end of this dynamic. Similar to past recessions, it began with a dramatic increase in inflow rates. Unlike past recessions, however, outflows from unemployment have remained fairly high. In part, this is due to a composition effect, as the higher outflow rates are driven by the relatively high rates of reemployment among the temporary unemployed. Additionally, labor demand as proxied by job vacancies is somewhat lower than before the start of the COVID-19 recession but remains elevated.

Our analysis shows that assuming that the unemployment outflow rate follows the dynamics of past recessions may cause one to overstate the severity of the COVID-19 recession. We conjecture that this is one of the main reasons behind the pessimistic forecasts. In fact, our findings indicate that in order for our model to rationalize the professional forecasts, separation rates would need to further increase by more than 50 percent. A similar drop in vacancies and recall rates, although increasing the predicted unemployment rate, still cannot fully explain the gap between our forecast and professional forecasts.

We conclude that our model provides some rigorous support for measuring labor market slack taking into account the composition of the unemployed—in particular, accounting for the distinction between temporary and permanent unemployment (and the share of the temporary unemployed who are actively searching) and the distinction between short-term and long-term unemployment. We believe this adjusted measure of labor market slack provides more useful guidance to forecasters and policy-makers, and our analysis leads to a more nuanced interpretation of recent labor market struggles. While it is tempting to draw inferences about the path

of the labor market from aggregate statistics on the state of the labor market, our findings demonstrate the important role of unemployment heterogeneity. In the case of the COVID-19 recession, past recessions may not be the most reliable guide to the future.

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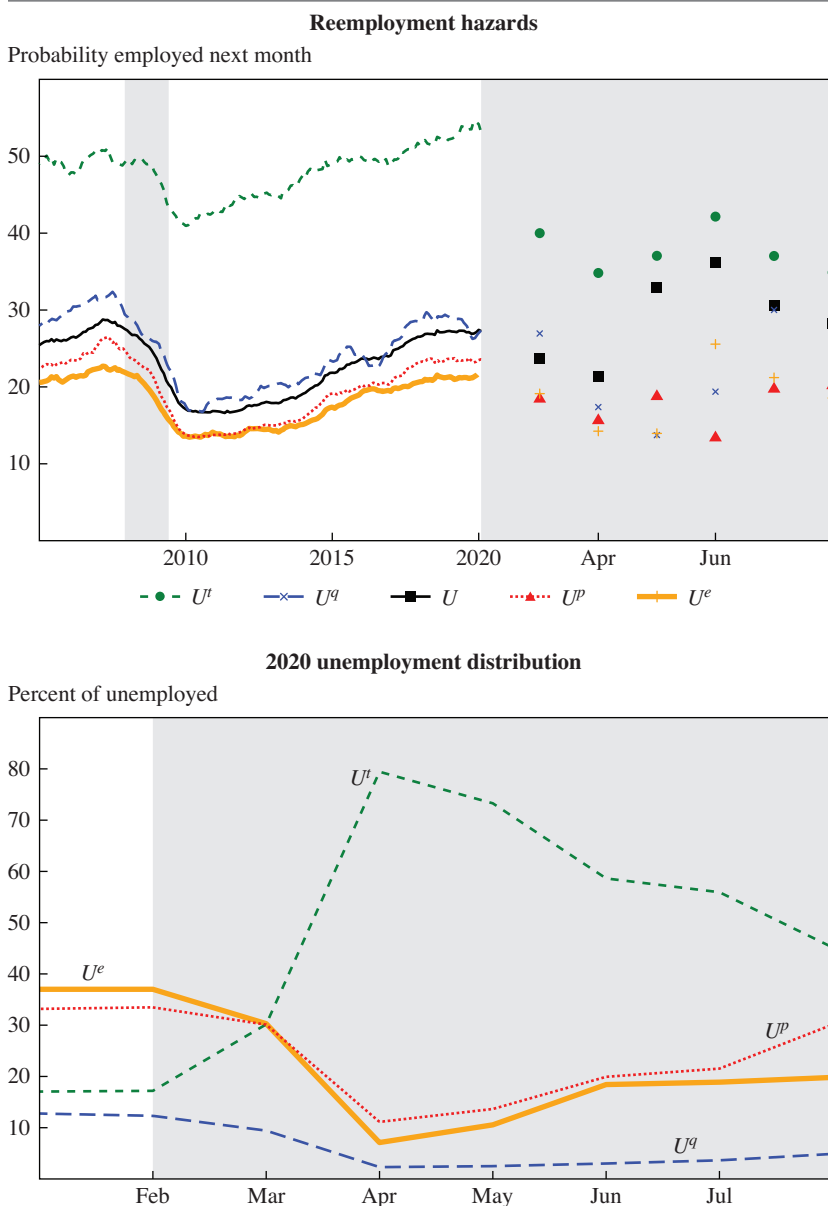
Comment and Discussion

COMMENT BY

GABRIEL CHODOROW-REICH Jessica Gallant, Kory Kroft, Fabian Lange, and Matthew J. Notowidigdo provide a very nice summary of the COVID-19 labor market to date and an optimistic forecast of the path forward. In this discussion, I will play the skeptic's role and elucidate the forces that may temper their optimism. To get there, I will start with a brief overview of the COVID-19 labor market, then review the authors' exercise, and finally present three key questions about the future of the recovery and highlight where their forecast omits potentially adverse forces.

LABOR MARKET OVERVIEW Gallant and her colleagues provide a comprehensive overview of the labor market in the early months of the COVID-19 recession. Four features merit special emphasis. First, despite the unprecedented magnitude of the flows across labor market states, the matching process has remained relatively stable once one conditions on the type of unemployment. That is a key result for the authors. Second, there has been a historically high share of unemployed on temporary layoff who traditionally have high reemployment rates. Third, separation rates into unemployment have remained high even as the labor market has recovered. The fourth is an implication of the previous: there is a lot of churn.

Figure 1, adapted from Chodorow-Reich and Coglianese (2020), summarizes the unusual nature of transitions from unemployment into employment. The top panel shows the historical average reemployment hazard rates by type of unemployment and the hazard rates during the COVID-19 recession, computed from the basic monthly Current Population Survey (CPS) micro data files. After falling in March and April, the overall reemployment hazard from unemployment rose to a historically high level, as shown by the black squares. At the same time, the reemployment hazard for those on temporary layoff, shown in the round dots, and permanent

Figure 1. Reemployment Heterogeneity

Source: Current Population Survey and author's calculations.

Notes: The top panel plots the reemployment probabilities from unemployment overall (U) and the subcategories unemployed-temporary layoff (U^t), unemployed-permanent layoff (U^p), unemployed-quit (U^q), and unemployed-entrant (U^e) as twelve-month moving averages through February 2020 and the monthly values thereafter. The bottom panel plots the distribution of unemployment by status in 2020.

layoff, shown in the triangles, fell relative to their historical average. The rise in the overall reemployment hazard despite the decline in hazards within unemployment type must reflect changes in composition, shown in the bottom panel. Temporary layoffs have been a historically high share of the unemployed, as high as 80 percent in April, and those on temporary layoff have much higher reemployment rates. Put simply, the fast labor market recovery to date is entirely driven by the historically high share of temporarily laid off individuals.

GALLANT, KROFT, LANGE, AND NOTOWIDIGDO EXERCISE The authors' exercise is easily summarized. They extend a standard search-and-matching framework to account for heterogeneity among the unemployed. In particular, they allow for different job-finding rates for those on temporary layoff and not searching, who account for about three-quarters of temporary layoffs, those on temporary layoff and actively searching, by duration, and other unemployed by duration. The exogenous driving forces are the number of vacancies, the separation rate out of employment, transitions among unemployment states and out of the labor force, and the reemployment rate for those on temporary layoff and not actively searching. The endogenous outcome is the job-finding rate of searching unemployed, which varies with duration. So another way to view the exercise is as an assessment of the stability of a properly specified matching function. The model fits the data very well overall. The goodness of fit partly reflects the importance of the contribution of the temporary layoff not actively searching category, whose job-finding rates are fit exogenously. To put it more generously, the exercise makes clear the importance of temporary layoffs in accounting for flows so far during the COVID-19 recession, formalizing the compositional point made by figure 1.

Gallant and her colleagues use their model to draw two stark implications for the future. First, they project a much more rapid labor market recovery than most government or professional forecasters. Assumed continued high rates of reemployment of those on temporary layoff and declines in new separations underlie this optimism. Recent downward revisions of the unemployment rate by professional forecasters lend some credence to their conclusion. For example, the median forecast of Federal Reserve Board members and bank presidents in September anticipated an unemployment rate of 7.6 percent in 2020:Q4, down from a median forecast of 9.3 percent in June.¹ Second, they foresee relatively little

1. Table 1. Economic projections of Federal Reserve Board members and Federal Reserve Bank presidents, under their individual assumptions of projected appropriate monetary policy, September 2020; <https://www.federalreserve.gov/monetarypolicy/files/fomcprojtabl20200916.pdf>.

long-term unemployment, given how high the unemployment rate went. This conclusion comports well with Chodorow-Reich and Coglianese (2020), which takes the very different approach of a factor structure of flows to project unemployment durations during the COVID-19 recession.

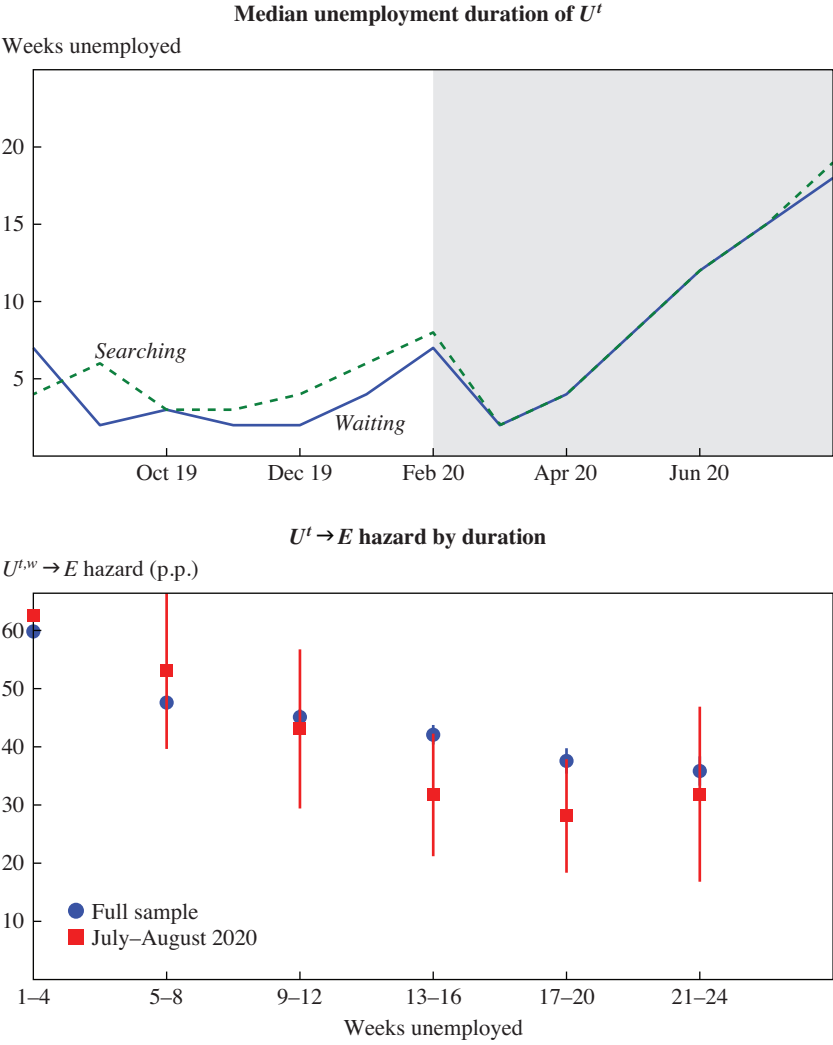
I now raise three key questions, the answers to which will determine whether the authors' optimistic forecast proves correct. The first concerns the reemployment hazards of the temporary unemployed, the second the separation rate going forward, and the third the general level of labor demand.

REEMPLOYMENT FROM TEMPORARY LAYOFF As of August there were 6.2 million individuals on temporary layoff, which comes to 3.8 percent of the labor force. With an overall unemployment rate of 8.4 percent, rapid reemployment of these individuals would generate a fast labor market recovery. Figure 1 of this comment already showed that the reemployment hazard rate from temporary layoff during COVID-19 has been below its historical average. The authors' baseline forecast assumes the recall rate *rises* back to its pre-COVID-19 level (which was at a historical high) over the next twenty-four months, and their alternative scenario assumes it flatlines. In either case, individuals on temporary layoff are reemployed relatively quickly.

I will now suggest the possibility that the reemployment rate from temporary layoff could actually *fall* further instead. Why might this occur? As the share of the unemployed on temporary layoff declined after April, the average duration of unemployment for those still on temporary layoff rose. The top panel of figure 2 shows the median unemployment duration for those on temporary layoff, separately for those actively searching and waiting. For both categories, the median duration rose from less than four weeks in normal times to eighteen weeks in August. In other words, the median person on temporary layoff in August first became unemployed as part of the huge separation surge in April.

The authors' model accounts for duration dependence among those who are on temporary layoff and searching but not those on temporary layoff and waiting. The bottom panel of figure 2 shows the declining hazard rate among those on temporary layoff and waiting, the counterpart to the paper's figure 8 which shows the declining hazard among those on temporary layoff and actively searching. The round dots plot the duration coefficients from a pooled regression over 1994–2020 of an indicator for returning to employment from temporary layoff on bins of unemployment duration and month fixed effects. The square dots plot the duration relationship using only the most recent CPS survey in August. The pattern is, if anything, more

Figure 2. Duration Dependence of Temporary Unemployed and Waiting



Source: Current Population Survey and author's calculations.

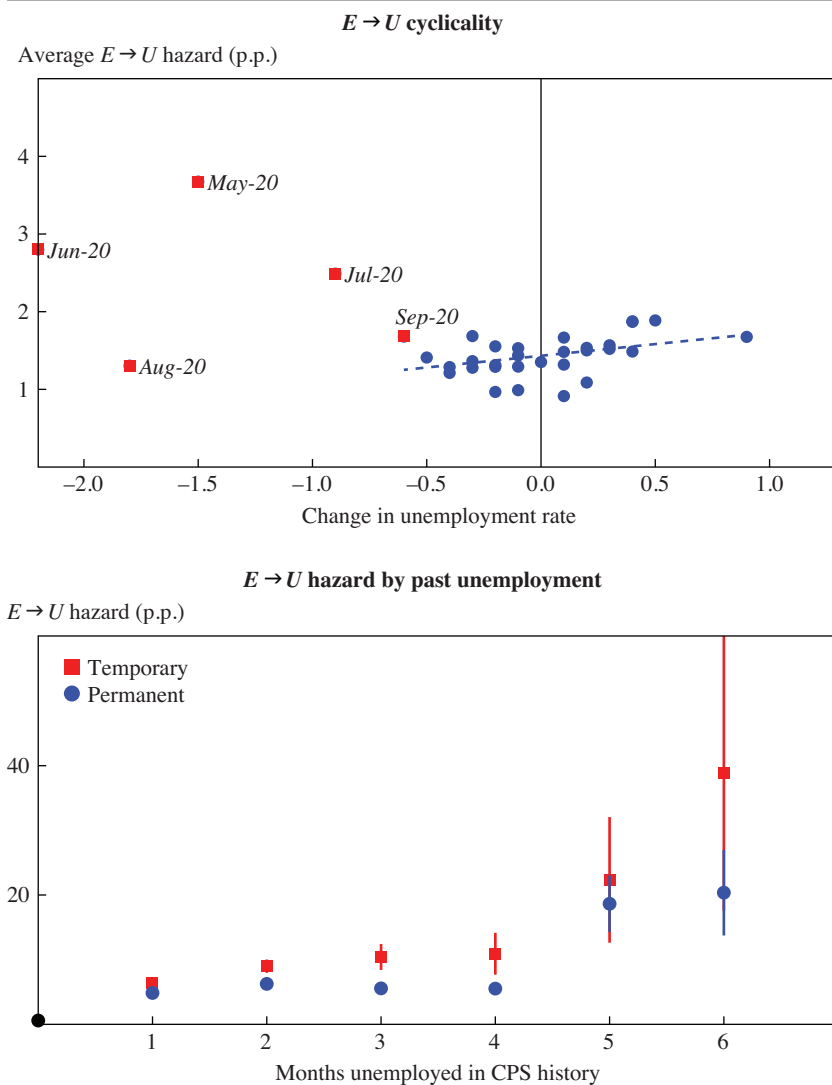
Notes: The top panel plots the median self-reported unemployment duration for individuals on temporary layoff and searching (dashed line) or not (solid line). The bottom panel plots the coefficients $\{\beta_j\}$ from the regression: $\mathbb{I}\{E_{i,t} | U_{i,t}^{t,w} = 1\} = \delta_t + \sum_j \beta_j \mathbb{I}\{\text{Duration} = j\} + \epsilon_{i,j,t}$, where $E_{i,t+1} = 1$ if individual i is employed in month $t + 1$ and 0 otherwise, and the sample includes individuals on temporary layoff and not searching in month t .

pronounced in the current episode. For a paper that otherwise shines in its attention to duration dependence among the unemployed, the absence of duration dependence for the temporary laid off not searching, who account for about three-quarters of all temporary layoffs, is an important lacuna.² Accounting for it would suggest that the overall reemployment rate from temporary layoff may decline rather than rise in the coming months, eventually resulting in a concomitant increase in the stock of unemployed not on temporary layoff. This scenario more closely resembles a counterfactual that Gallant and her colleagues relegate to the online appendix, where the recall rate of temporary unemployed not searching falls exogenously over the next several months, generating a substantial increase in unemployment relative to their baseline scenario in the paper.

SEPARATIONS INTO UNEMPLOYMENT An extremely unusual feature of the COVID-19 labor market has been the continued high rate of separations from employment into unemployment despite an overall falling unemployment rate, as shown in the top panel of figure 3. The round dots show that typically the $E \rightarrow U$ hazard is lower when the unemployment rate is falling. The square dots show May–August 2020. Separations have remained well above the historical norm despite unprecedented declines in unemployment. This finding echoes the historically high levels of new unemployment insurance claims that have persisted despite the fall in the unemployment rate.

Forecasts of the overall unemployment rate more pessimistic than the authors' implicitly assume these high separations continue. This could come from aggregate forces, as I discuss next. History dependence may also contribute. Gallant and her colleagues do not model history dependence among the employed. However, a recent literature on exactly this topic finds that those with recent spells of unemployment return to unemployment more quickly (Hall and Kudlyak 2019; Jarosch 2021). A key question concerns whether this history dependence reflects true causality or instead selection, which might be less important in the current episode. (The same question applies with equal force to the previous discussion of exit hazards from unemployment by duration.) The literature has not reached consensus on this question. One obvious dimension of heterogeneity concerns history dependence for those previously on temporary versus permanent layoff. Chodorow-Reich and Coglianese (2020) explore this dimension by analyzing

2. There is substantial scope to further condition these hazard rates on observable characteristics such as age, sex, industry, and geography of the worker, which might shed additional light on the recall hazards going forward.

Figure 3. Separation Hazards and History Dependence

Source: Current Population Survey and author's calculations.

Notes: The top panel plots the hazard rate for separating from employment into unemployment, by month. For readability, the scatter plot excludes the month of April 2020, which had a 10.3 percentage point increase in the unemployment rate and 11.2 percent $U \rightarrow E$ hazard rate. The bottom panel plots the coefficients $\{\beta_j^i\}$ from the regression: $\mathbb{I}\{U_{i,t}|E_{i,t} = 1\} = \delta_i + \sum_{j \in \{1,2,3,4,5,6\}} \beta_j^i \mathbb{I}\{U_{i,j}^t = 1\} + \sum_{j \in \{1,2,3,4,5,6\}} \beta_j^p \mathbb{I}\{U_{i,j}^p = 1\} + \epsilon_{i,j,t}$, where U^t and U^p index whether individual i was on temporary or permanent layoff, respectively, in the CPS month-in-sample j .

separation hazards of respondents who are employed in their seventh CPS interview month, conditional on their employment status in the previous six interviews. The bottom panel of figure 3 follows that analysis and plots the separation hazard by past months of unemployment, separately for temporary and permanent layoff. Perhaps surprisingly, if anything previous unemployment matters more if the spell was temporary, and this result does not appear driven by seasonality. Thus, incorporating heterogeneity in separation hazards of the employed would suggest that high separation rates may continue as the recovery progresses.

OVERALL LABOR DEMAND Third, probably the most important driver of the labor market recovery is overall demand. The path of overall labor demand is not a question this paper is well suited to answer; the driving forces—recall rates, vacancies, new separations—all depend on the overall level of labor demand. Nonetheless, we can speculate. The optimistic scenario is simple: a fully functional vaccine arrives quickly, or there is dramatic improvement in testing capacity or treatment. A pessimistic scenario might involve a new wave of infections as flu season ramps up and diminished policy support due to political gridlock. Unfortunately, the pessimistic scenario appears highly plausible. For example, the September forecast of the Institute for Health Metrics and Evaluation had as its baseline outcome a new daily high of COVID-19 deaths in December, stemmed only by the reimposition of social distancing measures.

CONCLUSION Gallant and her colleagues provide what should become a touchstone overview of the early months of the COVID-19 labor market as well as a useful forecasting exercise. I fully agree with their emphasis on temporary layoffs. However, I have offered reasons for caution in adopting their optimistic view of the path forward. Already their forecast provides grounds for concern. In both simulations shown in the paper, the stock of unemployed individuals not on temporary layoff peaks in July 2020 (see figure 14). In fact, this stock rose in August and September. If this trend continues, the labor market will recover more slowly than the authors' forecast.

REFERENCES FOR THE CHODOROW-REICH COMMENT

- Chodorow-Reich, Gabriel, and John Coglianesi. 2020. "Projecting Unemployment Durations: A Factor-Flows Simulation Approach with Application to the COVID-19 Recession." Working Paper 27566. Cambridge, Mass.: National Bureau of Economic Research. <https://www.nber.org/papers/w27566>.
- Hall, Robert E., and Marianna Kudlyak. 2019. "Job-Finding and Job-Losing: A Comprehensive Model of Heterogeneous Individual Labor-Market Dynamics."

Working Paper 25625. Cambridge, Mass.: National Bureau of Economic Research.

Jarosch, Gregor. 2021. "Searching for Job Security and the Consequences of Job Loss." Working Paper 28481. Cambridge, Mass.: National Bureau of Economic Research.

GENERAL DISCUSSION Bob Hall noted that the paper could have supported its case with key evidence from the employer side. He suggested that the authors consider the Job Openings and Labor Turnover Survey (JOLTS) because it reports the duration of vacancies (one good measure of labor market tightness) and supplies the numerator of the standard measure of tightness, the vacancy/unemployment ratio. Hall said that labor market tightness took an initial hit (after the COVID-19 pandemic-induced recession) and has settled (as of December 2020) well above recession levels though below the high level prevailing just before the pandemic began.

Hall suggested that the vocabulary in the paper is inapt. He said that the terms "temporary" and "permanent" unemployment are inappropriate, because essentially all unemployment is temporary. He suggested instead using "recall-unemployment" and "jobless-unemployment," as in his work with Kudlyak.¹

In response to Hall, Jim Stock offered the designations "short-term" and "long-term" unemployment.

Steven Davis agreed with Hall that the labor market is, indeed, much tighter than headline unemployment numbers suggest and that vacancy-filling rates warrant greater attention. He also pointed out that an important omission from the discussion is the roughly 6 million people who removed themselves from the labor force in April and May. Davis noted that, in this recession, the number of workers who have removed themselves from the labor force is five times the number of workers who are counted as unemployed by reason of permanent job loss in the Current Population Survey. Furthermore, Davis continued, in no other postwar recession has the number of workers who abruptly left the labor force so greatly outnumbered the people who became unemployed by reason of permanent job loss.

Jason Furman asked if COVID-19 pandemic-induced recession has induced companies to automate, and if so, what effect would that have on

1. Robert E. Hall and Marianna Kudlyak, "Unemployed with Jobs and without Jobs," working paper 27886 (Cambridge, Mass.: National Bureau of Economic Research, 2020), <https://www.nber.org/papers/w27886>.

the model. He then asked for some predictions about whether policymakers should continue or cease the Federal Pandemic Unemployment Compensation (FPUC) program.

In response to Gabriel Chodorow-Reich's discussion, Matthew Notowidigdo agreed that duration dependence in the recall rate ought to be incorporated into the model. Notowidigdo pointed out, however, that their online appendix figures A42 and A43 display a scenario that is similar to allowing for duration dependence in the recall rate, and the alternative forecasts are very similar to the baseline scenario. This implies that allowing for duration dependence in the recall rate is unlikely to substantially change the baseline forecasts. He said job separations rather than vacancies and the recall rate have more of an impact on the forecasts.

Addressing audience questions, Notowidigdo said that he agrees with Hall that the authors do not like the "temporary" and "permanent" unemployment terminological dichotomy and that they will consider other options. Replying to Davis's comment, he remarked that the model does allow for movement between employment and nonparticipation. Addressing Furman's comment on policy, Notowidigdo stated that the authors do not have very much to say about policy relating to automation, but in regard to unemployment insurance, they are interested in the decision of temporary unemployed workers to wait instead of actively searching for work.

Chodorow-Reich responded that because the labels "temporary" and "permanent" layoff come directly from the Current Population Survey, it would be better not to change them.

Replying to Furman's comment, Chodorow-Reich reflected that there has always been some churn in the supply shock. Lastly, he said, one way to think about this declining hazard rate for those on temporary layoff is partly a selection of the people who are in industries that are not going to come back.

SESSION THREE
Fiscal Policy and
International Implications

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Effects of COVID-19 on Federal, State, and Local Government Budgets

ABSTRACT This paper examines how the COVID-19 pandemic and the associated policy responses affected federal, state, and local government budgets. The pandemic raised federal deficits temporarily but has had a modest effect on long-term budget projections, in part because of sharply lower projections of interest rates. With low interest rates and the economy in recession, the debt accumulation resulting from the pandemic does not require immediate offsetting policies. For state and local governments, we note the unusual nature of the current recession: the concentration of job losses among low-wage workers; the unprecedented increases and expansions of unemployment insurance benefits and business loans; and strong performance by the stock market. To address these issues, we use a bottom-up approach that accounts for the geographic variation in economic outcomes. Relative to analyses based on the historical relation between revenues and the unemployment rate, we estimate notably smaller revenue losses. We further estimate that federal aid has been large relative to these revenue losses, but not necessarily relative to need—for public health, remedial schooling, services for the elderly, and others—especially if the pandemic persists and especially in certain hard-hit states.

The COVID-19 pandemic and the associated policy responses have had a significant impact on government budgets. Federal spending has skyrocketed. State and local governments, almost all of which face some form of annual balanced budget rule, confront fiscal shocks on both the revenue

Conflict of Interest Disclosure: Byron Lutz is on the board of the National Tax Association. The authors did not receive financial support from any firm or person for this paper or from any firm or person with a financial or political interest in this paper. Other than the aforementioned and positions listed on Brookings expert profiles, none of the authors are currently officers, directors, or board members of any organization with an interest in this paper.

and spending sides that threaten to make the recession deeper and slow the recovery. This paper examines the impact of COVID-19 on the fiscal status of the federal government and the states.¹

Section I provides new projections of the federal budget outlook, with five main results. First, we document that the pandemic and the policy responses to it rapidly and substantially raised federal deficits, but only on a temporary basis. Spending and revenue are projected to return to pre-COVID-19 baseline values relatively quickly.

Second, the long-term fiscal outlook through 2050 has deteriorated somewhat. Under the Congressional Budget Office's (CBO 2020a) assumptions for GDP growth and interest rates, we project that the debt-to-GDP ratio, currently 98 percent, will rise to almost 190 percent in 2050 under current law, compared to a pre-COVID-19 baseline projection of 180 percent. CBO (2020a) obtains a similar projection—195 percent—using a slightly different set of assumptions.

Third, although the economic downturn and COVID-19-related legislation raise debt permanently, sharply lower projections of interest rates for the next dozen years help moderate future debt accumulation. Nevertheless, even during the period when interest rates are expected to be low, the projected debt-to-GDP ratio rises steadily due to substantial and rising primary deficits, driven largely by rising outlays on health-related programs and Social Security. As the economy grows and debt accumulates, the average interest rate on government debt is projected to rise and to exceed the nominal GDP growth rate by increasing amounts starting in the early 2040s.

Fourth, under a current policy projection that allows temporary tax provisions—such as those in the Tax Cuts and Jobs Act of 2017—to be made permanent, the debt-to-GDP ratio would rise to 222 percent by 2050 and would continue rising thereafter.

Fifth, the long-term projections are sensitive to interest rates. If interest rates remain very low (that is, at their projected level for 2025), rather than rising as in the CBO projections, the debt-to-GDP ratio would equal 157 percent in 2050 under current policy.

We discuss several aspects of these results, including how the current episode compares to past debt changes, the role of historically low interest

1. Other countries are facing similar fiscal issues. The International Monetary Fund (2020) estimated that, as of July, the effects of COVID-19-related automatic and discretionary policy changes have increased cumulative deficits by 13.6 percent of GDP in advanced countries.

rates, and recent Federal Reserve Board policies. Because of the macro-stabilization effects of fiscal tightening, and because low interest rates create “breathing room” for fiscal policy (Elmendorf and Sheiner 2017; Blanchard 2019a, 2019b), we do not see the large, short-run debt accumulation resulting from the current pandemic as necessitating any immediate offsetting response. But the long-term projections show that significant fiscal imbalances remain and will eventually require attention.

Section II discusses the effects of the pandemic on state and local government budgets. We first examine recent estimates of the effects on revenues—some of which find relatively modest effects and others of which find effects that dwarf those experienced during the Great Recession. We note that the very unusual nature of the current recession means that relying on the historical relationships between the state of the economy and state and local tax revenues may produce misleading results. We instead attempt to calculate the impact on state and local governments using a bottom-up approach that accounts for the geographic variation in the distribution of unemployment and consumption declines, the fact that low-wage workers have been particularly hard hit this recession, and the fact that the stock market has held up.

Our findings suggest that this pandemic is indeed having very unusual effects on state and local revenues. We estimate far smaller income tax losses than would have been expected on the basis of historical experience, which we attribute to the fact that employment losses have been unusually concentrated on low-wage workers, the unprecedented increases and expansions of unemployment insurance benefits and business loans, which will shore up taxable income in 2020, and the fact that the stock market has held up so far, unlike most of the prior economic downturns. On the other hand, our estimates of the losses in sales and other taxes and fees are much larger than one would have expected—the decline in use of transportation services alone seems likely to depress revenues by over \$45 billion this year. In aggregate, we estimate that state and local own-source revenues, excluding fees to public hospitals and institutions of higher education—which we view as somewhat distinct—will decline \$156 billion in 2020, \$165 billion in 2021, and \$143 billion in 2022. Including lower fees to hospitals and higher education would bring these totals to \$189 billion, \$187 billion, and \$165 billion.

We then turn to a discussion of federal aid to states and localities. We estimate that the legislation enacted in March 2020 provides about \$211 billion in aid, excluding aid to public hospitals and higher education, and \$253 billion including that aid. While this appears to be larger than the

total revenue declines expected for 2020, that doesn't mean that the aid has been sufficient to preclude tough budget choices and poor macroeconomic outcomes. First, should the economy remain below its pre-COVID-19 baseline for many years, as the CBO projections suggest, state and local governments will face significant shortfalls in coming years. Knowing that, they are likely to restrain spending somewhat this year and make additional cuts in coming years. Second, the pandemic itself has likely increased the demands on state and local governments—for public health spending, virtual schooling, the elderly, and so on. Simply maintaining pre-COVID-19 levels of spending may not be enough to assure that necessary services aren't cut. Finally, our analysis shows that smaller states got much more generous aid relative to their losses and that states like New York and California will likely be facing budget shortfalls in the current year even without consideration of the spending demands brought on by the COVID-19 pandemic.

Section III provides concluding remarks.

We note at the outset that the CBO economic projection is more pessimistic than that of many other forecasters. Activity has already rebounded far more quickly than CBO had anticipated in July 2020—for example, the unemployment rate ended the third quarter at 7.9 percent whereas the CBO had projected it to be 10.5 percent in the fourth quarter. Moreover, the CBO has the economy operating below potential for almost a decade, while other forecasters predict a much quicker rebound. As we base our calculations on the CBO's economic projection, our federal, state, and local projections are likely somewhat more pessimistic than would be implied by alternative economic forecasts.² Alternatively, the CBO's economic outlook may prove more accurate when viewed over a longer time period.

I. The Federal Budget Outlook

We examine the fiscal outlook over ten- and thirty-year horizons. While the shorter horizon conforms to that used by the CBO in its standard budget analysis, the longer horizon provides additional insight about underlying budget trends and questions of fiscal sustainability.

2. A second set of estimates using a more optimistic economic projection, as our discussion suggested, would clearly be a useful addition, but unfortunately we were not able to include it given the time and space allotted.

I.A. Constructing Budget Baselines

TEN-YEAR OUTLOOK To provide perspective on both the current budget outlook and how it was affected by the COVID-19 pandemic, we examine three baselines. The pre-COVID-19 baseline is based entirely on current law projections that the CBO made in January, predating any consideration of the impact of COVID-19 on the economy.³

The current law baseline is embodied in the CBO's most recent ten-year budget projection (CBO 2020b) and is consistent with their most recent economic projection (CBO 2020d). These projections—by law and convention—assume that Congress does (almost) nothing in the way of new programs or tax changes for the next ten years.⁴ Current law projections serve an important purpose—they show where the government is headed in the absence of almost any action. Another way to proceed, however, is to ask where the government is headed if policymakers continue to make choices like they have in the past. Constructing a baseline along these lines—typically characterized as current policy—clearly requires judgment calls to project the consequences of Congress following a business-as-usual approach.

Our current policy projections start with current law projections and make a series of adjustments (based on CBO data). These adjustments simply show the effects of what, in our judgment, can be viewed as a continuation of current policies. Given the wide array of provisions enacted in the last year due to the COVID-19 pandemic, judgments about what constitutes current policy are particularly difficult under present circumstances, so we take a conservative approach and focus narrowly on items that are conventionally included in current policy estimates.

Specifically, we assume that Congress, as it has done in the past, makes temporary tax cut provisions permanent, including the temporary

3. Congressional Budget Office, “Long-Term Budget Projections” [data file], <https://www.cbo.gov/system/files/2020-01/51119-2020-01-ltbo.xlsx>.

4. But the projections do require that Congress increase or suspend the debt limit as needed to carry out the tax and spending programs in the baseline, that temporary entitlement programs (like SNAP and TANF) are reauthorized on schedule, and that outlays for discretionary spending programs remain constant in real terms over the decade, unless such authority is governed by a specific law. Also, current law projections assume that when the Social Security, Disability, and Medicare Part A trust funds are exhausted, Congress will authorize full payment of promised benefits and cover any shortfalls with general revenue financed by federal borrowing.

provisions in the 2017 Tax Cuts and Jobs Act.⁵ We allow real nondefense discretionary spending to rise with population growth, rather than remaining constant over time, as the CBO assumes, because maintaining current services for these programs is likely to require a population adjustment. In contrast, defense spending, which largely provides a nonrival public good, plausibly can maintain current services over the relatively short ten-year horizon without a population adjustment.⁶ We assume all Coronavirus Aid, Relief, and Economic Security (CARES) Act provisions are implemented and allowed to expire as scheduled and that the president's payroll tax deferral has no effect on any budget outcome.

THIRTY-YEAR OUTLOOK Looking only at the next ten years gives an incomplete picture of the fiscal outlook, even with adjustments made to characterize current policy. Projections covering thirty years are generally sufficient to capture most long-term trends. To generate the longer-term projections, we begin with budget and economic figures for 2030 (in the three baselines developed above) and project forward each part of the government budget. Except where noted below, the three baselines are based on similar assumptions after 2030.

First, following the CBO (2020a), the nominal growth rate of GDP is set equal to 3.6 percent for 2031–2040 and 3.5 percent for 2041–2050. Second, for Medicare and Old-Age, Survivors, and Disability Insurance (OASDI), we project all elements of spending and dedicated revenues (payroll taxes, income taxes on benefits, premiums, and contributions from states) using the growth rates as a share of GDP in the intermediate projections in the 2020 Boards of Trustees reports for the period between 2030 and 2050. Third, for Medicaid and the Children's Health Insurance Program (CHIP), we use the most recent long-term CBO (2020a) projections. Fourth, all

5. Examples of major expiring provisions in the 2017 tax act include 100 percent bonus depreciation (expensing of business investment in qualifying equipment), the marginal individual rate cuts, the increased standard deduction, the repeal of personal exemptions, the increased estate tax exemption, the cap on state and local tax deductions, and the 20 percent deduction for certain pass-through income. Examples of expiring provisions outside of the 2017 tax act include tax credits for biodiesel and alternative fuel mixtures and the deduction for mortgage insurance premiums.

6. The ten-year current law projections for discretionary spending are uncertain because the law does not specify appropriations over the whole period. Thus, one might argue that not all nondefense discretionary spending requires a population adjustment, implying that our projections are too high. On the other hand, defense spending depends not just on maintaining current services but also responding to the actions of our political adversaries, and so our projections may be too low. There is no way to know for sure, so we follow rules of thumb that are both plausible and easy to understand.

other noninterest spending—other mandatory spending and discretionary spending—is assumed to remain constant as a share of GDP. Fifth, income taxes other than those tied to Social Security and Medicare benefits grow with bracket creep according to the CBO’s most recent long-term projections. Sixth, all other revenues (corporate taxes, excise taxes, etc.) remain constant at their 2030 shares of GDP. Seventh, current law and current policy average interest rates on the public debt follow the projections in the latest long-term budget outlook (CBO 2020a). To estimate net interest payments in the years after 2030, we multiply the average interest rate in a given year by the sum of half of the primary deficit in that year and outstanding government debt at the end of the previous year.⁷

In addition to projecting debt and deficits over the thirty-year horizon, we also present estimates of the fiscal gap, an accounting measure that is intended to reflect the long-term budgetary status of the government.⁸ The fiscal gap answers the question: If one starts a policy change in a given year

7. Alternative projections of policy over a thirty-year period naturally differ for a variety of reasons. In particular, the assumptions underlying our thirty-year projections differ in several ways from those made by the CBO (2020a) but the aggregate effects of their projections and ours are similar. The CBO (2020e) uses its own estimates for Social Security and Medicare, which project longer life spans and thus higher spending than the estimates we use, which come from the Boards of Trustees of those programs (scaled for differences in GDP projections). We allow other mandatory spending and discretionary spending to remain constant shares of GDP from 2030 to 2050. The CBO has them declining somewhat. Despite these differences, both our projections and the CBO’s generate primary deficits of 4.5 percent of GDP in 2050. We use interest rate estimates embedded in the CBO (2020a) projections. Although the projected interest rates reported in CBO (2020a, 47) are larger than those reported above, the difference is due to different definitions. The CBO reports effective interest rates as the ratio of net interest payments in a given year to debt at the end of the previous year. We report effective interest rates as the ratio of net interest payments in a given year to the sum of half of the primary deficit in that year and the debt at the end of the previous year. Finally, the CBO generates a debt-to-GDP ratio of 195 percent in 2050, compared to our estimate of almost 190 percent under current law. The CBO (2020a) compares its budget outlook to its 2019 long-term budget outlook (CBO 2019), which projects a 2049 debt-to-GDP ratio of 144 percent. We compare our current law baseline to the CBO’s January 2020 long-term baseline—which was the most recent projection prior to the pandemic and which projects a 2050 debt-to-GDP ratio of 180 percent.

8. See Auerbach (1994). Online appendix 1 describes the construction of the fiscal gap and how interest rates affect it. Auerbach, Gale, and Orszag (2003) discuss the relationship between the fiscal gap, generational accounting, accrual accounting, and other ways of accounting for government. Note that estimates of the fiscal gap do not in any way imply that level reductions as a share of GDP are the best way to achieve a given fiscal target, rather than, say, level reductions as a share of primary deficits (which in the present circumstance would imply a growing path of primary deficit reductions). The fiscal gap measure just provides one convenient way to think about the magnitude of a fiscal shortfall, given a future fiscal goal.

to reach a given fiscal target in a given future year, what is the size of the annual, constant share-of-GDP increase in taxes or reduction in noninterest expenditures (or combination of the two) that would be required, holding projected economic performance unchanged? For example, one might ask what immediate and constant policy change would be needed to obtain some target debt-to-GDP in 2050.⁹ Or, one might ask what constant share-of-GDP change would be required, starting with a delay, say in 2025, to achieve a net interest-to-GDP ratio of 2 percent by 2050.

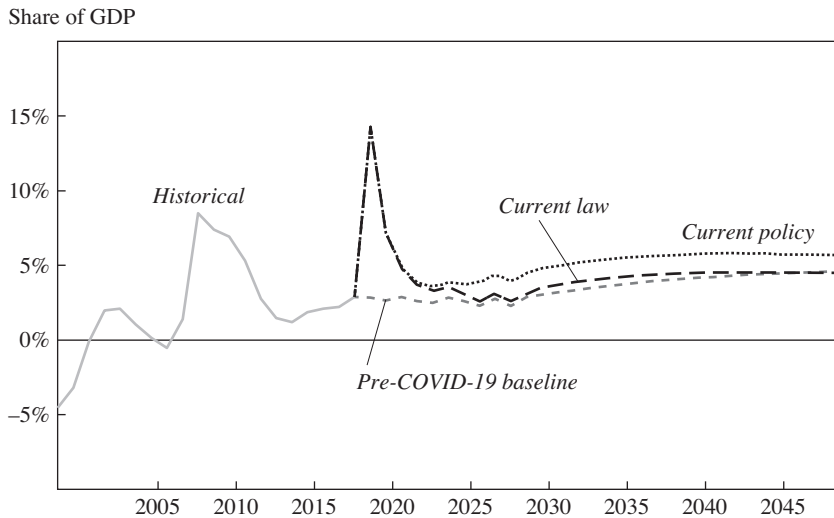
I.B. Projections

ECONOMIC PROJECTIONS Relative to the pre-COVID-19 baseline, projected real GDP falls significantly early in the decade and is not projected to reach the pre-COVID-19 baseline even by 2030 (online appendix figure 1). Economic growth between 2030 and 2050 is lower than under pre-COVID-19 projections. The weaker economy, slower inflation, and aggressive Federal Reserve policy translate into sharply lower projections of interest rates for about a dozen years (online appendix figure 2).¹⁰ The average interest rate falls to 1.1 percent by mid-decade before rising to its pre-COVID-19 baseline value (2.9 percent) by 2034 and then rising further to 4.1 percent by 2050. That is, the projection implies that nominal interest rates will rise above the nominal GDP growth rate around 2042 and will exceed the growth rate by more than 0.5 percentage points by 2050. These economic projections help drive the budget outcomes discussed below.

EFFECTS OF COVID-19: COMPARING THE PRE-COVID-19 BASELINE AND CURRENT LAW Noninterest spending spiked in 2020 (online appendix figure 3), mostly because of the CARES Act, rising by 11 percent of GDP relative to the pre-COVID-19 baseline but is projected to fall rapidly in subsequent years and to return to about its pre-COVID-19 baseline projection of 21 percent by 2030. After that, noninterest spending under both the pre-COVID-19 and current law baselines rises by about 2 percent of GDP through 2050. These spending increases are driven mainly by health care (Medicare, Medicaid, CHIPS, and exchange subsidies) and, to a lesser extent, Social Security.

9. Implementing the adjustments indicated by the fiscal gap does not stabilize debt after the target year—say 2050; it only adjusts tax and spending trajectories so that the debt hits a target by 2050. Under all the scenarios considered in this paper, the debt-to-GDP ratio would continue rising after hitting the specified target in a specified year.

10. Online appendix figure 2 shows effective interest rates, the ratio of net interest payments in a given year to the sum of half of the primary deficit in that year and debt outstanding at the beginning of the year.

Figure 1. Primary Deficit, 2000–2050

Source: Authors' calculations based on CBO (2020a, 2020b, 2020d).

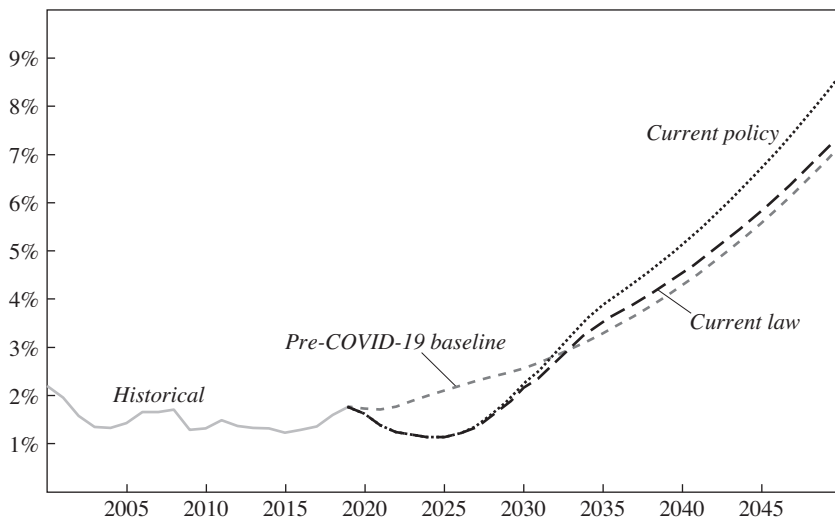
Revenues, as a share of GDP, dip somewhat in 2020 and 2021 but regain pre-COVID-19 shares of GDP by 2022 and essentially mimic pre-COVID-19 shares thereafter (online appendix figure 4). Of course, with post-COVID-19 GDP lower than under the pre-COVID-19 baseline, the projected level of revenues is still substantially below what had been expected in January. Revenues are projected to rise more slowly than noninterest spending, however. Between 2030 and 2050, projected revenues rise by less than 1 percent of GDP, reaching 18.6 percent of GDP under both the current law and the pre-COVID-19 baselines, with the only changes over time due to bracket creep in the income tax and a slight increase in payroll tax revenues.

As a result of these changes, the primary deficit spikes in 2020—exceeding 14 percent of GDP—but then falls sharply in the next few years and then hews closely to its projected values under the pre-COVID-19 baseline (figure 1). The primary deficit rises gradually from 3.2 (2.9) percent of GDP in 2030 to 4.5 (4.6) percent of GDP in 2050 under the current law (pre-COVID-19) baseline.

Under the current law projections, interest payments plummet and then explode (figure 2). Despite the increase in COVID-19-related debt, net interest payments fall from about 1.6 percent of GDP currently to

Figure 2. Net Interest, 2000–2050

Share of GDP



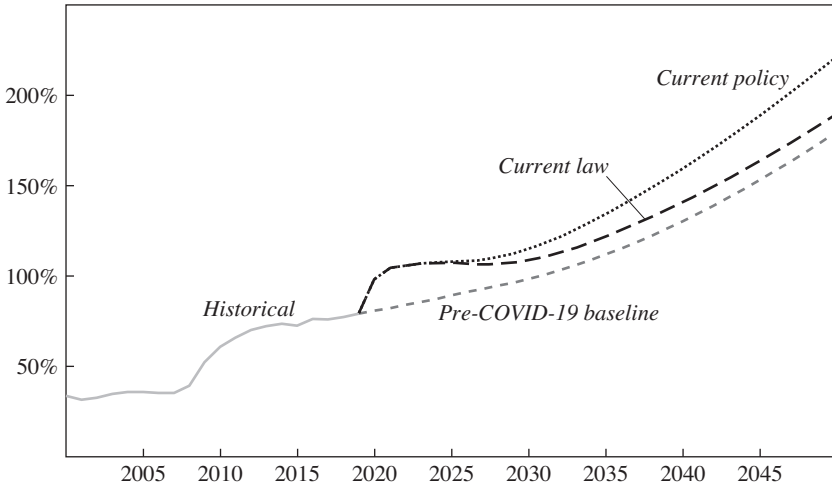
Source: Authors' calculations based on CBO (2020a, 2020b, 2020d).

1.1 percent in 2024–2025 because of the projected decline in interest rates. But as a result of economic growth and rising debt, both of which raise interest rates, interest payments rise to 2.2 percent of GDP in 2030 and continue rising over time, reaching 7.4 percent of GDP under current law in 2050, slightly higher than the 7.2 percent of GDP projected under the pre-COVID-19 baseline. Both figures, however, far exceed the peak historical net interest level of 3.2 percent of GDP in 1991 (CBO 2020f).

The unified deficit, combining the effects of primary deficits and interest payments, reached 16 percent of GDP in 2020—more than 11 percent of GDP larger than was predicted in the pre-COVID-19 baseline, and much higher than even the peak deficit in the Great Recession—about 10 percent of GDP (online appendix figure 5). The effect is projected to be temporary, however. Deficits are projected to decline sharply after 2020 and to return to their pre-COVID-19 projected share of GDP by 2024. At that point, relative to the pre-COVID-19 baseline, the projections imply that noninterest spending will be about 1 percent of GDP higher, net interest payments will be about 1 percent of GDP lower, and revenue will raise about the same share of GDP. By the end of the decade, the deficit is projected to be 5.3 percent of GDP under current law.

Figure 3. Public Debt, 2000–2050

Share of GDP



Source: Authors' calculations based on CBO (2020a, 2020b, 2020d).

The projected 2020–2030 unified deficit rose from \$14.2 trillion in the pre-COVID-19 baseline to \$16.3 trillion under current law. Excluding net interest, legislative changes added \$2.6 trillion to the projected deficit—more than the entire increase in deficits. The effects of macroeconomic changes added another \$1.3 trillion, and other changes accounted for \$0.4 trillion more. Despite these increases in spending and reductions in revenue, net interest payments are projected to decline by \$2.2 trillion because of sharply lower projected interest rates.

After 2030, the unified deficit continues to rise under both the pre-COVID-19 baseline and the current law scenario. By 2050, the unified deficit reaches almost 12 percent of GDP under both baselines.

Figure 3 shows the impact of COVID-19 on the public debt. Before the pandemic, the United States already had historically high debt as a share of GDP—the highest since just after the end of World War II. Under the pre-COVID-19 baseline, the stock of outstanding public debt would have been 81 percent of GDP at the end of fiscal year 2020 and 82 percent by the end of fiscal year 2021. Now, analogous current law projections are 98 percent and 104 percent, respectively. Projected debt rises gradually for the rest of the decade, reaching 109 percent of GDP in 2030 under current law, compared to 98 percent under the pre-COVID-19 baseline.

Table 1. Fiscal Gap (as a Percentage of GDP)

<i>Target</i>	<i>Current law beginning</i>			<i>Current policy beginning</i>		
	<i>2021</i>	<i>2025</i>	<i>2030</i>	<i>2021</i>	<i>2025</i>	<i>2030</i>
Debt = current	3.19	3.54	4.24	4.23	4.74	5.73
Net interest = 3.2	3.79	4.21	5.06	4.81	5.40	6.55

Source: Authors' calculations based on CBO (2020a, 2020b, 2020d).

After 2030, rates of debt accumulation pick up because of rising primary deficits and rising interest payments. By 2050, the debt rises to 190 percent of GDP under current law compared to 180 percent in the pre-COVID-19 baseline. Essentially, the higher deficits incurred in 2020 and 2021 are carried forward on a long-term basis but since interest rates are lower than growth rates on average over the 2020–2050 period, the effect relative to GDP is slightly dissipated.

CURRENT LAW VERSUS CURRENT POLICY While comparing the pre-COVID-19 baseline to current law shows the impact of the pandemic, comparing current law to current policy shows the impact of certain business-as-usual changes that Congress tends to make. These differences occur during the first ten years, given our process for generating projections, but they have ramifications for longer-term outcomes. Making the temporary provisions of the Tax Cuts and Jobs Act permanent, along with modest adjustments to spending, would raise the 2050 debt-to-GDP ratio to 222 percent compared to 190 percent under current law. By 2050, revenues would be at 17.6 percent of GDP, compared to 18.6 percent under current law; the primary deficit would rise to 5.7 percent of GDP and interest payments would rise to 8.7 percent of GDP, compared to 4.5 and 7.4 percent, respectively, under current law. The current policy projections use the same interest rate assumptions as the current law projections; incorporating any upward impact of higher debt in the current policy projections on interest rates would raise debt by additional amounts.

THE FISCAL GAP Turning to the fiscal gap, under current law projections, obtaining a debt-to-GDP ratio in 2050 equal to its 2020 level of 98 percent would (ignoring any macroeconomic feedback effects) require permanent tax increases or noninterest spending cuts totaling 3.2 percent of GDP starting in 2021 (table 1). This would be the equivalent to a sustained tax increase equal to about 34 percent of income tax revenues, a 17 percent increase in all tax revenues, or a 14 percent reduction in average non-interest spending. The longer policymakers wait to implement change, the

larger are the required changes, because the debt must be brought down to meet the assumed target over fewer years.

Policymakers could choose a net-interest-to-GDP target instead of a debt target. To hold 2050 interest payments equal to 3.2 percent of GDP—the historical maximum for this ratio, obtained in 1991—would require policy changes equal to about 3.8 percent of GDP starting in 2021.

Under current policy, all the shortfalls are larger. Obtaining the current debt-to-GDP ratio would require policy changes equal to 4.2 percent of GDP starting in 2021. Holding net interest payments to their historical maximum share of GDP would require policy changes of 4.8 percent of GDP.

SENSITIVITY ANALYSIS How future economic and budget outcomes evolve depends crucially on how the virus and the economy change over time. After the Great Recession, the CBO (and many other forecasters) expected the economy to recover to close to its prerecession path, which, in the end, did not happen.¹¹ As a result of prolonged slower growth, the CBO eventually significantly lowered its projections for potential GDP.¹² The CBO's current GDP projection is that real GDP will be 1.1 percent lower in 2030 than prior to the pandemic.¹³ If the economy's gap from the pre-COVID-19 path is larger than projected, the fiscal outlook will likely be worse, with the obvious caveat that if interest rates fall enough, the overall fiscal position could be improved. However, projected rates are already very low, so there is a limit on how much lower they can fall. To address the possibility that the economy may not recover as close to the pre-COVID-19 path, we use the CBO's interactive workbook (CBO 2020c) to apply the agency's rules of thumb for the impact of alternative economic scenarios on budget projections and find that if the annual productivity growth rates were lower than projected by 0.5 percentage points for each of the next ten years, the debt-to-GDP ratio would rise by an additional 12 percentage points by 2030. The CBO (2020a) shows that if the annual growth rate of

11. See Gale (2019a) for a more detailed analysis.

12. In its January 2009 budget outlook (<https://www.cbo.gov/sites/default/files/111th-congress-2009-2010/reports/01-07-outlook.pdf>), the CBO noted that its projection of potential output in 2018 had been revised downward by 1 percentage point. In 2014 (<https://www.cbo.gov/publication/45150>), the CBO wrote that its projection of 2017 potential GDP had fallen by more than 7 percent since 2007.

13. According to the January 2020 long-term budget outlook, 2030 GDP would have been \$25,885 billion (in 2019 dollars; Congressional Budget Office [data file], <https://www.cbo.gov/system/files/2020-01/51119-2020-01-ltbo.xlsx>), while in the September 2020 long-term budget outlook, 2030 GDP is projected to equal \$25,595 billion (in 2019 dollars; Congressional Budget Office [data file], <https://www.cbo.gov/system/files/2020-09/51119-2020-09-ltbo.xlsx>). In both data files, see "Economic Vars," line 44.

total factor productivity is 0.5 percentage points lower than projected, debt will rise to 239 percent of GDP in 2050 under current law, compared to the 195 percent figure in its baseline.

Online appendix figure 2 shows that projected rates decline until 2025 and then rise more or less steadily through 2050. In our alternative scenario, we assume that interest rates stay constant at their 2025 levels through 2050. Under this specification, the 2050 debt-to-GDP ratio reaches 133 percent under current law and 157 percent under current policy. Net interest payments rise slowly, remaining below 1.4 percent of GDP, lower than their average value over the last fifty years. The CBO (2020a) shows that if interest rates are 1 percentage point higher (lower) than predicted over the next thirty years, the debt-to-GDP ratio will be higher (lower) by 69 (46) percent of GDP by 2050 under current law.

I.C. Perspectives and Interpretations

The sharp changes in the economy brought about by the COVID-19 pandemic and the associated policy responses raise several interesting issues for fiscal policy. First, the debt-to-GDP ratio is projected to rise by 25 percentage points between 2019 and 2021 and could rise by more if there is new legislation or a weaker than expected recovery. This increase is sizable but is not out of line with other debt buildups over the past century. For instance, the coupling of World War I with the 1918 flu pandemic led to a debt-to-GDP increase of 30 percentage points over three years. World War II raised the debt-to-GDP ratio by 64 percentage points over six years. The Great Recession boosted the debt-to-GDP ratio by about 31 percentage points over four years.

Second, the previous peak in the debt-to-GDP ratio—106 percent—occurred just after World War II, following which the debt-to-GDP ratio gradually dwindled over the ensuing thirty-five years to 25 percent in 1981, an outcome that contains both good and bad news for the current long-term fiscal shortfall (Gale 2019a, 2019b). Between 1945 and 1980, interest rates on government debt were often below the economic growth rate, which helped to reduce the debt-to-GDP ratio. Likewise, although economic growth is projected to be lower than during the earlier postwar period, so are interest rates, which as discussed above are projected to remain below growth rates for the next thirty years, providing the same help in reducing the debt-to-GDP ratio over time.

However, the federal government maintained balanced primary budgets on average over the 1945–1980 period. In contrast, we project sizable and growing primary deficits as a share of GDP even after the pandemic and its

economic aftermath subsidy. These primary deficits are sufficiently large to cause debt to grow inexorably relative to GDP despite lower interest rates, and there is nothing in the forecast to suggest that this growth will slow even after 2050.

Approaching a balanced primary budget through reductions in spending would be much more challenging now than in the earlier postwar period because of differences in demographics and budget composition. In 1945 and the years that followed, defense spending was an important part of the federal budget, expenditures on Social Security were small, and Medicare and Medicaid did not exist. In fiscal year 2019, the last prepandemic fiscal year, federal spending on defense was just 3.2 percent of GDP, while spending on the three major entitlement programs accounted for 10.8 percent of GDP and over half of noninterest federal spending. Moreover, spending on the entitlement programs is projected to grow faster than GDP over the next three decades, due to population aging and increases in health care costs. At the same time, with greater inequality than during the period ending in 1980, there is stronger support for increased spending on social services. One may also conjecture that demand will increase for health insurance coverage, a stronger social safety net, and more redistribution, given the differential impact of both COVID-19 itself and the economic burdens associated with the pandemic. In short, the upward pressure on federal spending is much stronger now than in the past.

Reducing the primary deficit through tax increases may prove difficult politically, but there is room to maneuver. As a share of GDP, federal revenues equaled 16 percent in 2020. If the Tax Cuts and Jobs Act and other temporary provisions are extended in the usual manner, then revenues are projected to total just 17.0 percent over the 2020–2050 period. In the fifty years prior to 2020, revenues averaged 17.4 percent of GDP and reached a high of 20 percent in 2000.¹⁴

Third, a key factor in the fiscal picture is the path of interest rates. The reduction in projected interest rates unambiguously improves the federal government's overall fiscal stance—because it is a net borrower. We can certainly borrow more and consume more with low interest rates and not hurt future generations (who can in turn borrow more from later generations). But the optimality of this pattern may fall apart if interest rates subsequently rise, resulting in higher interest rates on higher levels

14. See Congressional Budget Office [data file], <https://www.cbo.gov/system/files/2020-01/51134-2020-01-historicalbudgetdata.xlsx>.

of debt (Ball, Elmendorf, and Mankiw 1998), particularly if this rise in interest rates is not accompanied by a sufficiently large increase in the rate of productivity growth.¹⁵

The path of interest rates will also depend in part on monetary policy. But the relevance of the Federal Reserve to the fiscal picture goes well beyond its role in the determination of interest rates. The Fed has sharply expanded its balance sheet since the onset of the pandemic, acquiring large quantities of the new government debt being issued.¹⁶ In addition, through facilities created under its emergency lending authority, it has taken on the debts of companies and state and local governments. Some have argued that these facilities, which were utilized in response to the financial crisis and expanded in scope in the current situation, signify a growing role of the Fed in conducting fiscal policy (Plosser 2012; Warsh 2020). Alternatively, however, the facilities can be viewed as an extension of the Fed's traditional lender of last resort role, which reflects the relative shift in financial activity since the Fed's creation away from bank loans toward securities traded in capital markets (Labonte 2020). Moreover, the facilities can only address temporary interruptions to liquidity via loans. Addressing solvency issues, which requires fiscal spending authority, has been left to Congress and the presidential administration (Powell 2020).

Nonetheless, the previously sharp lines between monetary policy, fiscal policy, and debt management policy have arguably become blurred somewhat in recent years (Greenwood and others 2014). With the Federal Reserve's adoption of paying interest on reserves held by banks, bank balance sheets have become functionally similar to Treasury bills.¹⁷ And there may be concerns over the extent to which the Treasury can use changes in the federal debt's maturity structure as a debt management tool while the Fed is pursuing its own policies to influence the term structure of interest rates. Finally, as the Fed's tool kit has expanded in recent years, so too may the pressure to use those tools to implement fiscal or debt management objectives (Plosser 2012; Warsh 2020).

15. If the increase in interest rates is in response to higher productivity, the effect on debt sustainability is unclear (Sheiner 2018).

16. Data in the CBO (2020b, table 2) imply that Federal Reserve holdings of public debt will rise by about 70 percent of the increase in public debt from 2019 to 2021.

17. Several international central banks also have the authority to pay interest on reserves.

II. Effects of COVID-19 on the State and Local Sector

The COVID-19 pandemic presents the states with potentially serious fiscal problems, but ones that differ from the federal situation. State and local governments generally must balance their operating budgets each year, which not only constrains their behavior, but does so in a way that is particularly damaging to the macroeconomy during a business cycle contraction. Specifically, when an economic downturn reduces revenues, state and local governments may be forced to cut spending or raise taxes to make up the budget shortfall. Not only do these changes deprive taxpayers of valuable services or reduce their disposable income in a time of economic stress, but they also impede the economic recovery.

This dynamic was particularly strong in the recovery from the Great Recession (Cashin and others 2018). As shown in online appendix figure 6, state and local government purchases of goods and services—the state and local government contribution to GDP—were flat, on net, over the course of the economic expansion following the Great Recession. In contrast, these purchases rose significantly in most prior expansions.

The states and localities entered the COVID-19 pandemic in a relatively strong fiscal position along some dimensions. State total balances—reserve accounts (so-called rainy day funds) plus general budget surpluses—stood at \$122 billion in fiscal year 2019, equal to 14 percent of general fund expenditures—a historic high (National Association of State Budget Officers 2020). And the decision to sharply curtail infrastructure investment in recent years led to less need for borrowing and a gradual reduction in debt, which fell from around 20 percent of GDP prior to the financial crisis to around 14 percent currently; the interest payments of these governments fell from around 1.9 percent of GDP at the end of 2009 to roughly 1.4 percent currently.¹⁸ Moreover, the CARES Act and other legislation enacted in the spring of 2020 provided federal aid to states and localities of over \$200 billion.

Nonetheless, many believe that these savings and federal aid will be insufficient to meet the scale of the revenue losses and spending requirements these governments will experience over the next few years, and the state and local sectors will again generate significant economic headwinds for the economic recovery (Bernanke 2020). Moreover, state and local governments are responsible for many public goods that are crucial to

18. Authors' calculations based on data from the Financial Accounts of the United States and the US Bureau of Economic Analysis.

the response to the pandemic, for example, public health departments and public hospitals. Budget strain may impair their ability to mount an effective response to the COVID-19 outbreak.

Although most states have balanced budget requirements of some kind, some are more stringent than others. Some, for example, require midyear adjustments to spending and taxes to offset any shortfalls, while others only require governors to submit budgets that they expect to balance. Thus, revenue shortfalls in the near term can constrain spending for many years, as we saw in the Great Recession. Capital expenditures—which are typically not subject to balanced budget requirements—are also surprisingly cyclical (US GAO 2011), perhaps because spending required to plan and maintain capital projects comes out of operating budgets, governments may wish to avoid the costs of servicing debt during times of economic stress, and many areas require voter approval for any bond issuance, which is less likely to be forthcoming during an economic downturn.¹⁹ Finally, unemployment benefits, which are also not subject to balanced budget requirements, leave debts that need to be repaid within two to three years to avoid having the federal government raise the federal unemployment tax.

II.A. Estimates of Revenue Losses from COVID-19 in the Literature

As shown in table 2, a number of researchers have estimated the likely effects of the pandemic on the fiscal health of states and localities. The estimates of state and local revenue losses over the two fiscal years starting from the onset of the pandemic vary widely, ranging from \$130 billion (White, Crane, and Seitz 2020) to \$875 billion (Bartik 2020).²⁰ The range reflects both differences in underlying economic assumptions and differences in coverage (all state and local revenues or some subset), as well as differences in methodology.

The top three estimates in table 2 all rely on the work of Fiedler, Furman, and Powell (2019), who estimate that a 1 percentage point increase in the unemployment rate lowers real per capita total state revenues by 3.7 percent. Both Bivens and Walker (2020) and Bartik (2020) increase this number by about a third to roughly account for the impact of COVID-19 on local taxes. These estimates tend to show very large effects of the pandemic.

19. Tax Policy Center, Briefing Book, “The State of State (and Local) Tax Policy,” <https://www.taxpolicycenter.org/briefing-book/what-are-municipal-bonds-and-how-are-they-used>.

20. Fiscal years for states generally end on June 30, so these two fiscal years end June 30, 2021.

Table 2. Summary of Recent Projections for Revenue Losses from COVID-19 in the State and Local Sectors

<i>Authors</i>	<i>Revenue sources considered</i>	<i>Revenue losses FY2020 and FY2021 (billions)</i>		<i>Economic forecast underlying estimate</i>	<i>Methodology</i>
		<i>State and local taxes</i>	<i>FY2020 and FY2021 (billions)</i>		
Bartik (2020), Upjohn Institute	State and local taxes		\$899	May CBO	Historical relationship augmented for assumed local revenue effect; 1 percent increase in unemployment to lower state and local revenues by \$60 billion.
McNichol, Leachman, and Marshall (2020), Center on Budget and Policy Priorities	State taxes		\$395	April CBO	Historical relationship: 1 percent increase in unemployment rate lowers revenues 3.7 percent.
Bivens and Walker (2020), Economic Policy Institute	State and local taxes		\$345	Goldman Sachs April forecast	Historical relationship augmented for assumed local revenue effect: 1 percent increase in unemployment associated with a \$60 billion decline in state and local revenues.
Clemens and Veuger (2020a)	State income and sales tax		\$148	April CBO	Historical relationship: 1 percent decline in personal income lowers revenues by 1.6 percent.
White, Crane and Seitz (2020), Moody's Analytics	State revenues general funds		\$130 baseline; \$203 more severe scenario	Baseline: max. 10 percent decline in real GDP, gradual recovery. More severe: max. 14 percent decline in real GDP, gradual recovery. Best: recovery complete by 2020:Q4. Worst: second wave shutdown 2020:Q4; economy recovered by 2021:Q4. States' forecasts	Proprietary model that includes state-by-state regressions of state revenues on economic revenues.
Whitaker (2020b)	All state and local revenue (including fees, charges, etc.)		\$200–\$490		For income taxes: estimate wage declines and assume tax revenues decline proportionally.
Urban Institute (2020)	State taxes		\$200		For sales taxes, use national changes in portions of PCE likely subject to sales tax. Estimated for all fifty states based on forecast data from twenty-seven states.

Source: Authors' compilation.

A second method—relied on by Clemens and Veuger (2020a)—uses the historical relationship between changes in personal income and income tax collections and changes in personal consumption and sales tax collections.²¹ White, Crane, and Seitz (2020) adopt a broadly similar approach at the state level. Whitaker (2020a, 2020b) uses a variety of methods to project changes in the whole suite of state and local revenues and fees. Finally, Dadayan (2020) uses information on states' own forecasts of revenue losses to project losses for the nation as a whole.

The estimates in the literature that relate changes in economic conditions to changes in revenue collections seem appropriate as a general rule of thumb to know what the effect of a typical recession might be on revenues. Indeed, Fiedler, Furman, and Powell (2019) note that their estimate is intended to capture not only the direct effect of unemployment on revenues but also any indirect effects stemming from changes in economic conditions that occur in recessions. But there are reasons to believe that these historical relationships may not prove to be very accurate for the current very unusual recession. First, as noted by Chetty and others (2020), while all recessions affect those with the lowest incomes the most, this one appears to have hit low-wage workers disproportionately hard relative to historic norms; these individuals often work in service industries that have been decimated by a fall in demand and are also the least likely to be able to work from home. Indeed, data on employment rates by income group from Opportunity Insights suggest that the recession is basically over for high-wage workers, but still very severe for low-wage workers.²² This concentration of unemployment among the lowest-paid workers means that the increase in the unemployment rate may be less consequential for state and local revenues than in the past.

Second, most recessions are accompanied by stock market declines. Stock market declines depress revenues by depressing taxable capital gains realizations and are likely associated with lower taxable business income. But although the market did fall by almost 30 percent in March 2020, the recovery in equity prices was swift and, as of October 19, the market was

21. Clemens and Veuger (2020b) update the income and sales tax estimates in Clemens and Veuger (2020a) and also extend the estimates by accounting for other state taxes, as well as local taxes. They estimate a total state and local government revenue loss due to the COVID-19 pandemic of \$240 billion in fiscal year 2021. In these papers, as we do here, they base their COVID-19 shock on the evolution of CBO economic projections.

22. Data from Opportunity Insights are at [Tracktherecovery.org](https://tracktherecovery.org).

up almost 5 percent for the year, suggesting that capital gains tax revenues won't be significantly depressed relative to a typical year.²³

Third, the huge fiscal response to this recession at the federal level has important implications for state and local tax revenues. While the \$1,200 rebate checks sent to most families are not taxable, much of the Paycheck Protection Program (PPP) spending will likely show up as higher profits for sole proprietorships, partnerships, and S corporations (all taxed at the individual level), and the large expansion and increase in unemployment benefits is taxable in most states with an income tax.²⁴ Projections based on historical relationships between tax collections and the unemployment rate will miss these increments to taxable income, as they far surpass anything that has been enacted in the past. Projections based on the regressions on personal income, on the other hand, will capture the higher income from unemployment benefits but will also capture the approximately \$300 billion in rebate checks, which are not taxable.²⁵

Fourth, the pattern of consumption changes in this recession are very different than in previous recessions. The drop in consumption is far larger than observed in previous recessions—suggesting that regressions based on income or the unemployment rate will understate the decline in sales tax revenues. But the composition of the consumption decline has also changed dramatically. Consumption of services—which are usually far less cyclical than consumption of goods—has plummeted, while consumption of goods has shown much more resilience. Given that most services are untaxed, this might lessen the hit to sales tax collections. State and local governments also rely importantly on fees and charges, however. With driving and flying

23. The effects of changes in the stock market tend to affect tax receipts with a lag, as much of the effect occurs when people make estimated quarterly tax payments or final payments in April of the following year.

24. Autor and others (2020) calculate that the PPP loans created 2.3 million jobs at an average annual wage of \$60,000. These loans covered only two and a half months of payroll, meaning that only \$29 billion went to firms who otherwise would have laid off their workers; the remaining \$489 billion accrued to business profits. Alaska, Florida, Nevada, New Hampshire, South Dakota, Tennessee, Texas, Washington, and Wyoming do not have income taxes on earned income and so don't tax unemployment benefits. In addition, California, Montana, New Jersey, Pennsylvania, and Virginia exempt unemployment benefits from income taxes; see "Is Unemployment Taxable? State-by-State Guide to Unemployment Benefits," Kiplinger, <https://www.kiplinger.com/slideshow/taxes/t055-s001-state-taxes-on-unemployment-benefits/index.html>. The \$1,200 rebate checks may, however, indirectly boost sales tax revenues by supporting consumption.

25. Clemens and Veuger (2020a) correct for this by taking out the rebate checks when doing their calculations.

Table 3. State and Local Tax Revenues and the Business Cycle, 1985–2019

<i>Independent variable</i>		<i>Dependent variable: log change in real per capita state and local income taxes</i>			
		<i>All</i>	<i>Exclude 2009</i>	<i>Include stocks</i>	<i>Include stocks and exclude 2009</i>
Change in unemployment rate	Coeff.	−4.9	−3.5	−3.3	−2.7
	Rsqr adj.	0.56	0.24	0.65	0.35
Log change real per capita personal income	Coeff.	2	1.4	1.4	1.1
	Rsqr adj.	0.58	0.28	0.65	0.36
Log change real per capita taxable personal income	Coeff.	1.5	1.1	1.1	0.89
	Rsqr adj.	0.61	0.33	0.67	0.4

<i>Independent variable</i>		<i>Dependent variable: log change in real per capita state and local sales taxes</i>			
		<i>All</i>	<i>Exclude 2009</i>	<i>Include stocks</i>	<i>Include stocks and exclude 2009</i>
Change in unemployment rate	Coeff.	−3	−2.3	−2.4	−2
	Rsqr adj.	0.72	0.44	0.75	0.49
Log change real per capita personal income	Coeff.	1.1	0.7	0.8	0.6
	Rsqr adj.	0.6	0.27	0.64	0.31

Sources: Data on taxes and personal income from the Bureau of Economic Analysis (BEA); unemployment rates from the Bureau of Labor Statistics (BLS); stock market uses the Wilshire 5000 from FRED.

way down and many public parks closed, this category of revenues is likely to suffer much larger declines than in previous recessions.

Finally, as we show below, even after making various adjustments, these types of regressions are very sensitive to the experience of the Great Recession, when revenues fell sharply even given the very large rise in unemployment. It is unclear whether that outsized relationship reflected a structural change or something specific to the Great Recession.

II.B. A Reexamination of the Historical Relationships between State and Local Revenues and the State of the Economy

In table 3, we reexamine some of the historical relationships at the national level. As noted by Fiedler, Furman, and Powell (2019), examining the relationship between actual tax revenues and economic conditions can lead to an underestimate of the true coefficients, because state and local governments may respond to lower anticipated tax revenues by raising taxes and fees. However, they show that such effects are quite modest, and so we ignore these policy responses here. In the bottom-up approach we focus on

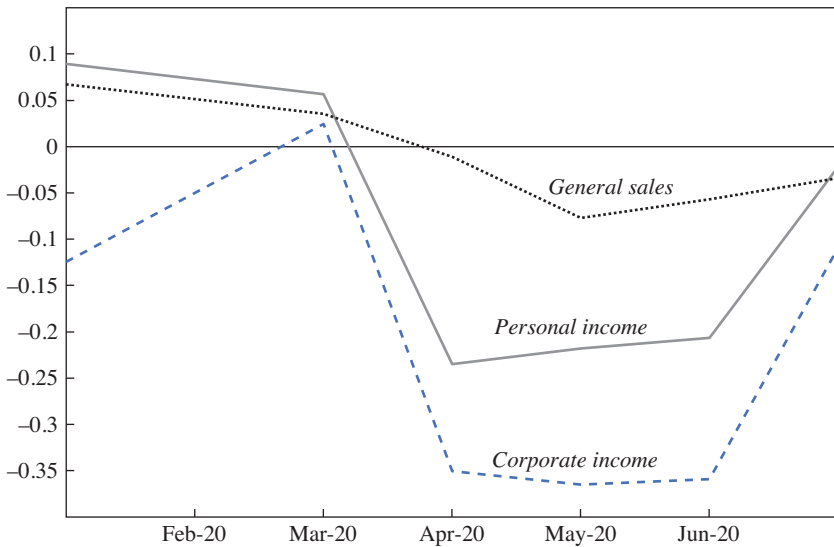
below, we control for any such policy changes directly by using existing tax codes to project state and local revenues.

We first examine the relationship between the log difference of real state and local income taxes and sales taxes and two economic indicators: the change in the unemployment rate and the log change in real per capita personal income. In order to try to assess the importance of changes in stock market returns in depressing tax revenues during recessions, we include the lagged change in the log of the inflation-adjusted Wilshire 5000 index.

The regressions illustrate a few important points. First, excluding 2009 leads to much smaller estimates of the effects of changes in the economy—regardless of the economic indicator—on both income and sales tax collections. Second, including a measure of stock price changes similarly lowers the estimated coefficient, and including stock prices and excluding 2009 lowers the estimates yet again. For example, the effect on the percentage change in state and local income tax revenues from a 1 percentage point increase in the unemployment rate is a fall from -4.9 percent to -2.7 percent, or by about half, and a similar change is seen in the coefficient on the change in personal income. Third, the estimates are relatively variable across specifications.

Using the change in unemployment projected by the CBO for 2020 as a whole, for example, the estimated revenue loss from income taxes declines from roughly \$160 billion using the estimates in the first column to about \$88 billion using the estimates in the fourth column.

We also attempt to understand the relationship between changes in personal income and changes in income tax revenues. Clemens and Veuger (2020a), for example, use an elasticity of state income tax revenue with respect to personal income of 1.6, even though state income tax systems are not very progressive. We note that a large and growing share of personal income is not subject to taxation and is not very cyclical—including Medicare, Medicaid, Social Security, and imputed rent on owner-occupied housing. That means that when personal income falls by 1 percent in a recession, the taxable and more cyclical components fall much more, giving rise to a coefficient on personal income greater than one in a regression of tax collections on personal income. To test whether this wedge between taxable and total personal income accounts for the large elasticity of state income tax revenue with respect to personal income, we run the regression using the taxable portion of personal income. We define this as all personal income less governments transfers other than unemployment insurance (which is taxable in most states), imputed rent on owner-occupied housing, and employer-provided benefits like health insurance and pensions. As

Figure 4. State Taxes: Year-to-Date Percent Change Relative to Previous Year

Source: Data provided by the Urban Institute, <https://www.urban.org/policy-centers/cross-center-initiatives/state-and-local-finance-initiative/projects/state-tax-and-economic-review/data-subscriptions>.

Notes: Figure displays percentage changes for 2020 relative to 2019 for year-to-date state government tax collections. Personal income tax collections reflect data for thirty-three states, which accounted for roughly 85 percent of national income tax collections in 2019; corporate income tax collections reflect data for thirty-six states, which accounted for roughly 82 percent of national corporate income tax collections in 2019; sales tax collections reflect data for thirty-six states, which accounted for roughly 88 percent of national sales tax collections in 2019.

shown in the third row of table 3, a regression of income tax revenues on taxable personal income shows a much smaller coefficient. Indeed, it is just below one once the stock market is included in the regression and 2009 is excluded.

But the large differences between this recession and previous ones suggest that relying on past experience may not necessarily provide very accurate projections of budget pressures for state and local governments. Indeed, data on state government tax collections suggest that, at least through midsummer, the revenue shock may not have been as severe as suggested by some of the estimates considered so far.

Figure 4 displays the percent change in year-to-date tax collections through July relative to 2019.²⁶ Tax revenue plummeted following the

26. The data are collected by the State and Local Finance Initiative at the Urban Institute, <https://www.urban.org/policy-centers/cross-center-initiatives/state-and-local-finance-initiative/projects/state-tax-and-economic-review/data-subscriptions>.

onset of the pandemic as many states followed the federal government's decision to delay final 2019 and estimated quarterly 2020 income tax payments from April and June to July. The decline in collections was historic and exceeded the declines experienced as a result of the Great Recession (Gordon, Dadayan, and Rueben 2020). However, year-to-date personal income tax collections rebounded smartly in July as delayed payments came in. Sales taxes staged a more muted recovery in June and July, reflecting the broader economic recovery as well as delays in filing and remittance deadlines in some states (Urban Institute 2020).

Overall, year-to-date personal income tax and sales tax collections in July were down around 2 percent and 3.4 percent, respectively, relative to last year; corporate collections were down a much larger 11 percent. The declines in personal income taxes and sales taxes are smaller than the decline in economic activity over the same period. This divergence likely reflects, in part, the effects of the massive fiscal stimulus enacted by the federal government—for example, the boost to personal income attributable to the expanded unemployment insurance (UI) program. Nonetheless, tax collections remain depressed due to the pandemic. Moreover, year-to-date growth in collections could well fall back in the months ahead—for example, the end of the \$600 supplement to UI payments in July will reduce taxable personal income.²⁷

Given the unusual nature of the current economic downturn, and the corresponding uncertainty over the appropriateness of using elasticities based on historic experience, our preferred approach is to use a more detailed bottom-up method that accounts for the geographic variation in the magnitude of the impact on employment and consumption, the distributional effects, and the impact of federal fiscal policy on taxable income. We attempt a detailed projection of revenues through the end of calendar year 2022. These bottom-up estimates should be viewed as complementary to the more standard top-down estimates discussed above.

27. The 2020 year-to-date collections include revenue from the prepandemic months of January and February; these months will become a relatively smaller share of year-to-date collections as additional months of collections come in. The Urban Institute (2020) documents that the percentage declines in cumulative tax collections from March through July relative to 2019 are larger than the year-to-date percentage declines reported here. Finally, looking to 2021 tax revenue, final tax payments for the 2020 tax year, to be collected in 2021, may well be weaker than 2019 final payments. See Gordon, Dadayan, and Rueben (2020) for a much more detailed, point-in-time description of state and local government finances as of July 2020.

II.C. A Bottom-Up Methodology for Calculating State and Local Revenues

Our bottom-up approach explicitly accounts for heterogeneity across states and estimates revenue losses on a state-by-state basis. We consider state and local governments jointly by state. While this is appropriate given the substantial fiscal linkages between a state and its localities, it does gloss over the substantial heterogeneity in fiscal conditions at the local level.²⁸

We consider five categories of revenues for state and local governments: individual income taxes, which make up 16 percent of general own-source revenues (revenues excluding utility, liquor store, and insurance trust fund revenue, as well as rents from the federal government); sales taxes, which account for another 16 percent; corporate income taxes, which make up just 2 percent of general own-source revenues; and fees and charges, which make up 44 percent. House prices have held up well so far in this recession and property taxes respond to changes in market values with a lag of several years (Lutz, Molloy, and Shan 2011). Accordingly, we assume no change to property taxes, which make up 22 percent of own-source revenues.²⁹

Our basic methodology compares recent data on employment and consumption with what had been projected pre-COVID-19 to measure the COVID-19 shock, using the CBO's economic projection from January 2020 as the pre-COVID-19 baseline. We project that shock forward using the difference between the CBO's economic post-COVID-19 projections (July 2020) and their pre-COVID-19 projections (January 2020), as well as their estimate of social distancing. We describe the methodology for each type of revenue briefly below and in detail in section II of the online appendix.

The CBO projections include much lower inflation over the next few years, which we take on board in the form of lower nominal wages, capital income, and consumption, and hence lower revenues. Whether lower revenues due to lower inflation represent strains for state and local governments depends on what happens to the prices of the items they purchase.

28. See Chernick, Copeland, and Reschovsky (2020) for a detailed examination of the effect of the pandemic on the fiscal position of large cities; these authors find substantial variation in the fiscal effect across cities.

29. Delinquencies could push down property tax revenues. However, even during the housing crisis coincident with the Great Recession, delinquencies appear to have had only a minor effect on property tax collections. A decline in commercial real estate prices could, however, eventually push down property tax collections. See Chernick, Copeland, and Reschovsky (2020) for a discussion of these issues.

While we think using nominal revenue decline is reasonable, we also report declines in real revenues.

THE EFFECTS OF COVID-19 ON STATE AND LOCAL INCOME TAXES To calculate state and local income tax revenues, we create a small-scale micro-simulation model using data from the Current Population Survey and the NBER's TAXSIM, which, given a set of inputs about taxable income, calculates individual income tax liabilities by state using each state's tax code.³⁰ We gross up state revenues to account for local income taxes, using the ratio of local to state income tax revenues in 2017. In using TAXSIM, we are calculating annual tax liabilities, rather than tax payments—for example, some of the declines in 2020 tax liability won't show up until April 2021, when final payments are due.

We compare the revenues under a pre-COVID-19 baseline to one that reflects the effects of the pandemic on income. To calculate post-COVID-19 income, we use CBO economic projections to shock wage rates, income, dividends, pensions, and business income on a national basis. To calculate wage income and unemployment rates, we use data from Opportunity Insights on employment by month by state for three broad income groups: those in the bottom quartile, those in the middle two quartiles, and those in the top quartile.³¹ These data allow us to capture the heterogeneity across states and across income groups in the effects of the recession. We adjust the size of the employment declines each month so that, rather than being relative to January (as the Opportunity Insights data are), they are relative to the employment levels in the CBO's January 2020, pre-COVID-19 economic projections.³² Using these data, we have a different COVID-19 shock for each state and income group combination. We use the unemployment benefits calculator in Ganong, Noel, and Vavra (2020) and our estimates of unemployment by month to calculate weekly unemployment insurance benefits by state.

30. At the time of writing, TAXSIM had state income taxes only through 2018, but there have been few significant changes in tax laws since then. We use TAXSIM based on the 2018 state tax codes.

31. The Opportunity Insights data come from the private sector, whereas we are implementing the shocks for all workers. Because the private sector experienced, on average, somewhat higher relative employment losses than the public sector, we view the shocks to wages as an upper bound. The cutoffs for the bottom and top quartiles in the data are 27,000 and 60,000, respectively. Using these cutoffs with the CPS wage data put too many people in the top quartile, which would have understated unemployment. Instead, we used the 25 percent and 75 percent quartiles from the national CPS data to define the income groups.

32. That is, we account for the fact that simply reaching January's employment doesn't mean that the economy is back to the pre-COVID-19 baseline.

We use Opportunity Insights data through August 2020. To calculate 2020:Q3, we assume that September employment was unchanged from August. To project employment into the future, we assume the recovery in employment for each state follows the recovery in the CBO unemployment projection. For example, the unemployment rates for 2021:Q3 and 2021:Q4 in the CBO's July 2020 projection are 8 percent and 7.6 percent, respectively, compared to 3.6 percent for both quarters in the January 2020 projection. Thus, the difference between the CBO's pre- and post-COVID-19 unemployment rates falls 9 percent between 2021:Q3 and 2021:Q4; we use that rate of decline for each state/income group.³³

One issue we had to contend with is that the incoming data have been far stronger than anticipated by the CBO in their July projection. For example, the CBO projected that the unemployment rate would be 14.1 percent in the third quarter and then begin to decline, hitting 8.6 percent by the second quarter of 2021. In fact, the unemployment rate was 10.2 percent in July and 8.4 percent in August. We assume that the CBO simply missed the timing of the recovery, and, rather than assuming the shock continues to dissipate over the remainder of the year, we have chosen to keep it constant at its current value through the middle of 2021 and then allow it to follow the CBO path. That is, we assume no improvements in employment relative to baseline until the middle of next year. While this is a less optimistic projection than many other forecasters, it may be reasonable given that, unlike these other forecasts, it is a current law projection that assumes no additional fiscal stimulus. Furthermore, it provides for the possibility of a second wave in the fall or winter that will slow the recovery.

Line 2 of table 4 provides our results of the effects of the pandemic on state and local personal income tax collections. Online appendix table 1 contains projections for each state. Income tax revenues decline 5.2 percent in 2020, 7.4 percent in 2021, and 7.5 percent in 2022, for totals of \$24 billion, \$36 billion, and \$38 billion, respectively. These revenue losses are the result of losses in taxable income of 4.3 percent, 6.3 percent, and 6.4 percent, suggesting that state tax systems are moderately progressive.³⁴ In real pre-COVID-19 dollars, these declines are quite a bit smaller in 2021 and 2022 (line 17).³⁵

33. The 9 percent decline comes from comparing 4.4 ($8 - 3.6$) to 4 ($7.6 - 3.6$).

34. See Cooper, Lutz, and Palumbo (2015) for a discussion of state personal income tax progressivity.

35. The CBO lowered GDP inflation by 1.2 percentage points in 2020, 1.3 percentage points in 2021, and .5 percentage points in 2022, which lowers revenues accordingly. Our "real" revenue losses exclude losses due to these changes in inflation.

Table 4. Effects of the Pandemic on State and Local Fiscal Outlook, National Summary

		\$ (billions)		
		2020	2021	2022
1	Projected nominal declines in revenues excluding fees from higher education and hospitals	156	165	143
2	Personal income tax revenues	24	36	38
3	Corporate income tax revenues	2	29	14
4	Sales tax revenues	49	45	46
5	Other taxes and fees	82	55	45
6	Projected nominal declines in fees to public hospitals and institutions of higher education	33	22	22
7	Additional demands on spending	?	?	?
8	Nominal state aid excluding hospitals and higher education	211	16	12
9	COVID-19 relief	150		
10	K-12 aid	13		
11	Transit	25		
12	Medicaid (excess over additional spending)	23	16	12
13	Nominal state aid to hospitals and higher education	42		
14	Health provider relief	35		
15	Higher education relief	7		
<i>Declines in real revenues (pre-COVID-19 \$)</i>				
16	Revenues excluding fees from higher education and hospitals	140	130	98
17	Personal income tax revenues	19	25	24
18	Corporate income tax revenues	1	29	12
19	Sales tax revenues	44	35	33
20	Other taxes and fees	76	42	28
21	Fees to public hospitals and institutions of higher education	30	15	13

Source: Authors' calculations.

The moderate size of these declines—especially relative to the declines that would have been estimated using the regressions above—primarily reflects the low incomes of most of the unemployed and the sizable taxable fiscal stimulus. We calculate that, without the CARES Act, income tax revenues would have declined an additional \$11 billion in 2020, \$5 billion from unemployment insurance and \$6 billion from PPP.³⁶

THE EFFECTS OF COVID-19 ON CORPORATE TAXES While corporate tax collections make up only a small part of state and local revenues, they are also

36. As discussed in the online appendix, the amount of PPP money included in these estimates is quite minor.

highly procyclical, and the large declines in federal corporate tax collections in the CBO forecast suggest that the revenue declines for state and local governments are likely to be substantial. The CBO has adjusted its estimates of corporate tax receipts down because overall corporate profits are down, because the taxable share of profits tends to decline in recessions, and because of legislative changes made in the CARES Act. We adjust the July CBO projections to take out the legislative effects, as these are unlikely to affect state tax collections.³⁷ We then calculate the COVID-19 shock to corporate tax collections as the difference between this adjusted July projection and the January CBO projection and apply this percentage shock to our estimate of what state corporate tax revenues would have been in the absence of COVID-19. We calculate these counterfactual state corporate receipts using the 2017 Census of Governments, increased by the average growth rate of such taxes between 2014 to 2017. As shown in line 3 of table 4, we project that state corporate tax collections will decline \$2 billion in 2020, \$29 billion in 2021, and \$14 billion in 2022.

THE EFFECTS OF COVID-19 ON SALES TAX REVENUES The sales tax is a large source of revenue for state and local governments. Forty-six states impose general sales taxes and so do some local governments. Because the sales tax is based on the dollar value of sales, sales tax revenues move proportionally with consumption of taxed items. But because of the unusual patterns of consumption changes during the current recession—large increases in groceries and large decline in spending at restaurants and hotels, for example—and because not all items of consumption are subject to the sales tax, looking at the past relationship between aggregate consumption expenditures and, particularly, unemployment and sales tax revenues may not yield a reasonable estimate of the effect of the pandemic on sales tax collections, at least in the near term. Online appendix table 2 describes the composition of state sales tax bases.

To isolate some of these unique effects, we approximate changes in taxable consumption for each state by using a combination of changes in spending by consumption category from the Opportunity Insights data, calibrated using national data for the second quarter from the National Income and Product Accounts (NIPA), and state-by-state variation in the sales tax base. Our projections of sales tax revenues take the easing of social distancing into account. In particular, following the CBO, we assume that the

37. The largest legislative change affecting corporate profits involved an adjustment to how net operating losses are treated. Most states did not adhere to this change in treatment (Ernst and Young 2020).

shock to spending coming from social distancing abates over the next three quarters. By the middle of 2021, we assume that the shock to consumption no longer reflects social distancing but instead only reflects the overall state of the economy. The online appendix contains detailed information on our methodology as well as results on a state-by-state basis.

Line 4 of table 4 shows our results for the nation over the next three years. The results by state are in online appendix table 3. In aggregate, we project that sales taxes will decline \$49 billion this year, \$45 billion next year, and \$46 billion in 2022. As discussed above, part of this decline reflects the fact that the CBO has lowered the price level substantially as a result of COVID-19. Examining constant pre-COVID-19 dollars—line 19—the declines are somewhat smaller: \$44 billion, \$35 billion, and \$33 billion. These projections may be somewhat too pessimistic. While we assume that the effects of social distancing wane, we do not account for the possibility that some of the lost spending will be made up. It seems likely that at least some of the cars not purchased and trips not taken represent consumption delayed rather than forgone, especially given the large rise in personal savings since the pandemic began.

THE EFFECTS OF COVID-19 ON OTHER TAXES AND FEES State and local governments derive significant revenue from sources other than the individual income tax, corporate income tax, property tax, and general sales tax, including revenue from selective sales taxes, fees and charges, and various other sources. Online appendix table 5 provides a detailed breakdown.

We use an approach similar to Whitaker (2020a, 2020b) to estimate the revenue declines. In most cases, we assign each revenue source a tax base measured at the monthly frequency in the NIPA. For instance, higher education fees are assigned a base of consumption of proprietary and public higher education services. For most categories of spending, we do not have state-specific information and assume that the declines in the tax bases in the NIPA are uniform across the states. The exceptions to this are for our estimates of motor fuel tax collections and hospital fees. We use a similar method to project the shocks forward as used for sales taxes—assuming that categories of spending driven by social distancing rebound to the average national decline in consumption by the middle of next year. The online appendix includes more detail on our methodology, and results by state are in online appendix tables 6 and 7.

As shown in line 5 of table 4, we estimate that the pandemic will lower revenues from other taxes and fees, excluding fees to public hospitals and institutions of higher education, by \$82 billion this year, \$55 billion next year, and \$45 billion in 2022. Online appendix table 5 reports the

components of the revenue loss. The largest source—by far—is related to transportation, accounting for \$46 billion in tax losses this year. This big hit to taxes and fees on transportation represents a massive difference from prior recessions.

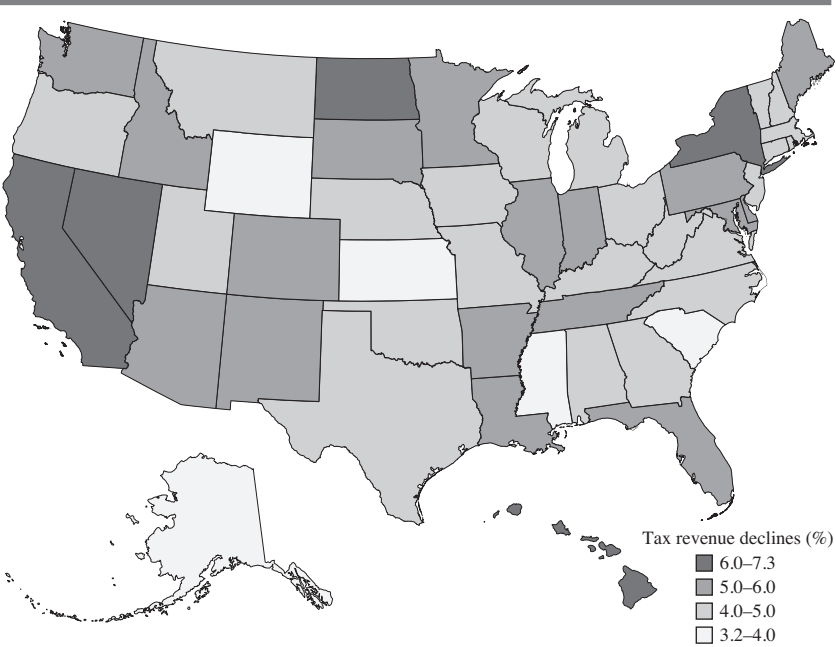
We estimate that the pandemic will lower fees to public hospitals and institutions of higher education by \$33 billion this year, \$22 billion in 2021, and \$22 billion in 2022. It is difficult to assess the extent to which the projected declines in these fees should be included in our measures of revenue losses because these fees are typically provided in exchange for services rendered. As fees decline, so too do services and, possibly, expenditures. For example, the sharp decline in health expenditures in the spring meant that health care facility revenues plunged. To the extent that public hospitals reduced employment or cut back on supplies, these revenue losses were likely offset by declines in spending. On the other hand, running a hospital or university involves significant fixed costs, so the decline in revenues was likely not fully offset.³⁸

Furthermore, while reductions in revenues offset by reductions in expenditures do have macroeconomic implications, much of this is the result of social distancing rather than tight budgets. Providing aid to state and local governments would not likely boost these expenditures. Furthermore, unlike declines in revenues that are not offset by declines in spending, they don't require any further changes in state and local spending beyond those already observed. Of course, some of these same dynamics apply to non-fee-based services. For example, according to BLS data, employment in local education declined about 5 percent in the spring. While some of these declines might have been in anticipation of tight budgets ahead, they also likely reflected, at least in part, layoffs of bus drivers, cafeteria workers, and other workers not needed for online schooling. From that perspective, these layoffs—while a negative for the macroeconomy, the workers, and the students—might be viewed as loosening budget constraints rather than as reflecting tight ones.

TOTAL REVENUE LOSSES As shown on line 1 of table 4, we estimate total revenue losses, excluding those from fees to public hospitals and institutions of higher education, of \$156 billion in 2020, \$165 billion in 2021, and \$143 billion in 2023. These represent 5.8 percent, 5.9 percent, and 4.9 percent of general own-source revenues for 2020, 2021, and 2022,

38. Of course, it is possible that much of the lost revenue will be made up in the future as people ultimately get their conditions treated, a possibility we do not include in our projections.

Figure 5. Variation in Revenue Declines across States



Source: Authors' calculations.
Notes: This map shows projected declines in revenues from 2020 to 2022, as a share of own-source revenues excluding fees to hospitals and higher education. State-by-state numbers can be found in online appendix table 8.

respectively. Part of the reason revenue losses remain high is because of the CBO's assumption of lower inflation post-COVID-19. Line 16 shows the revenue losses excluding the effects of lower inflation, which are quite a bit lower, particularly in 2022.

Figure 5 shows the variation in nominal revenue losses, excluding hospitals and higher education, as a share of pre-COVID-19 own-source revenues from 2020–2022. The three states with the largest revenue losses—Nevada, California, and New York—have revenue losses exceeding 7 percent of own-source revenues, while the states with the smallest revenue losses—Wyoming, Alaska, South Carolina, and Kansas—have losses of less than 4 percent of own-source revenues. Online appendix table 8 includes the revenue losses by state by year.

ACCOUNTING FOR FEDERAL AID TO STATE AND LOCAL GOVERNMENTS States and localities are due to receive more than \$200 billion in extra federal aid this year. The largest portion of that aid is \$150 billion through the

coronavirus relief fund.³⁹ Legislation enacted last spring also provided aid to transit, education, and health care providers and raised the federal share of Medicaid spending by 6.2 percentage points—more than enough, we estimate, than necessary to cover additional Medicaid costs. The online appendix describes our methodology for our Medicaid estimates and the allocations of aid by state.

At least for 2020, federal aid seems large enough to offset state and local revenue losses. Looking forward, however, should the economy remain below its pre-COVID-19 baseline for many years, as the CBO projects, these governments will need additional aid in order to avoid cutting back on services or raising taxes and impeding the recovery.

Furthermore, even if state and local governments are not cutting back on spending in the aggregate, so that they are not a net drag on the economy, changes in the need for spending brought on by the pandemic could still mean that these governments might have to cut back on essential services. For example, if it is expensive to provide decent virtual education and public health services, then the ability to simply maintain pre-COVID-19 levels of spending may not be enough. A complete analysis of the fiscal conditions of state and local governments requires knowing much more about the spending side of the budget than we do at this point.

In addition, just because federal aid appears sufficient in the near term in aggregate does not mean that it is sufficient for every state. As shown in online appendix table 9, there is a great deal of variation across the states in the amount of aid received. While the largest source of federal aid, the \$150 billion coronavirus relief fund, is generally distributed on the basis of population, states received a minimum of \$1.25 billion. That made the aid exceedingly generous for some states, while others are likely to face budget shortfalls even in the absence of significant increases in COVID-19-related spending. For instance, Vermont, South Dakota, and Montana each received aid exceeding 20 percent of 2020 own-source revenues, whereas Iowa, Missouri, Mississippi, California, Connecticut, New York, and Washington received aid of 6 percent or less.

II.D. The Fiscal Outlook for State and Local Governments in the Medium Term

Because state and most local governments have to roughly balance their operating budgets, near-term fiscal distress should mostly be accompanied

39. Although those funds are required to be used for COVID-19-related spending that was not anticipated in the prior year's budget, the states have now mostly appropriated these funds, indicating they are likely to be spent (Gordon, Dadayan, and Rueben 2020).

by near-term cutbacks in spending and reductions in spending, although, as we saw in the Great Recession, severe near-term fiscal distress can linger on as states spread the fiscal distress over multiple years and rebuild their rainy day funds.⁴⁰ The pandemic will also affect some sources of revenue that are not subject to balanced budget requirements—in particular, spending on unemployment insurance, interest costs on state and local debt, and asset returns on state and local pensions.

EFFECTS OF COVID-19 ON STATE UNEMPLOYMENT INSURANCE FINANCING State unemployment insurance (UI) programs are funded jointly by the federal and state governments through an employer-side payroll tax. State UI taxes are deposited in a state-specific trust fund at the US Treasury and used to pay UI benefits in that state. If the trust funds become insolvent, states may borrow from the US Treasury to cover the shortfall. The UI program is typically viewed as an automatic stabilizer which buffers the economic cycle by increasing benefit payments as the economy slows. However, concerns have been expressed that increases in UI tax schedules due to depletion of trust funds may impede labor market recovery (Duggan, Guo, and Johnston 2020) and the need to replenish trust funds may divert resources from other uses in already strained state budgets. Indeed, following the Great Recession most UI trust funds became insolvent and average UI tax rates rose.

Nevertheless, the effects of UI financing strains seem likely to be fairly moderate. The various expanded UI benefits are not subject to experience rating and hence will not trigger increased tax rates. In addition, as of May 11, over half the states had exempted at least some current UI benefit charges from experience rating (Loughead 2020). Moreover, although UI tax rates increased significantly in percentage terms in the aftermath of the Great Recession and some firms and industries experienced large increases, in aggregate the average tax rate was only 0.6 percent of payroll in 2008 and rose to only 0.9 percent in 2012 before falling back.⁴¹

In terms of state budget strain, states may borrow to address UI financing shortfalls; as a result, they can adjust to the shock gradually over many years, as opposed to the much quicker adjustment necessitated by general revenue shortfalls. Indeed, following the Great Recession, states in

40. See Rueben and Randall (2017) for a discussion of the stringency of state balanced budget requirements. States held \$119 billion in budget balances (rainy day funds plus general fund surpluses) at the end of 2019; these funds, which are not explicitly accounted for in the analysis in this paper, will initially allow the states to mitigate the magnitude of expenditure cuts and tax increases.

41. See Pavosevich (2020). In dollar terms, state UI taxes rose from about \$30 billion in 2008 to about \$50 billion in 2012.

aggregate eliminated their UI debt very slowly, only extinguishing it in 2019 (US Department of Labor 2014, 2020).

EFFECTS OF LOWER INTEREST RATES ON STATE AND LOCAL FINANCES State governments are both borrowers and savers. The saving is mostly in the form of contributions to state and local employee pension funds, while the borrowing is through the issuance of municipal debt—mostly to finance long-term capital projects. According to the Census of Governments for 2017, total state and local government debt equaled \$3 trillion in 2017, while total financial assets were \$6.9 trillion. Thus, on net, state and local governments are net lenders rather than borrowers; this was true not just for the United States as a whole, but for each state individually as well.

To a first approximation, the immediate fiscal pressures coming from lower interest rates can be calculated as the change in rates of return multiplied by net financial assets, assuming that changes in Treasury rates are passed on one-for-one to changes in rates of return on other assets.⁴² The CBO lowered its projection of rates on Treasuries by about 1.1 percentage points in 2020, 1.4 percentage points in 2021, and 1.6 percentage points in 2022. In the aggregate, we estimate that the lower real interest rates reduce funds available to state and local governments by roughly \$40 billion in 2020, \$50 billion in 2021, and \$60 billion in 2022.

Looking beyond the near term, a longer-term decline in interest rates would place additional stress on state and local employee pension funds. But, as argued by Lenney and others (2019), lower real interest rates not only increase the rate of contributions needed to close existing pension funding gaps; they also make the case for pre-funding pensions weaker. Lenney and others (2019) note that when valuing the liabilities at risk-free rates, these plans have always been less than fully funded, and thus state and local governments have long been carrying implicit debt. Lower interest rates lessen the value of pre-funding.

Furthermore, recognizing that not fully funding pension contributions is a form of borrowing, it is worth asking whether lowering contributions could provide fiscal space if necessary. State and local governments contributed \$169 billion to their defined benefit pension plans in 2019.⁴³ Budget balances (rainy day funds plus general fund surpluses) at the end of 2019, while at a record high of \$119 billion, can only be used once—whereas

42. This calculation ignores the fact that not all debt and financial assets roll over immediately but should nevertheless give a reasonable measure of the near-term fiscal effects of lower rates of return.

43. Bureau of Economic Analysis, Nation Income and Product Accounts (NIPA), table 7.24., line 5, <https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=2>.

contributions can be cut for multiple years. Furthermore, while budget balances were at a record high for the country as a whole, not all states were in such a good position. Yet, as shown in online appendix figure 7, many states without much in reserves do make sizable pension contributions, which could provide them some fiscal space if needed. Thus, cutting back on pension contributions could go some distance toward mitigating spending cuts. However, cutting back on pension funding comes at the cost of making pension commitments less sustainable over medium and longer terms. Moreover, higher grants from the federal government would be a more efficient way of smoothing through the costs of the pandemic: the federal government is better able to bear debt, has lower borrowing costs, and can internalize the economic spillovers arising from the macroeconomic effects of higher state and local spending.

III. Conclusion

The COVID-19 pandemic has had the biggest effect on the economy, at least in the short run, of any downturn since the Great Depression. The policies undertaken to deal with the crisis will have important implications for the length of the recession and the strength of the recovery. The pandemic will also affect the conduct of fiscal policy once the crisis is past, given the projection of rising debt, the long-lasting effects on the economy, and the effects of the crisis on US political imperatives.

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Comment and Discussion

COMMENT BY

DOUGLAS HOLTZ-EAKIN I want to thank the authors for a paper that is timely and relevant to policymakers, but also rigorously executed and a contribution to our understanding of the mechanics of the COVID-19 recession and recovery. The analyses of the federal budget impacts and the state and local impacts could each stand on their own; together they form an extremely valuable paper.

FEDERAL FISCAL EFFECTS There are two main questions to be answered. First, what is the fiscal outlook, especially over the longer term? Second, how did COVID-19 contribute to that outlook?

As a start to the former, the authors build a “current law,” thirty-year projection off of the recently released revised ten-year baseline and long-term budget outlook from the Congressional Budget Office (CBO 2020a, 2020b). They find that if the budget is effectively put on autopilot, the ratio of federal debt to gross domestic product (GDP) rises to almost 190 percent in 2050 and would continue to rise thereafter. In short, the fiscal outlook is terrible and unsustainable.

For followers of the federal budget outlook, this is not news. The same basic trajectory has been baked in since the early 2000s. The magnitudes, however, have gotten worse due to the legislation that was passed. The authors attempt to capture the future of this dynamic by presenting a “current policy” projection that embodies future legislative decisions (e.g., making the provisions of the Tax Cuts and Jobs Act permanent) consistent with their view of current policy. By this metric, federal debt will rise to over 220 percent of GDP by 2050.

Current policy is fundamentally subjective, and that is the Achilles’ heel of any such analysis. At the present juncture, it is even more difficult to discern as it depends crucially on the outcome of the election.

For example, many believe that a Democrat-controlled administration and Congress would make permanent the paid family leave enacted in the Families First Coronavirus Response Act. This is excluded from the authors' current policy analysis. I could name a number of such examples. My own view is that current policy is to pass only laws that worsen the deficit and debt. That means current law is the lower bound for the debt trajectory, and the future is essentially unbounded. Again, this has been true since the early 2000s.

The second question is how did COVID-19 affect the fiscal outlook. This is new territory, and the authors have a series of interesting findings. I think three points stand out. First, the policy response to the COVID-19 recession has been historically large—the deficit reaches 16 percent of GDP in 2020 and the ratio of debt-to-GDP hits historic highs—because the economic downdraft has been historically large.

Second, the response to date has been genuinely temporary; the Coronavirus Aid, Relief, and Economic Security (CARES) Act, in particular, has no impact on the outlook for spending and revenues after a few years. One might not have anticipated that Congress would pass up the opportunity to alter the long-term outlook in its response to the coronavirus.

Third, the most important indirect impact of COVID-19 is the downward revision to the interest rate outlook. Indeed, this is the real impact of COVID-19 on the long-term budget trajectory, and it is substantial. Over the ten-year window, the budgetary impact of reduced interest rates is comparable in magnitude to the budgetary impact of the CARES Act.

I have no real criticisms of this work. It is carefully executed and captures the fiscal outlook and implications of COVID-19 in a straightforward way.

STATE AND LOCAL BUDGET IMPACTS The section on state and local governments has three main exercises. The first is to document sharp differences between the mechanics of this recession and previous US downturns. These are dramatic and important and lead the authors to conclude—correctly in my view—that it is inappropriate to use historical relationships between economic indicators of the cycle (e.g., the unemployment rate) and the health of state and local budgets, in general, and revenues, in particular.

The second is to build careful, state-by-state estimates of the impact of the COVID-19 recession on income taxes, sales taxes, corporate income taxes, and other fees and taxes. These are painstakingly detailed efforts that will be a durable contribution to the analysis of states and localities. They find that these receipts will decline by \$156 billion in 2020, \$165 billion in

2021, and \$143 billion in 2022. Thus far, federal aid to states and localities has totaled around \$200 billion; the authors suggest that a failure to close the gap between \$464 billion and \$200 billion will force fiscal retrenchment and harm the recovery.

The composition of the revenue losses is an important finding by the authors. While attention is typically focused on income taxes (estimated to be off by \$24 billion in 2020) or sales taxes (\$49 billion), the big losses (estimated at \$82 billion) are in other taxes and fees. These declines are driven by declines in transportation fees, an important difference between the COVID-19 experience and previous recessions.

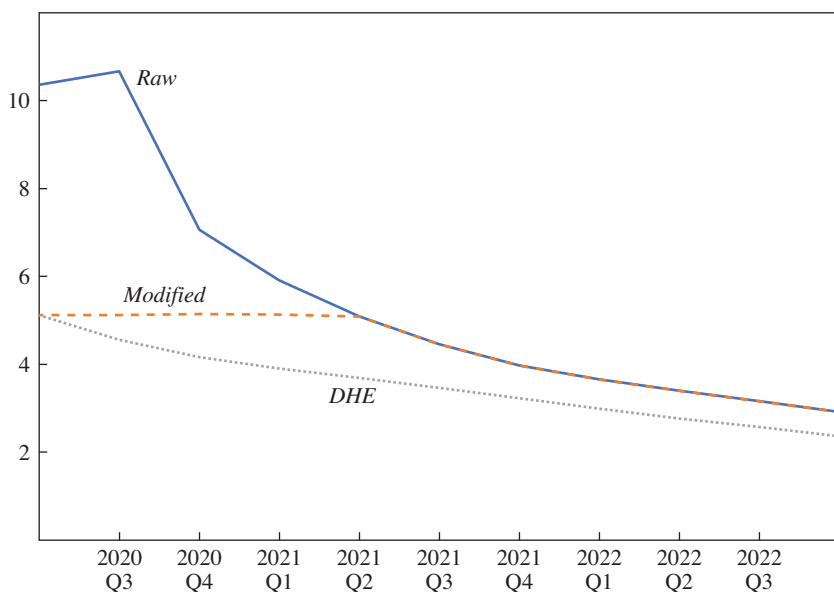
Perhaps most importantly, the authors provide not only these aggregate results, but state-by-state estimates of the revenue declines and federal aid receipts. Not surprisingly, there is considerable heterogeneity in the impact of COVID-19 on state and local finances. It is a real contribution by the authors to have documented this variation.

The final analysis is to look longer-term at the budgetary implications of the enormous demand for unemployment insurance and the low interest rate environment.

For many, the most topical aspect of the paper will be the estimated revenue shortfalls and their implications for federal aid. My main comment is to emphasize that the analysis appears to embody an extremely pessimistic outlook for the near-term recovery. The authors acknowledge this as it is an artifact of using the CBO projection for unemployment. In simple terms (and the actual computations are far more intricate), a decline in employment reduces labor earnings and lowers income taxes, which are 16 percent of general own-source revenue.

The authors parametrize the COVID-19 “shock” to employment as the difference between the CBO economic projections of the unemployment rate in July 2020 (post-COVID-19) and January (pre-COVID-19). These are shown in figure 1, showing the raw difference in the projections. As the authors note, this measure runs into the issue that the unemployment rate is already substantially lower in the third quarter of 2020 than the CBO projected in July. To use the raw difference would be to overstate the shock and overstate the decline in personal income taxes.

The authors’ solution is to freeze the size of the shock at its current level until mid-2021 (when it matches the differences in the CBO projections) and then to follow the path of the CBO projections. This is shown as the “modified” path in figure 1. However, this is tantamount to assuming that there will be essentially no labor market improvement for the next year. The fiscal consequences for state and local income taxes follow directly.

Figure 1. Alternative Unemployment Rate Shocks

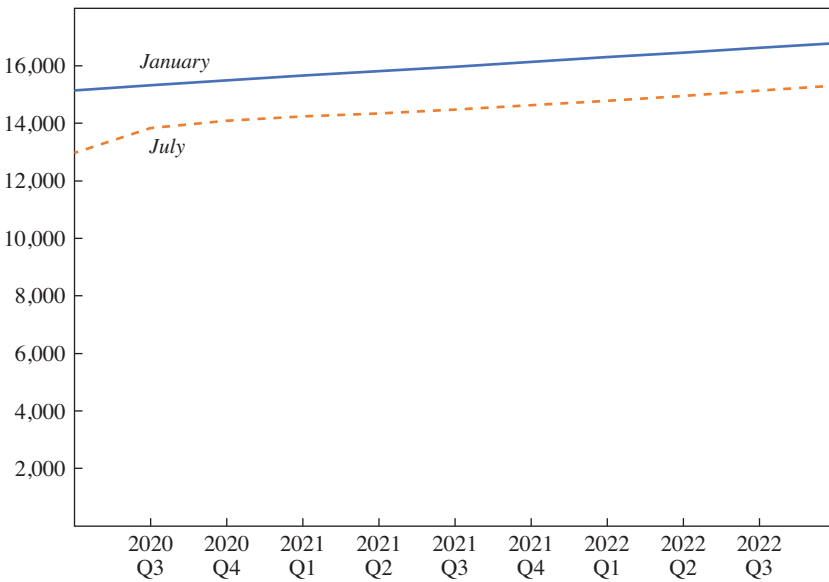
Source: Author's calculations.

Obviously, there is no “right” projection of the labor income shock. However, one alternative that uses the same CBO projections as its foundation is labelled DHE in figure 1. The authors note that one way to think about the outlook is that the CBO missed the timing of the recovery but not the trajectory. The alternative simply assumes that the pace of labor market improvement starting in 2020:Q3 is the same as the CBO projected to begin a year from now.

The important point is that this alternative would show a shock that is smaller, and diminishing, over the key projection period 2020–2022.

A similar point can be made regarding the shock to nominal personal consumption expenditures (PCE). This shock underlies the authors’ analysis of the impact of COVID-19 on sales taxes (another 16 percent of revenues) and state and local fees (which account for 44 percent of revenues). Again, at the core, the decline in household spending translates into lower sales taxes and collection of fees.

Once more, to operationalize the analysis the authors use the difference in the July and January projections of nominal PCE as their measure of the

Figure 2. CBO Projection: Nominal PCE

Source: Author's calculations.

COVID-19 shock. Figure 2 shows those projections. Clearly, the analysis implicitly assumes that the shock does not diminish over the 2020–2022 projection period.

As a whole, then, the authors' estimates strike me as built on a relatively pessimistic near-term outlook. Given the attention that will be given to this analysis, it is important to be clear about this. More generally, I think it highlights the desirability of a sensitivity analysis built on alternatives for the near-term recovery.

This is, of course, an oversimplification of the actual analysis. I want to especially applaud the detailed efforts made to simulate the impact of COVID-19 on the income taxes, sales taxes, and fees.

CONCLUSION The authors have produced timely, useful, quality analyses of the budgetary outlook at the federal, state, and local levels. In each case, an important focus is the impact of the COVID-19 recession and response. I think the major lesson at the federal level is the transitory nature of the deficits produced by the policy response, while the composition of the revenue losses and the heterogeneity across states stand out in the state and local analysis.

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CBO (Congressional Budget Office). 2020a. “The 2020 Long-Term Budget Outlook.” Washington. <https://www.cbo.gov/publication/56516>.

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GENERAL DISCUSSION Alan Blinder began the discussion by congratulating the authors on writing a very useful paper. Noting that the authors’ forecasts of the near-term economy are critically dependent on the course of the pandemic, Blinder asked to hear more about the CBO’s near-term assumptions about the pandemic going forward and whether the authors find them reasonable. He also asked how the authors accounted for the dramatic variation across states in the pandemic’s course, citing as examples the curves for infections or deaths in New York versus in Florida.

Olivier Blanchard pointed out an apparent tension between the paper’s estimated revenue declines at the federal and at state and local levels, noting that the deviation from the former deficit improves by the end of fiscal year 2020 while the state and local revenue losses are close to constant from 2020 to 2022. He wondered whether this phenomenon reflects federal subsidies to the states in 2020 and asked for clarification.

Robert J. Gordon asked to call attention to declines in mass transit use, which can be a source of state and local revenues and may need government bailouts. He argued that although personal consumption expenditures were only 4.4 percent below February 2020 levels as of July 2020, implying minor sales tax declines, national transit ridership and fare revenues declined in April 2020 from April 2019 levels by 73 percent and 86 percent, respectively.¹ He suggested that the authors include a section that comments on whether they consider this an issue for state and local governments.

Mark Mazur also pointed out that the projected 0.5 percent decline in federal revenues appears small, but given that federal revenues were expected to increase by 4.9 percent in fiscal year 2020 as of January 2020, it should be considered a 5.4 percent shortfall in revenues.

Alan J. Auerbach began by responding first to the comment made by Douglas Holtz-Eakin in his presentation that Congress reacted with an

1. US Bureau of Economic Analysis, Personal Consumption Expenditures [PCE], FRED, Federal Reserve Bank of St. Louis, <https://fred.stlouisfed.org/series/PCE>, accessed October 3, 2020.

appropriately large stimulus package in response to the shock but kept the impact transitory rather than taking advantage of the crisis to make any permanent changes. Auerbach speculated that any restructuring of entitlement programs or tax reforms in reaction to the crisis was likely to be in the direction of a stronger social safety net in both the short and long run, given that the pandemic was likely to make programs like Social Security, Medicare, and Medicaid popular, and he suggested that a short-term, limited response that didn't allow for large restructuring was more appropriate. Holtz-Eakin agreed.

Auerbach agreed with Mazur's suggestion to view the decline in federal revenues in comparison to pre-COVID-19 projections for revenue growth, adding that although not exact, the paper's estimated decline in revenues do appear to be smaller than expected due to the higher proportion of job losses affecting low-income individuals. Compared to other recessions, the changes are far larger on the spending side than the revenue side both in absolute terms and when comparing the difference between the two.

In response to Blinder's comments on the relevance of the near-term course of the pandemic to the estimates given in the paper, Holtz-Eakin added that the authors did run some sensitivity analyses, but he is consistently surprised by how little variations in the growth rate actually affect the future deficit. The small effects of a decline in the growth rate result from subsequent declines in interest rates, which allow the government to save on future interest payments. In contrast, the budget outlook is very sensitive to the level of interest rates. The course of the pandemic will affect the certainty of the budget outlook, he concluded, but the level of interest rates will have more of an impact than the level of output.

Byron Lutz thanked Holtz-Eakin for his comments and added that he agreed with Holtz-Eakin's feedback that the CBO projection used for the state and local estimates is too pessimistic. However, he continued, the CBO projection is a gold standard, and its detail and granularity are useful for the bottom-up methodology. Furthermore, although the CBO projection has been inaccurate in the near term, it may be more useful for the three-year estimates given in the paper—for example, improvements in the near term could be counterbalanced by a second wave of the pandemic. Given that the CBO projection is well outside the consensus of most private sector forecasters, Lutz concurred that the authors should follow up with sensitivity analyses using private sector projections.

In response to Blinder's comment about the estimates' sensitivity to the course of the pandemic, Lutz added that the CBO assumes social distancing

will gradually decrease over time and come to an end in the second half of 2021.² The state and local estimates are pinned tightly to that projection.

Finally, Lutz responded to Gordon's comment about the historic collapses in transit authority revenues. Lutz assured him that these declines are captured in the combined losses of state and local governments and emphasized that the decline in revenue from charges and fees was almost entirely driven by a large decline in transportation activity, particularly that of transit authorities. Louise Sheiner added that the paper uses data through August 2020 on actual vehicle miles driven in addition to consumption.

Furthermore, continued Sheiner, these first few months of data allow the estimates to capture the large variation in the course of the pandemic across states mentioned by Blinder. The initial months capture the disparities and then extend them unilaterally by the CBO's national estimates for social distancing, until all states return to their pre-COVID-19 activity levels.

In response to Blanchard's question about the difference between the federal and state and local outlooks, Sheiner explained that the losses in state and local revenues from 2020 to 2022 appear relatively constant because the state and local losses are expressed in nominal terms, which do not reflect falling price levels from low inflation, while the federal portion is in real terms relative to GDP.

Martin N. Baily asked whether the authors were concerned that foreigners may no longer be willing to buy US debt, given the large increase projected in the paper, despite the United States historically receiving stable flows of investments. Many are saying that deficits do not matter as long as interest rates remain low, he noted, but could an unstable downturn and rising interest rates that prevented the United States from financing its deficits lead to a constraint on the deficit? In response, Holtz-Eakin remarked that foreigners bought a fairly large share of incremental debt in the early 2000s but have bought a smaller share than that held by Americans in the last decade.³ If it becomes an issue, he concluded, it would be political rather than economic.

2. Congressional Budget Office, "An Update to the Budget Outlook: 2020 to 2030," Washington, July, <https://www.cbo.gov/system/files/2020-07/56442-CBO-update-economic-outlook.pdf>.

3. US Department of the Treasury, Fiscal Service, Federal Debt Held by Foreign and International Investors [FDHBFIN], FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/FDHBFIN>, accessed October 3, 2020.

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Will the Secular Decline in Exchange Rate and Inflation Volatility Survive COVID-19?

ABSTRACT Over the twenty-first century, and especially since 2014, global exchange rate volatility has been trending downward, notably among the core G3 currencies (dollar, euro, and the yen), and to some extent the G4 (including China). This stability continued through the COVID-19 recession to date—unusual, as exchange volatility generally rises in US recessions. Compared with measures of stock price volatility, exchange rate volatility rivals the lows reached in the heyday of the Bretton Woods system of fixed exchange rates. This paper argues that the core driver is convergence in monetary policy, reflected in a sharp reduction of inflation and short- and especially long-term interest rate differentials. This unprecedented stability, which partially extends to emerging markets, is strongly reinforced by expectations that the zero bound will be significantly binding for advanced economies for years to come. We consider various hypotheses and suggest that the shutdown of monetary volatility is the leading explanation. The concluding part of the paper cautions that systemic economic crises often produce major turning points, so a collapse of this new and extended Bretton Woods II regime cannot be ruled out.

One of the most surprising features of the COVID-19 shock has been the stunning stability in exchange rates, despite an epic global recession. Although the yen-dollar rate has barely moved, the exchange rate between

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the euro and dollar has appreciated 6 percent (as of this writing). But to put this in perspective, over the course of the 2008 financial crisis, the euro-dollar rate gyrated between 1.58 and 1.08 and the yen-dollar rate between 90 and 123. In this paper, we show that increasing G3 global exchange rate stability during the COVID-19 pandemic (so far) is an acceleration of a barely studied longer-term trend.¹ Incorporating China into a G4 that encompasses half of global GDP only strengthens the point. Figure 1 illustrates this fact, showing the decline in yen-dollar (top panel) and euro-dollar or Deutschmark-dollar (bottom panel) exchange rate variability since the mid-1970s.

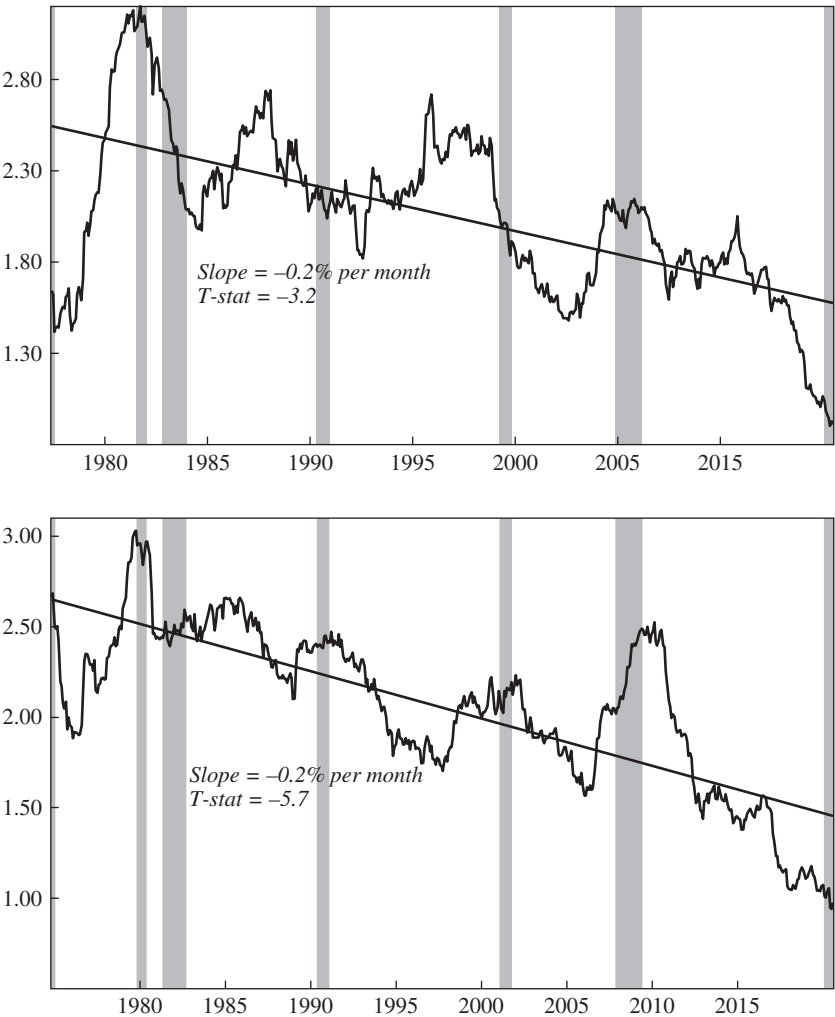
For the moment, the world is in an extended Bretton Woods II exchange regime, where not only are developing Asian currencies stable against the dollar but also much of the OECD, including Europe and Japan. Indeed, we will show that in some respects extended Bretton Woods II has now lasted as long as the open capital markets period of Bretton Woods I and has been more encompassing in terms of global GDP. Recent stability in the core global exchange rate system does not yet match the best years of the postwar Bretton Woods I system, but it is even more stable when compared to stock price volatility (see figure 2).

What is going on and what might the missing volatility portend for the future of the global exchange rate system, not just at the center but for emerging markets and the periphery? We will argue that a central driving force has been a collapse in international short-term and long-term interest differentials combined with an assumption in markets that the effective lower bound on interest rates is here to stay for a very long time. Relative volatility in conventional monetary policy has apparently been taken off the table for an extended period. The collapse of interest differentials not only reflects the global nature of the pandemic but also the stunning decline in long-term global inflation differentials. Even the gentle decline in the dollar against the euro that did occur over the latter part of 2020 may be largely attributed to a growing market expectation that liftoff from the zero interest bound for the US Federal Reserve would likely be years in the future, draining the last vestige of G3 (conventional) monetary policy uncertainty.

We will, of course, consider other possible explanations, including a fall in real or financial risk, massive post-COVID-19 fiscal interventions, and rising dollar dominance including enhanced Federal Reserve central

1. Rising stability in the core of the global exchange rate system is noted by Ilzetzi, Reinhart, and Rogoff (2019), but we did not explore the issue in detail.

Figure 1. Declining G3 Exchange Rate Volatility



Sources: International Finance Statistics, NBER, and authors' calculations.
Note: The figure shows the four-year moving average of the absolute value of month-on-month exchange rate change. Top panel: yen-dollar. Bottom panel: euro-dollar. The euro is replaced with the German Deutschmark before 1999. Shaded areas show US NBER recession dates.

bank swap lines. Greater synchronicity of real shocks is also possible. The pandemic has hit the entire world, albeit some countries have been affected much more than others through policy choices and vulnerabilities, with the epicenters moving across time.

For international economists, the “natural experiment” of the COVID-19 shock and its impact on exchange rates has produced interesting and perhaps surprising results. Dornbusch (1976) famously argued that monetary policy uncertainty can, in principle, be a major driver of exchange rate volatility. However, several decades of empirical research, following Meese and Rogoff (1983), have found that supporting this conjecture empirically is difficult. Instead, the literature of the past decade, particularly following the influential work of Gabaix and Maggiori (2015), has argued that risk factors and financial frictions likely play a dominant role; Itskhoki and Mukhin (2017, 2019) argue that there is no other plausible way to explain the major puzzles in international macroeconomics. Nevertheless, we argue here that the natural experiment of the COVID-19 shock, which has effectively shut down conventional interest rate policy while exacerbating uncertainty in other dimensions, suggests that monetary factors might be more important than previously recognized, not just in the hours following central bank policy announcements but over much longer horizons as well.

Although emerging market exchange rate volatility is slightly elevated, it remains well below 2008–2009 levels, despite the avalanche of challenges and relentless credit agency downgrades. The International Monetary Fund (IMF) has moved proactively to extend credit lines, but its funds are limited, and rallying cries for more aid are largely being lost on advanced countries mired in their own problems. No one believes that emerging markets are going to have access to the bailout resources that, for example, the eurozone has extended to southern Europe. After two decades of steady improvements, the risks of macroeconomic distress and a return to much higher inflation and exchange rate volatility seem greater than at any time since the 1980s.

In section III, we explore some stark differences between the COVID-19 pandemic and the 2008 financial crisis. The surfeit of liquidity today is certainly one striking feature: in 2008 massive central bank quantitative easing did not have a leveraged effect on broader monetary measures; banks largely held on to reserves without expanding lending. This time is different: within just a few months, the M2 money supply has spiked by 25 percent in the United States; monetary aggregates have seen a rapid rise globally; corporations have called on lines of credit and borrowing

as insurance against a credit squeeze; and in the United States, mortgage refinancing is also playing a significant role. There is a liquidity glut.

Lastly, we consider the role of the dollar at the center of the system, a status that most informed observers still view likely to remain extremely durable. However, as Farhi and Maggiori (2018) emphasize, a hegemon's natural temptation to expand debt to very high levels (because it does not fully internalize the risks to the rest of the world) can lead to a situation where the "safe" asset is no longer safe and becomes vulnerable to a loss of confidence. We note that the United States now has as much outstanding public debt in world markets as all of Europe and Japan combined, with plans to issue much more, even as the US share of global GDP continues its long-term declining trend. Again, the marginal risk/benefit trade-off may be entirely reasonable from the United States' perspective, but not necessarily from a global one.

1. The Secular Decline in G4 Exchange Rate Volatility

Our tour of the international monetary system in 2020 begins at its core, with the currencies of the largest economic areas by economic activity: the dollar, renminbi, euro, and yen, which we label the G4. Together these economies reflect approximately half of world GDP (in purchasing power terms). At their center is the dollar, by far the most traded currency, the currency of choice for central bank reserves, and the top invoicing currency in trade and financial contracts (Rey 2013; Gopinath 2015; Ilzetzi, Reinhart, and Rogoff 2017, 2019, 2020; Maggiori, Nieman, and Schreger 2020). In this section, we document our central finding: the long-term secular decline in the volatility of core exchange rates, enhanced when long-term interest rates essentially hit zero in late 2014 and early 2015, and continuing through the COVID-19 shock.² To put this recent decline in perspective, note that even during the period of Great Moderation (before 2008), exchange rate volatility remained relatively stable even as many real variables became notably less volatile (Rogoff 2006).

Figure 1 documents the declining volatility of G3 currencies: the dollar, euro, and yen. The top panel of the figure shows the volatility (four-year moving average of the absolute value of the month-on-month change) of the bilateral yen-dollar exchange rate from 1975 (shortly after the end of

2. Japanese bond yields declined below 50 basis points in October 2014. German and French ten-year bond yields hit 50 basis points in March 2015. They have all since declined to negative territory, in 2016 in Japan and in 2019 in the core euro countries.

the Bretton Woods system of fixed exchange rates) to August 2020. The bottom panel shows the same figure for the euro-dollar exchange rate, replacing the euro with the German Deutschemark before 1999. Both figures show similar dynamics. While exchange rate volatility has seen ebbs and flows, a (statistically significant) downward trend is clearly visible in both bilateral exchange rates. The euro-yen cross rate (not shown) has also declined in volatility.

Very recent trends are perhaps even more striking. G3 exchange rate variability has declined sharply and has been well below trend since around 2014. This decline includes the months of March–June 2020 amidst the global uncertainty surrounding the COVID-19 pandemic. The low exchange rate volatility during the COVID-19 recession or depression is a remarkable outlier given that exchange rate volatility has been procyclical historically, tending to increase in US recessions. This is evident in figure 1, where US NBER recession dates are shaded.³

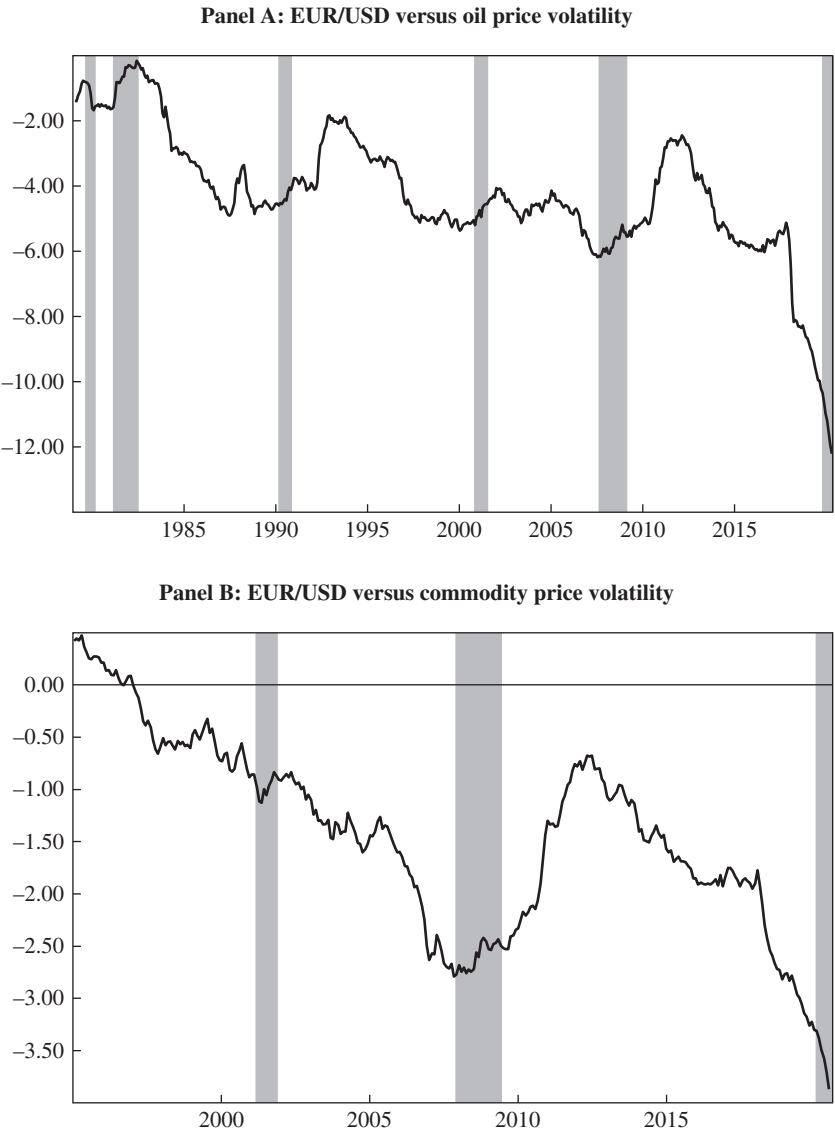
Figure 2 shows that exchange rate stability isn't merely a manifestation of low asset price volatility more broadly. It shows the difference between the absolute value of the monthly change in the euro-dollar (or earlier Deutschemark-dollar) exchange rate to the same metric for several other asset prices.⁴ Panel A gives the difference between exchange rate and oil price volatility. Panel B compares exchange rate and commodity price index volatility. Panel C compares exchange rate volatility to (US) stock market volatility, using the S&P 500 as a stock market index. Indeed, all three panels show that the declining trend in exchange rate volatility is even more pronounced when compared with other assets.

Panel D of figure 2 puts the recent exchange rate volatility decline into a longer historical context. The first two decades shown in panel D, the 1950s and 1960s, are the years of the Bretton Woods system of fixed exchange rates. Not surprisingly, these are years of low exchange rate volatility both in absolute and relative terms. However, the panel highlights that in the past several years, the volatility of exchange rates relative to that of other assets is now low even compared to Bretton Woods. Relative to the stock market, March 2020 was the month with the lowest exchange rate volatility on record.

3. The question of volatility is separate from what has happened to the level of the exchange rate. There has been some discussion as to whether there was an atypical decline in the dollar during “flight to safety” episodes throughout 2020. Whatever the value of the dollar relative to other major currencies, its variability has been nearly null relative to previous—and far smaller—recessions.

4. We use difference rather than ratio as our relative metric due to occasional zero and near zero observations.

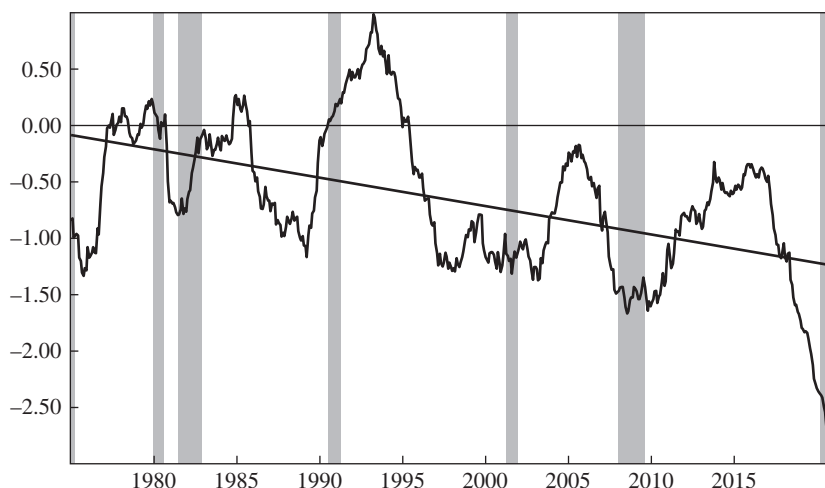
Figure 2. Declining Euro-Dollar Exchange Rate Volatility Relative to Asset Prices



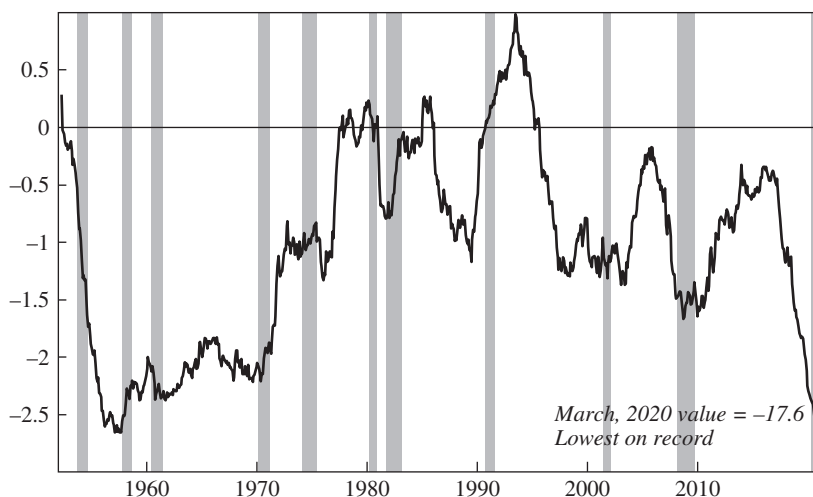
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Figure 2. Declining Euro-Dollar Exchange Rate Volatility Relative to Asset Prices
(Continued)

Panel C: EUR/USD versus stock market volatility, 1975–2020



Panel D: EUR/USD versus stock market volatility, 1950–2020



Sources: Federal Reserve Bank of St. Louis, International Finance Statistics, IMF primary commodities database, Shiller (2005), and authors' calculations.

Note: The figure shows the four-year moving average of the difference between the monthly change in the euro-dollar exchange rate (spliced with the German Deutschemark at 1999) and the absolute value of the monthly change in asset prices. The assets in the four panels are (A) oil—spot price of crude West Texas Intermediate (WTI), dollars per barrel; (B) all-commodity price index; (C) S&P 500, 1975–2020; and (D) S&P 500, 1950–2020.

While the Chinese renminbi still plays a far less important role in international commerce and finance compared to G3 currencies, China is already the largest economy in the world at PPP exchange rates, the world's largest exporter, and the renminbi is gradually expanding its international role.⁵ Thus, in comparing the international system under extended Bretton Woods II to earlier episodes, it makes sense to consider the renminbi in a basket of the main G4 currencies.

Figure A1 in the online appendix shows the renminbi's volatility vis-à-vis the dollar and the euro. Over the past two decades, China has fixed its exchange rate, first against the dollar and starting in 2015, to a basket. Hence the stability of the renminbi-dollar exchange rate is hardly news. However, the figure demonstrates two less obvious facts. First, as the People's Bank of China moved toward pegging the renminbi to a basket of currencies, the greater volatility in its dollar exchange rate has been replaced roughly one-to-one with declining volatility relative to the euro. Whereas the renminbi has shown slightly more volatility relative to the dollar since 2015, its flexibility relative to the euro and the yen has declined. Second, even prior to 2015, renminbi-euro exchange rate variability was on a downward trend because of the declining euro-dollar volatility documented in figure 1.

Figure A2 in the online appendix compares G4 currency volatility during the two decades of extended Bretton Woods II with the volatility of the top four currencies (the dollar, Deutschemmark, UK pound, and French franc) during the original Bretton Woods system from 1950 to 1970. The figure shows that in its prime Bretton Woods saw far lower (nearly zero) exchange rate variability than core rates during the past two decades. However, the figure also illustrates the relative durability of the current international monetary arrangement. With inflation in Western Europe hitting double digits in the 1950s, and active parallel markets for the exchange of these currencies, the shadow exchange rate among the core countries was still volatile. Indeed, with the United Kingdom devaluing the pound and serving as the largest borrower from the IMF during the 1950s, it took a full decade before Bretton Woods brought about the exchange rate stability originally promised. This success was also short lived. The figure shows that only a decade later the system was coming apart at the seams. Bretton Woods II has already outlived its namesake.

5. As a currency, the renminbi is gradually making inroads as an international currency and some predict that it may have equal status to the dollar within decades (Eichengreen 2011).

Further, the modern G4 comprises 50 percent of world GDP (in purchasing power terms, even more at market rates) compared to 40 percent for the previous G4 in 1960, according to the Conference Board and International Finance Statistics. It is also useful to recall that the Soviet Union was the second-largest economy in the world and was not part of the Bretton Woods arrangement. The current arrangement is thus far more global in its reach than Bretton Woods I. Finally, note the increased exchange rate stability *within* blocs, as the modern period is characterized by the advent of the euro and the elimination of nineteen national currencies in Europe.

Turning to other high-income economies outside the G4, the trends look different in some respects but similar in others. Figure A3 in the online appendix shows the exchange rate volatility of the next three main currencies in terms of trading volumes. In contrast to G4 currencies, the Australian and Canadian dollars have gradually moved toward greater exchange rate flexibility. However, similarly to the G4, the past five years have shown a dramatic decline in exchange rate variability, with exchange rate volatility well below trend, including during the COVID-19 crisis.⁶ This points to common factors, particularly in the past half decade, leading to universally low exchange rate variability.

Table 1 shows that the changes that are visually apparent are also statistically significant. It reports results of regressions of all pairs of G3 currencies' weekly absolute change in value against several trends and break points. In most specifications we find a small secular downward trend in exchange rate volatility from 1999 to 2020. In all specifications, we find that this downward trend accelerated more than fivefold since 2014. The 2014 break point corresponds almost precisely to the date when the European Central Bank (ECB) set negative interest rates for the first time and many European long-term bonds started trading at negative yields.⁷ This began the period

6. The exception is the UK pound, where the large depreciation following Brexit and the volatility due to Brexit uncertainty have led to a small increase in exchange rate volatility.

7. The break point is located in August 2014, where the test by Bai and Perron (1998) identifies a statistically significant break point in the trend of the absolute value of change of the dollar exchange rate against a GDP-weighted euro-yen basket. This date shortly follows the adoption of negative interest rates by the ECB in June 2014. An additional break point is in August 2008, corresponding to the global financial crisis. This break point is due to an *increase* in trend volatility and most likely reflects a temporary increase in the level of volatility in that period, rather than its trend, an impression visually reinforced in figure 1. Accordingly, we control for the crisis itself, not a change in trend volatility in the crisis. Results are identical when controlling for a break in trend exchange rate volatility in August 2008. COVID-19 wasn't identified as a formal break point. One is unlikely to capture break points with so few observations at the end of the sample.

Table 1. Trends and Break Points in G3 and G4 Currency Volatility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Trend	-.03***	-.02***	-.01	-.02***	-.02***		
Trend after August 2014		-.12***	-.17***	-.14***	-.15***	-.15***	-.10***
Abs($\Delta\%$ S&P 500)			.07***	.05***	.05***	.05***	.04***
Abs($\Delta\%$ Oil Price)			.02***	.01***	.01***	.01***	.01***
Global financial crisis				.74***	.74***	.74***	.56***
Currency pair fixed effects	No	No	No	No	Yes	Yes	Yes
Currency pair specific trends	No	No	No	No	No	Yes	Yes
Including China	No	No	No	No	No	No	Yes

Source: Authors' calculations.

Note: The table shows results from a panel OLS regression where the dependent variable is the absolute value of the week-on-week change in G3 exchange rate pairs. "Trend" is a linear time trend. "Trend after August 2014" is an interaction between a linear time trend and a dummy equaling one for weeks after August 2014. This is the date identified as a trend break point in a stability test by Bai and Perron (1998). Coefficients on these two variables are multiplied by 100 to ease reading and reflect the monthly change in the absolute value of exchange rate change in basis points. The regressions show more than a fivefold acceleration in the decline in volatility starting in 2014, with exchange rate volatility declining at a rate of close to 10 basis points per year from an average of 75 basis points. A constant and a dummy for weeks after August 2014 were included but not reported. Abs($\Delta\%$ S&P 500) and Abs($\Delta\%$ Oil Price) are the absolute values of the weekly percentage growth in the S&P 500 stock market index and crude West Texas Intermediate (WTI) oil prices. Columns 1–6 are regressions for G3 currency pairs. Column 7 also includes cross rates with the renminbi. Columns 5–7 include currency pair fixed effects. Columns 6–7 also include separate time trends for each currency pair.

of unprecedentedly low long-run interest rate volatility and differentials across countries, as we discuss in the following section. The table also shows that the trend since 2014 is even more pronounced when controlling for volatility in other asset prices, confirming the visual impression from figure 2. Allowing for an additional break in exchange rate volatility during the COVID-19 pandemic generally shows a further acceleration in the decline in exchange rate volatility, but the result is not yet statistically significant in most specifications, as could be expected due to the short time frame.

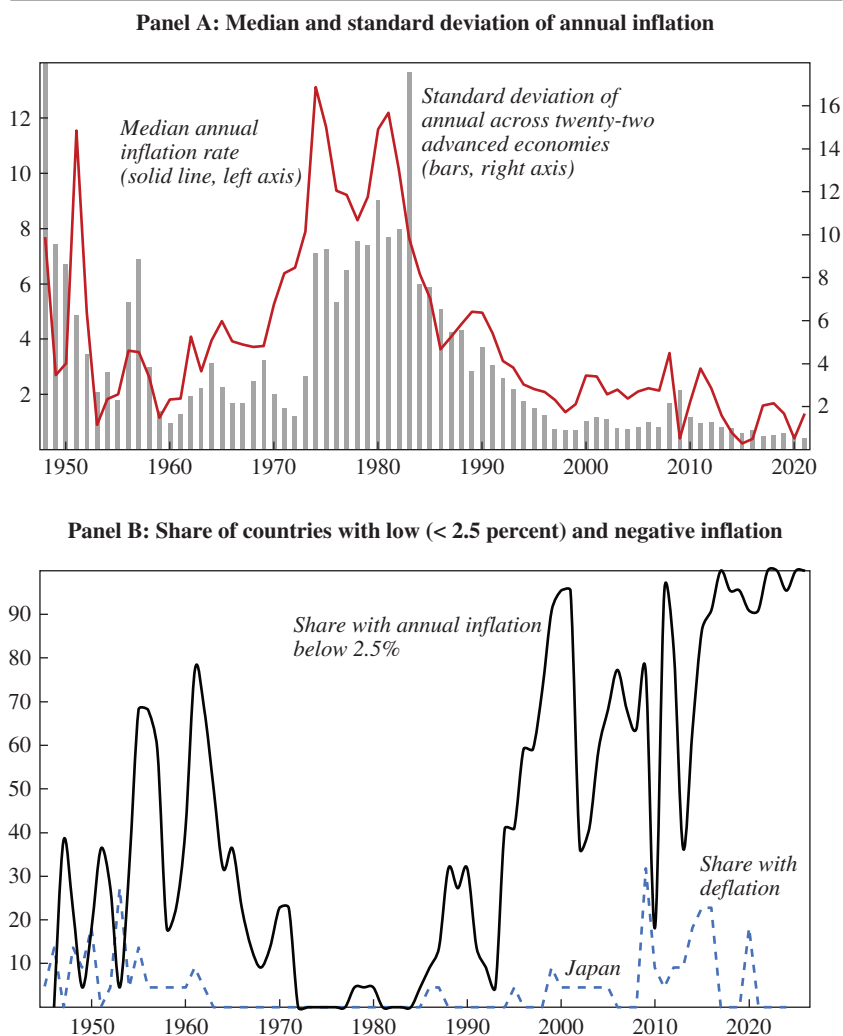
II. Exchange Rate Stability and Monetary Developments

What explains the declining G4 exchange rate variances and their surprisingly muted responses to the massive shocks of COVID-19? Only a single country (China) we analyzed in the previous section has an explicit policy of targeting its exchange rate. While others may have less-flexible exchange rate regimes *de facto* (Ilzetzki, Reinhart, and Rogoff 2019), there is no sign of a conscious move to greater exchange rate management among the central banks in question, certainly not from central bank statements. Instead, we conjecture that inflation, growth, and interest rate trends, culminating in the low inflation environment and the zero lower bound on monetary policy of the past decade, have led to low exchange rate volatility.⁸ In this section, we provide suggestive evidence that monetary convergence to the zero bound has been especially important. We then turn to other, less likely (in our view), explanations for the volatility decline.

II.A Inflation and Interest Rate Dynamics

Over the past decade, global inflation has been remarkably muted. Several major economies have flirted with deflation; inflation-targeting central banks faced the unusual challenge of attempting to hit their targets from below. With inflation in single digits virtually everywhere in the world, inflation differentials across countries have also declined. Purchasing power parity requires that exchange rates adjust to cross-country price differences in the long run. Hence low inflation differentials may lead to smaller contemporaneous and expected trend exchange rate adjustments.

8. In an important related paper, Stavrageva and Tang (2018) use surveys and data on macro news to decompose factors driving exchange rates. Their decomposition supports the view that the effects of monetary policy factors on exchange rate volatility have been diminishing over time for most exchange rate pairs.

Figure 3. Declining Inflation Volatility

Sources: IMF World Economic Outlook (including projections) and authors' calculations.

Panel A of figure 3 shows the standard deviation of annual inflation rates across twenty-two advanced economies (in bars) and the median inflation rate (in a line) from World War II to today. More pertinent for exchange rate determination is that cross-country inflation differentials have also declined. The past two decades have witnessed the lowest differentials in inflation across countries on record in the postwar period. The figure extends

to the year 2030, replacing actual inflation variation with variation in inflation projections across countries, using the April 2020 IMF *World Economic Outlook*. The differentials are projected to continue to shrink.

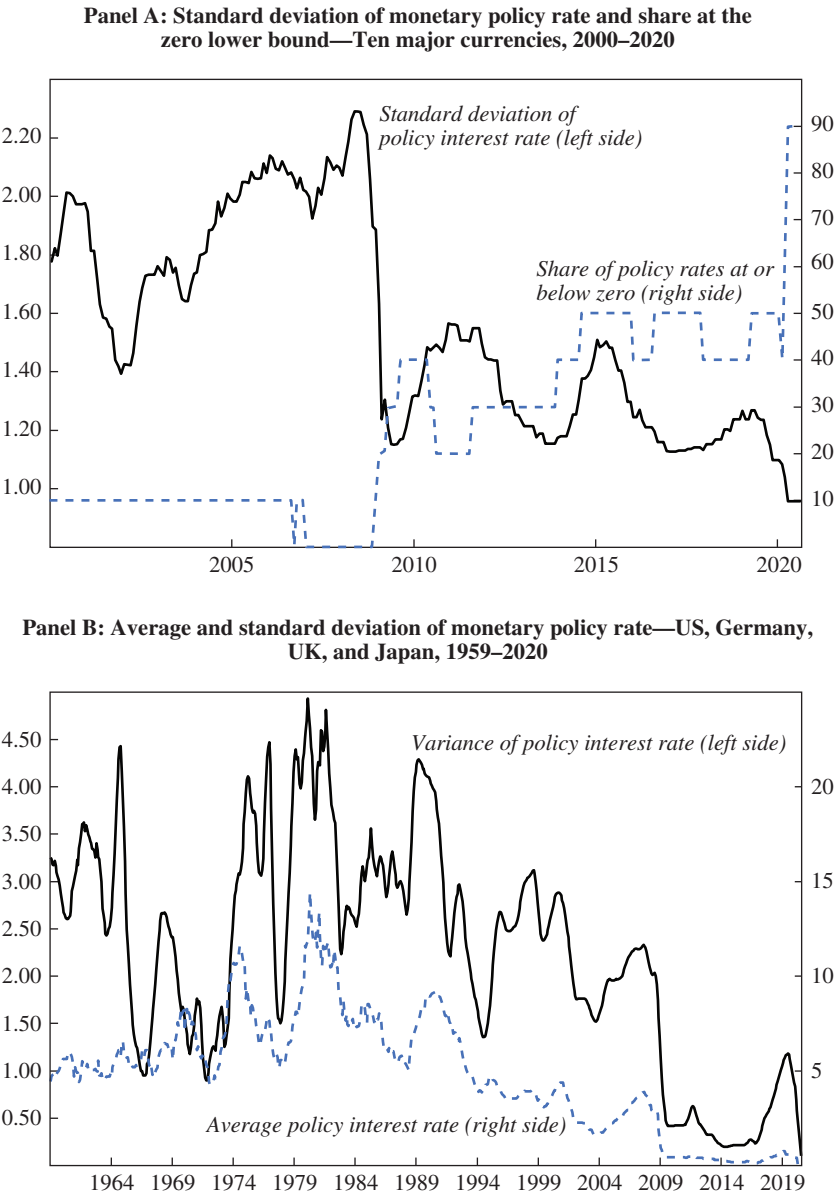
Panel B of figure 3 shows that the share of high-income countries with annual inflation below 2.5 percent (solid line) is now hovering near 100 percent, a feat never achieved in the Bretton Woods years. The dashed line shows the share of countries in deflation. The deflationary episodes experienced by many countries following the global financial crisis have subsided, so that today nearly all high-income economies have inflation rates in the narrow 0 to 2.5 percent band. Of course, purchasing power parity holds only weakly in the data and often requires many years to unfold (Rogoff 1996; Gopinath and others 2020). As such, inflation differentials can only be part of the story in explaining the decline in exchange rate variability, particularly at higher frequencies. Even more important, albeit related, is the convergence of short-term and long-term interest rates.

Panel A of figure 4 shows the standard deviation of the monetary policy interest rate of the central banks issuing the ten most traded currencies in 2020 (solid line), going back to 2000. The secular decline in the level of global interest rates is well documented, but as the figure emphasizes, this has been associated with smaller variation in policy rates across countries as well. The dashed line in the figure shows the percent of countries with zero or negative interest rates (defined as 25 basis points or below, as some central banks were reluctant to set rates exactly at zero).⁹

At the beginning of the sample only Japan had zero interest rates. By 2020, all but one of the central banks considered here (the People's Bank of China) had interest rates at zero or below. With policy interest rates stuck at zero, and shadow policy rates (estimated by, say, a Taylor rule) expected to remain well below zero for years to come, the scope for short-term interest rate differentials is minimal. (We recognize that we are abstracting from risk premia that can create a wedge between interest differentials and expected exchange rate movements, but these are small compared to the generalized collapse in interest rates.)

9. Interestingly, Lilley and Rinaldi (2020) find that, after the financial crisis, exchange rates for riskier advanced economy currencies (which would have included the euro during the euro crisis) became more correlated with measures of global market risk (e.g., the VIX), possibly because the zero bound constraint implied that central banks had less room to allow policy rates to move to offset changes in global risk, so exchange rates absorbed more of the adjustment.

Figure 4. Declining Policy Interest Rate Volatility



Sources: IMF, International Finance Statistics, national central banks, and authors' calculations.

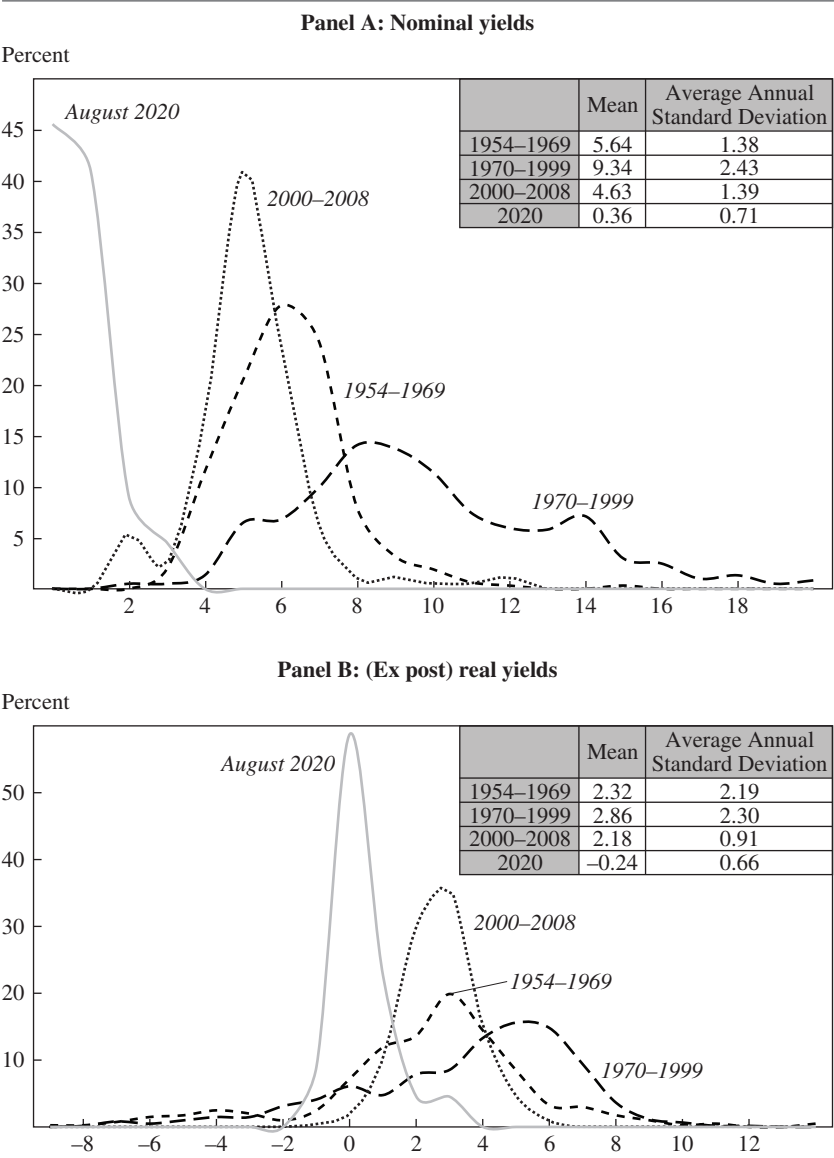
Panel B of figure 4 puts recent trends in a longer historical perspective going back to 1959, restricting attention to four major central banks (the Federal Reserve, Bundesbank/ECB, Bank of Japan, and the Bank of England). The figure shows that as average monetary policy rates have declined (dashed line), the variance among them has also declined. What little variance remains is mainly because some central banks have opted for negative rates while others have so far treated zero as the lower bound on the nominal policy rate. Interestingly, variation in policy rates across countries has been more stable in the second decade of the twenty-first century than it was under Bretton Woods I, when monetary policy coordination should have been a consequence of the fixed exchange rate system, at least once controls on international capital movements were lifted. With central banks setting policy interest rates to zero and expected to pursue these policies for years to come (because of economic conditions regardless of the credibility of forward guidance), the degree of *de facto* monetary coordination has never been greater.

Indeed, the collapse of long-term interest rate differentials, illustrated in figure 5, is a key element of the story; standard monetary models of exchange rates suggest that the entire term structure of interest differentials matters.¹⁰ Figure 5 illustrates how the distribution of the annual interest rate on ten-year bond yields for twenty-one high-income economies has evolved throughout the postwar period (panel A: nominal; panel B: real). The stable years of the Bretton Woods period (1954–1969) are shown in a solid black line, with ten-year bond yields averaging 5.6 percent and an average annual cross-country standard deviation of 1.4 percent.¹¹ The demise of Bretton Woods and the high inflation of the 1970s brought a period of higher yields (averaging 9.3 percent) and a dramatic increase in interest rate variability (an average annual standard deviation of 2.4 percent) in 1970–1999 (shown in a dashed black line). Long-term interest rate differentials across countries declined in the twenty-first century, returning to the standard deviation of the Bretton Woods period (averaging 4.6 percent and with an average annual standard deviation of 1.3 percent, shown in a

10. In addition, uncovered interest parity (UIP), relating interest rate differentials to exchange rate dynamics, holds better empirically with longer term rates. The decline in interest rate variance is in part a mechanical implication of the decline in the level of interest rates. However, according to UIP theory, exchange rate volatility is determined by the volatility of interest rates *differentials*, even if the latter declined due to this mechanical artifact.

11. We exclude Greece from the sample as its high bond yields dominate the mean and variance in the 1950s and 2000s.

Figure 5. Ten-Year Bond Yields for Twenty-One High Income Economies



Sources: IMF, International Finance Statistics, *World Economic Outlook*, and authors' calculations.
Note: Ex post yields calculated based on inflation in the preceding year.

dashed gray line).¹² Finally, the solid gray line shows the distribution of long-term interest rates in early August 2020.¹³ The decline in long-term interest rates is unprecedented in the modern era; nearly half of the high-income economies are borrowing at *negative* nominal rates at ten-year horizons. The standard deviation across countries is also at historical lows (0.8 percent). The bottom panel of the figure shows a similar decline in real long-term rates.

Although nonmonetary explanations are possible—and we will consider them—the collapse of exchange rate variability is certainly consistent with the exchange rate overshooting model of Dornbusch (1976), which placed monetary policy volatility front and center. Some might point to the mild decline in the dollar post April 2020 against the euro as evidence against stability, but this decline is moderate by historical standards and so far reflects only a minor blip in the trend toward lower volatility. Indeed, the weakening dollar can be interpreted as a firming of beliefs that the US Federal Reserve may not raise interest rates for years to come, removing most residual (conventional) monetary policy uncertainty for two to three years.

II.B Alternative Explanations for Exchange Rate Volatility

If not convergence of monetary policy, what other factors might explain the fall in exchange rate volatility?

THE DOLLAR'S RISE AS AN ANCHOR CURRENCY One plausible argument for greater exchange rate stability is that the dollar has cemented its role as the dominant currency, providing greater incentives for foreign central banks to stabilize their dollar exchange rates, leading to a decline in volatility across the system. Rey (2013) and Gopinath (2015) have emphasized the dominant role of the dollar; we review the evidence in Ilzetzki, Reinhart, and Rogoff (2019) and discuss why the euro has fallen so far short as a challenger in Ilzetzki, Reinhart, and Rogoff (2020).

12. The figures are for the years 2000–2008 to avoid overstating the variance due to the global financial crisis. However, the standard deviation is similarly low for the period 2000–2020 at 1.4 percent and even lower at 1.3 percent when excluding the single year of 2011, with a high variance because of rising yields in southern Europe during the eurozone crisis.

13. Each line in figure 5 shows a distribution of interest rates over time windows of different lengths. The distributions in the longer time periods are mechanically fatter because each reflects variation both over time and across countries. The tables in the figure show the *average annual* variance in each period, which is more comparable as it only includes variation across countries.

Dollar dominance is a plausible explanation, but by most measures it has been relatively stable for the past decade and cannot easily explain the sharp drop in volatility after COVID-19.¹⁴ If anything, thanks to a dramatic introduction of Eurobonds to cushion the most hard-hit European countries, the pandemic has given renewed strength to the euro as an alternative to the dollar over the next decade. We acknowledge that starting in 2008 and again in 2020, the Federal Reserve engaged in very proactive measures to stabilize international markets by offering dollar swap lines to advanced economy central banks and some emerging markets. Had the Fed not acted, there would almost certainly have been a crisis in overseas dollar funding markets, and the potential effects on exchange rate volatility could have been immense. In the future development of the global financial system, historians may regard the two crises as marking the evolution of the Fed toward taking a more international role.

The Federal Reserve's extension of swap lines is an intriguing alternative hypothesis, but on balance we are skeptical that it can explain the collapse of exchange rate volatility, going far beyond what might be expected if the Fed were simply offsetting a liquidity crunch. Nearly 90 percent of outstanding Fed swap lines were indeed to the ECB and the Bank of Japan, and it is certainly possible that they cushioned exchange rate volatility. However, COVID-19 central bank swap lines never reached the magnitudes of those in the global financial crisis. Further, by now the ECB has almost entirely drawn down its swap line balances, and the Bank of Japan has unwound three-quarters of its holdings. Finally, the decline in exchange rate volatility began accelerating in 2014, well after the previous round of swap arrangements ended and well before the COVID-19 swap lines were in place.¹⁵

A GENERALIZED DECLINE IN FINANCIAL RISKS As we have noted, the academic literature of the past decade has placed an increased emphasis on shifting risk premia and financial frictions as the major driver of short-term exchange rate volatility. Itskhoki and Mukhin (2019) argue that only shifting risk premia can simultaneously explain the Meese-Rogoff disconnect puzzle, the PPP puzzle, the terms-of-trade puzzle, the Backus-Smith puzzle, and the UIP puzzle. It is plausible that the paralysis caused by the zero lower bound actually reduces financial risk; Miranda-Agrippino and Rey (2020) argue

14. See Ilzetzk, Reinhart, and Rogoff (2019, 2020) for details.

15. See the Federal Reserve Bank of New York, <https://apps.newyorkfed.org/markets/autorates/fxswap>.

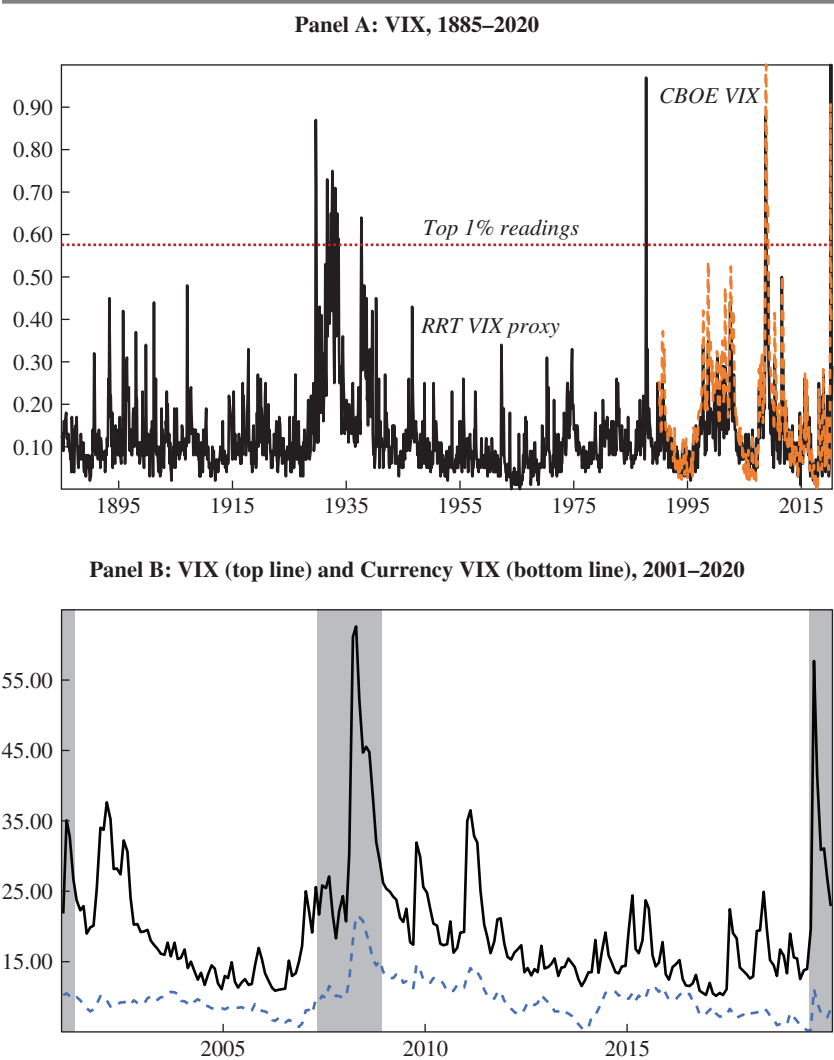
that shocks to US monetary policy are major drivers of global risk cycles. More work is necessary to discriminate the risk hypothesis from the Dornbusch model and from new open economy descendants, as in Obstfeld and Rogoff (1996).

Nevertheless, the notion that the secular stabilization in twenty-first-century exchange rates came about because the world has become a safer place flies against casual observation. The brief Pax Americana of the 1990s was shattered with a major terrorist attack on US soil in 2001 and led the United States to two major international conflicts in a single decade. The past twelve years have seen the greatest global financial crisis since the Great Depression and the most consequential pandemic in a century at least. The two crises combined have produced enormous political ferment and uncertainty about the role of the state and the uses of government debt. In the second quarter of 2020, the US economy saw its greatest quarterly GDP decline since modern national accounts data have been collected. Measures of financial uncertainty (such as the VIX) remain elevated, even if they have fallen since their huge rise in March 2020. At the same time, exchange rate volatility has declined. The top panel of figure 6 expands the analysis of figure 2, illustrating the decline in exchange rate volatility relative to other assets. It shows the VIX index, extended back over a century. The actual VIX index measures “implied volatility,” that is, private sector perceptions of risk implied from thirty-day futures options. We extend the series historically using realized volatility, but the two series are highly correlated (89 percent) for overlapping months.

The figure shows that the twenty-first century has been a volatile period for financial markets in historical comparison. The dashed horizontal line in panel A demarks observations that were in the top 1 percent of observations in the 135-year time series. Outside the Great Depression, only three other events have shown volatility of these magnitudes: Black Monday in 1987, the global financial crisis in 2008, and the COVID-19 shock of March 2020. Thus, the two decades of declining exchange rate volatility have occurred against the backdrop of two of the greatest episodes of implied stock market volatility in over a century.

Panel B of figure 6 focuses on recent years and shows the VIX (top line) alongside a currency equivalent of the VIX, the Currency VIX (CVIX, bottom line), constructed by Deutsche Bank. The CVIX averages the implied volatility of the top nine currency cross pairs in terms of trade volume. The CVIX has trended slightly downward: it hit its lowest reading on record in January 2020. The downward trend in the CVIX is moderated compared to our core currency comparisons because it includes not only the G3 currencies

Figure 6. Implied Volatility: VIX and the Deutsche Bank Currency VIX



Sources: Schwert (1990), Thompson Reuters, Deutsche Bank, Chicago Board Options Exchange, and authors' calculations.

of the dollar, euro, and yen (and excludes the renminbi), but also the British pound, Swiss franc, and Australian and Canadian dollars.

While the two series are certainly correlated, the CVIX has shown very different dynamics than the VIX during the COVID-19 pandemic. While the VIX hit near historic highs in 2020, the CVIX was below its historical average for all but the single month of March. In March, it hit a value of 11, a figure only half a standard deviation above the index's historical mean, and a value previously exceeded in the unremarkable month of February 2016. The VIX, on the other hand, has come down precipitously since March but remained well above its historical median through early 2021.

The evidence compiled in figures 2 and 6 show a decline in currency volatility relative to other assets, indicating that a benign risk environment is an unlikely explanation for the phenomenon.

THE REAL ECONOMY AND FISCAL POLICY We have already made the point that the trend decline in global exchange rate volatility, particularly at the core, has survived the worst global financial crisis in eight decades and the worst pandemic in a century. Although one can speak of a great moderation in the run-up to the 2008 global financial crisis, and a second moderation in the run-up to the COVID-19 shock, any measure that takes into account the two crises will show extremely high volatility in output, unemployment, global trade, and so on. The argument that exchange rate volatility has fallen because the real economy has become more stable seems highly dubious.

Similarly, it is difficult to reconcile the collapse in exchange rate volatility with recent fiscal activism, either in the run-up to COVID-19 or during the pandemic. For example, although the general direction of travel was similar across countries in the pandemic, the timing and magnitudes of fiscal announcements were quite varied across countries, and the exchange rate effects apparently minimal.

Having said this, the global nature of the crisis has itself led to a very coordinated response in central banks across the world. The nature of the shock may therefore have an indirect role in explaining the muted exchange rate volatility that followed. Further, there is far greater coherence across central banks in their expected responses to real shocks and inflation, which may have led to clearer market expectations on monetary policy going forward.

EMERGING MARKETS So far, we have mainly focused on advanced economies; we next turn to emerging markets. The greater exchange rate and inflation stability of the twenty-first century didn't bypass emerging markets. With some notable recent exceptions (Argentina, Ukraine, Venezuela),

emerging markets have seen low and stable inflation rates and the longest period in the postwar era without a single case of hyperinflation (2003–2013; Zimbabwe had a notable case of hyperinflation in 2008, but it isn’t typically classified as an emerging market). In terms of exchange rates, many emerging markets have bucked the G4’s trend and moved to greater exchange rate flexibility and eschewing formal exchange rate targets.¹⁶

Panel A of figure 7 shows that the global financial crisis and the monetary developments that followed revived the currency crash, with 6 percent of all currencies crashing in 2008–2009, and an additional 4 percent during the proverbial “taper tantrum” of 2013, when the Federal Reserve slowed its asset purchases. The figure shows the share of all countries experiencing a currency crash, defined in this case as a decline of 12.5 percent in their bilateral exchange rate with their anchor currency.¹⁷ COVID-19 saw only a handful (2 percent) of currencies crashing. Compared with previous shocks, this is a pittance—roughly half a taper tantrum and nowhere close to the global financial crisis. Panel B shows the generalized decline in hyperinflation, which is associated with much lower trend inflation in emerging markets overall. We will return to the risk to the apparent resilience of emerging markets in the next section.¹⁸

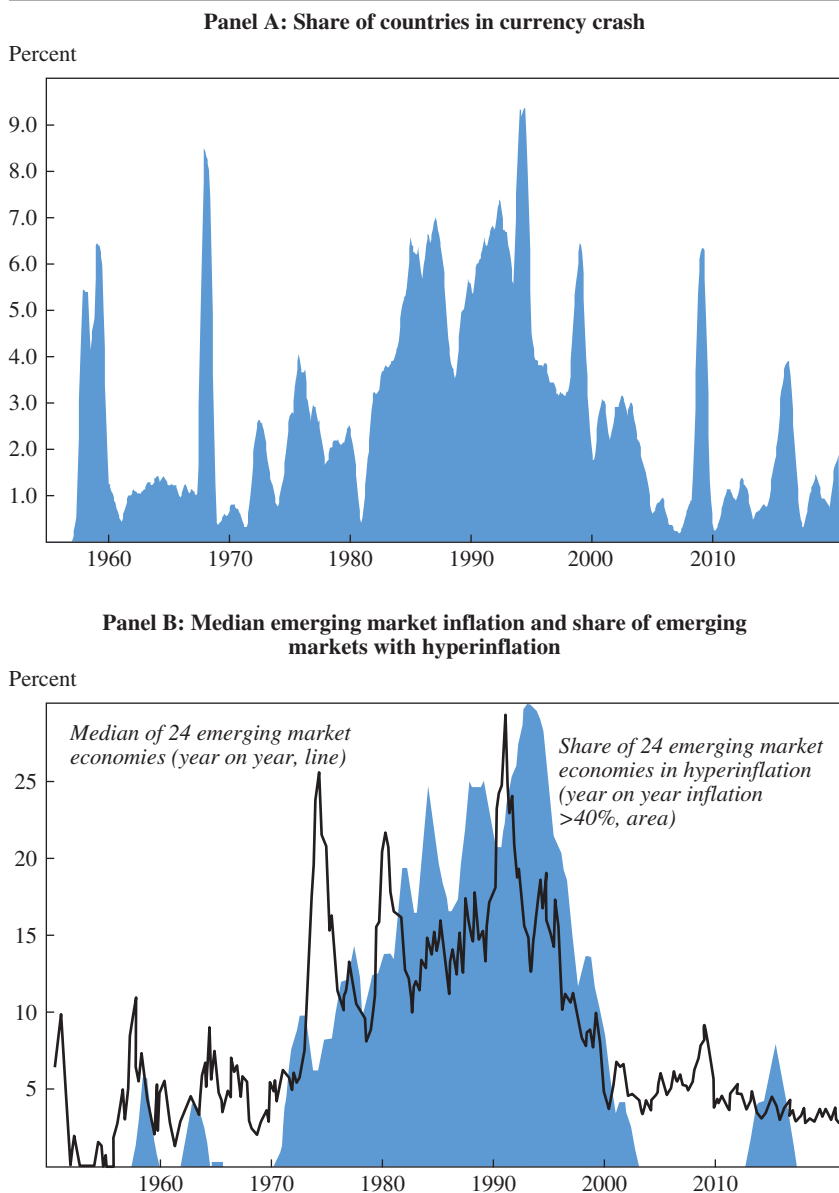
III. Risks to Extended Bretton Woods II

At the time of this writing, exchange rate stability among advanced economies has persisted and other financial assets have stabilized as well. However, the pandemic is still unfolding, cases and death tolls continue to accumulate worldwide, and a second acute round of the pandemic remains a distinct possibility. What risks does the continued pandemic—or its aftermath—pose to the downward trend in exchange rate volatility and to the international monetary system more broadly? Of course, in addition to macroeconomic and especially monetary policy, outcomes depend on success in dealing

16. See Ilzetzi, Reinhart, and Rogoff (2019) for evidence in this regard.

17. See Ilzetzi, Reinhart, and Rogoff (2019) on anchor classifications.

18. Exchange rate variability in some emerging markets has remained high during this period as many emerging market have opted for more flexible exchange arrangements. Kalemli-Özcan (2019) shows that variability in emerging market policy interest rates has declined in the twenty-first century, but unlike high-income countries, this decline has somewhat faltered since 2014 and rates have been well above zero. Further, the comparison with high-income countries is complicated due to risk premia, whose importance for emerging markets Kalemli-Özcan (2019) highlights.

Figure 7. Currency Crashes, Global Liquidity, and Emerging Market Inflation

Source: International Finance Statistics, the Conference Board, Federal Reserve Bank of St. Louis, and authors' calculations.

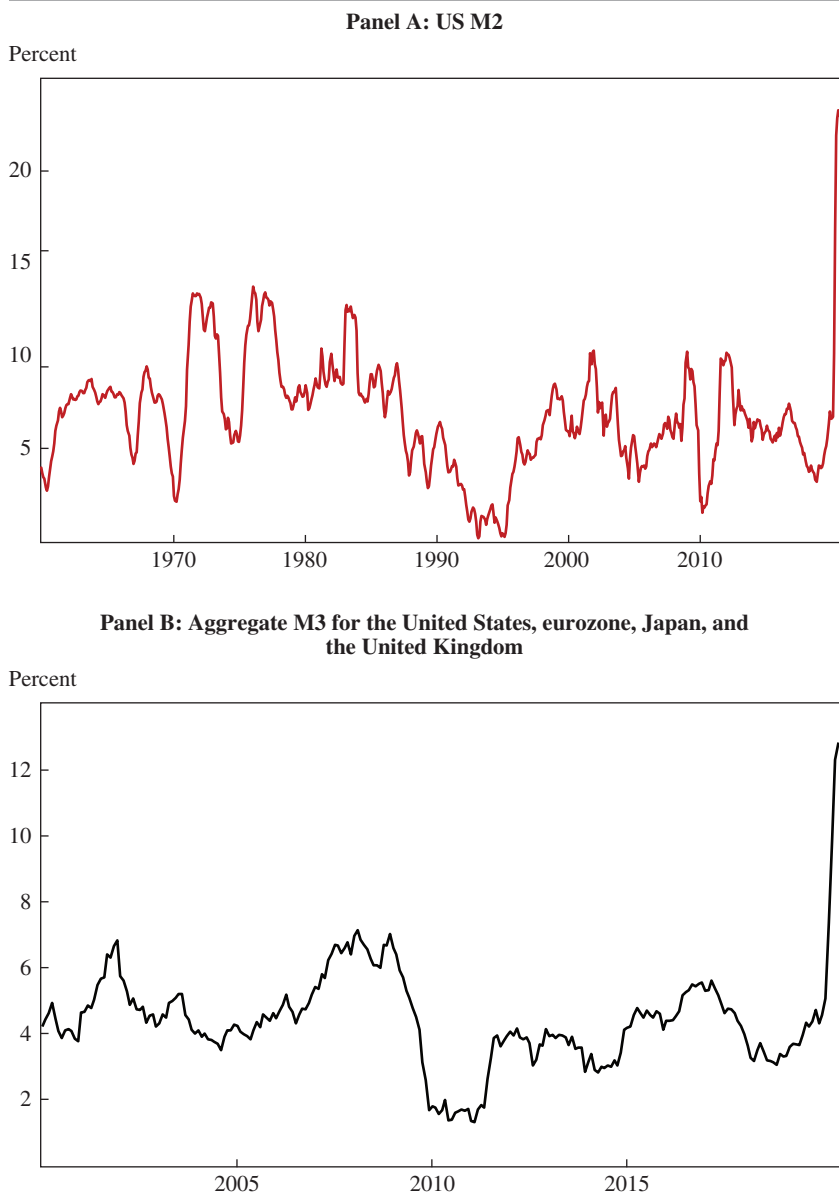
with the virus and on how well the public is reassured that further extreme risks do not lie around the corner.¹⁹

Determining whether the current period of exchange rate stability will continue is highly speculative, so in this section we can only highlight some considerations. But we certainly don't want to leave the reader with the impression that one can be highly confident in extrapolating extended Bretton Woods II indefinitely into the future. For example, some notable differences between the current pandemic recession and the 2008 financial crisis suggest a distinct chance that the inflation, interest, and exchange rate aftermath will eventually become much more volatile, even if markets presently heavily discount the possibility.²⁰

One factor, to which we alluded earlier, is that aggressive central bank intervention has produced far more market liquidity this time around. In 2008, massive increases in bank reserves largely sat at the central bank and did not have a leveraged effect on broader monetary aggregates. This time, many markets are experiencing significantly higher liquidity, notably the dramatic rise in monetary aggregates in the United States, Europe, Japan, and the United Kingdom, seen in figure 8. The top panel shows that M2 has grown at an unprecedented rate since the start of the COVID-19 pandemic, while the bottom panel shows that this monetary expansion has reflected in broader measures of liquidity (M3) and more globally. This is partially due to firms calling on lines of credit to have a war chest for the next spike of the pandemic, but in the United States, mortgage refinancing has also been important. It is an open question whether, as the economy heals, this higher liquidity will eventually bleed over into inflation, particularly if central banks remain concerned with low growth and high public and private sector debts. The Federal Reserve's new policy framework, which many other central banks are likely to follow, underscores that policymakers are now (rightly) willing to take more risks on inflation to promote growth.

19. Kozlowski, Veldkamp, and Venkateswaran (2020) argue that even if the pandemic ends by December 2020, the long-term effects of higher perceived tail risk will have a significant impact on investment and consumption for many years to come.

20. Inflation expectations collapsed at the onset of the COVID-19 crisis but have since recovered to pre-pandemic rates. Expectations remain below the Federal Reserve's 2 percent target (see top panel of figure A4 in the online appendix). At the same time, there are some indications of underlying inflationary pressures. Using scanner data in the United Kingdom, Jaravel and O'Connell (2020) show that *monthly* inflation spiked to 2.4 percent in the first month of the lockdown. Cavallo (2020) argues that official figures understate inflation in seventeen emerging and high-income economies, as they fail to consider shifting consumption patterns during the pandemic. The bottom panel of figure A4 in the online appendix shows an atypical divergence between food price inflation and CPI inflation, highlighting the current uncertainty in the effective inflation rate.

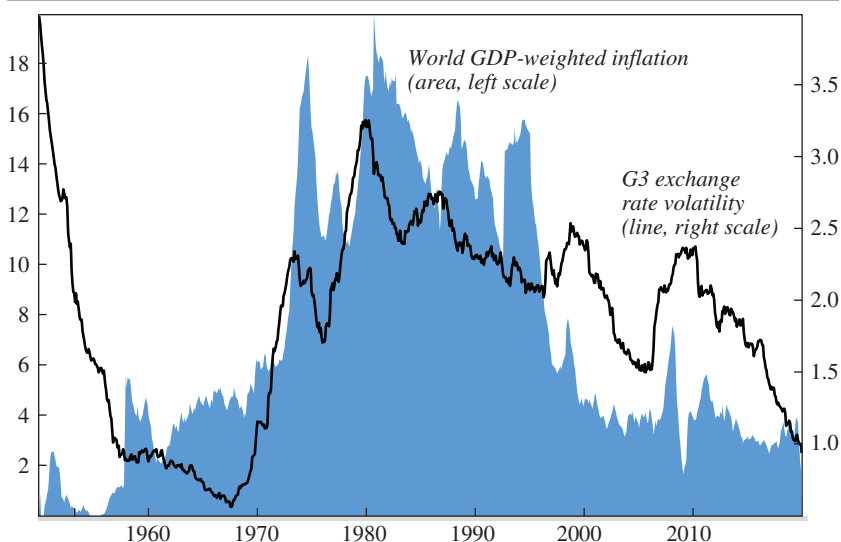
Figure 8. Growth in Monetary Aggregates

Sources: Federal Reserve Board, European Central Bank, Bank of Japan, Bank of England, and authors' calculations.

A second key difference is that the COVID-19 crisis is a significant supply shock; whereas it has likely accelerated some important positive productivity shifts (more telecommuting and teleconferencing), the medium-term effect could turn out to be quite negative. This is apparent in the stress on global supply chains and the fall in trade, which had already been growing at a slower rate since the 2008 financial crisis than in the previous several decades. A considerable body of evidence has accumulated indicating that global factors have been a major reason for downside surprises in trend interest rates and inflation the past two decades, as suggested in Rogoff (2004) and Kose and others (2020). Deglobalization, should it happen, could put the dynamic into reverse. Indeed, the massive effective growth in the global labor force over the past four decades, particularly due to the integration of China and Eastern Europe, as well as an expansion of women into the labor force, was likely a major force in pushing down labor shares and prices. Even without deglobalization, demographics point to a declining effective global labor force unless India and Africa pick up the slack as China ages (Goodhart and Pradhan 2020).

The COVID-19 crisis is also likely to lead to major domestic restructuring, away from consumer-facing businesses, which in turn could reverse the four-decade shift toward greater urbanization. Greater population density produces production efficiencies but at the cost of heightened pandemic risks. Financial stress can also take a toll. Even with very generous federal loans, many small businesses will not survive, and there is likely to be huge damage in commercial real estate. Thus, it is important to be careful in making analogies to the deflationary 2008 financial crisis; the lasting supply effects here could be much more adverse.

Turning to history as a guide, we have already seen (in figure A2 in the online appendix) that the international monetary system of the twenty-first century has by now outlived Bretton Woods. This may seem surprising since the Bretton Woods era is sometimes viewed as running from after World War II until its collapse in the early 1970s, but in fact one can divide the regime into two distinct phases. The first, from the end of the war to the mid-1950s was characterized by high volatility of market exchange rates (as measured by active parallel markets across Western Europe) in the face of high and volatile inflation. So although formally a period of fixed exchange rates, it was a very different regime than one with integrated capital markets, a unified exchange rate regime, and low inflation. The true heyday of Bretton Woods—the second phase from the mid-1950s to the late 1960s—was relatively short and only arrived when inflation declined to low single digits, exchange markets were unified, and as the eurocurrency market began to develop.

Figure 9. World Inflation and Exchange Rate Variability

Sources: International Finance Statistics, the Conference Board, and authors' calculations.

Note: World inflation is calculated as the average GDP-weighted year-on-year inflation. GDP weights are at 1990 Geary-Khamis purchasing power parity. Individual country inflation rates capped at 100 percent to avoid excessive influence of outliers. G3 exchange rate volatility is given as the four-year moving average of the monthly absolute value of exchange rate change averaged among the three cross rates of the US dollar, euro (or Deutschmark pre-1999), and yen.

Figure 9 shows the evolution of the international monetary system and of global inflation from 1950 to 2020. It combines world inflation (average inflation weighted by each country's share of world GDP, for over one hundred countries) with the average variation in G3 (United States, Germany, and Japan) bilateral exchange rates (a synthesis of the two panels of figure 1). The strong correlation between the level of global inflation and the variability of exchange rates is immediately apparent, much as we highlighted for advanced economies alone. Note that the mid-1950s saw the nadir of global inflation although inflation differentials were higher.²¹

21. In figure 9, global inflation is calculated as a GDP-weighted average of those countries for which data were available in each month. Inflation rates in the 1950s and 1960s should therefore be compared to recent inflation rates with caution: the sample in the 1960s contains far fewer developing countries and developing countries comprised a far smaller share of world GDP at the time. Nevertheless, it is interesting that exchange rates only began stabilizing in Bretton Woods in the deflationary years and years with low interest rates following the Korean War.

The Bretton Woods halcyon era formally ended when the United States de-linked the dollar from gold in 1971, but as the figure shows, the system was already in decline by the late 1960s. The inflation surge in the early 1970s was the straw that broke the camel's back. It is not coincidental that the departure from the gold standard was part of a package of policies all announced in tandem on August 15, 1971. The package included price controls in an attempt to limit already rising inflation and 10 percent tariffs on imported goods—another relevant parallel to today's world of heightened trade tensions.²²

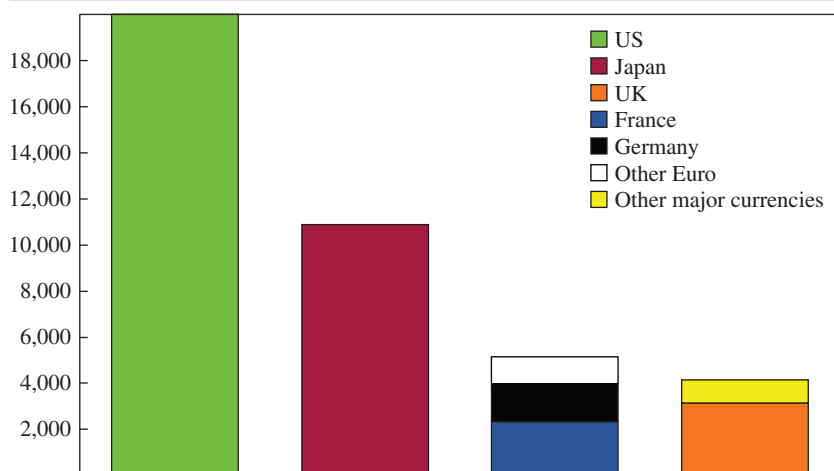
This ushered in a third phase of the global exchange rate system, a great de-anchoring, with world inflation consistently in double digits and peaking at 20 percent. We have seen that inflation was also very variable across high-income countries and even more so when including developing countries, many of which experienced hyperinflation.²³ This was also a period of high exchange rate volatility and multiple currency crashes (see figure 7). It was only in the mid- to late 1990s that world inflation stabilized at moderate rates and inflation differences across countries diminished. This ecosystem supported the emergence of the Bretton Woods II system, which has now morphed into the extended Bretton Woods II system, thanks to the decline in G4 exchange rate variability documented in this paper.

Clearly, a surge in global inflation could pose a threat to the current international monetary order. Inflation targeting has been the *de jure* monetary framework of choice in the twenty-first century. The proliferation of independent central banks and inflation targeting regimes may well have anchored inflation expectations and contributed to the benign inflationary environment of the past two decades. However, inflation targeting has not yet faced a test commensurate with the challenges that led to the great de-anchoring of the 1970s. It may yet face one after the COVID-19 crisis.

Another potential source of risk is the dramatic rise in global debt, both public and private. Sharply rising debt may well be perfectly benign given very low interest rates, but at the same time it can increase vulnerability to a loss of confidence. Theory suggests that an optimizing hegemon may be tempted to take advantage of global demand for its debt by sharply expanding issuance, taking the world from a safe zone to a risky multiple

22. See Richard Nixon's "Address to the Nation Outlining a New Economic Policy: 'The Challenge of Peace,'" American Presidency Project, <https://www.presidency.ucsb.edu/documents/address-the-nation-outlining-new-economic-policy-the-challenge-peace>.

23. Our world inflation index caps countries' inflation at 100 percent to avoid disproportionate weight on extreme hyperinflations.

Figure 10. Marketable Debt Securities, August 2020

Sources: National finance ministries and authors' calculations.

Note: Marketable debt securities in billions of US dollars, August 2020 (June or July for some countries depending on data availability, converted at market rates of August 2018). "Other euro" are highly rated eurozone securities (Austria, Belgium, Finland, and the Netherlands) other than France and Germany; other major currencies are Australia, Canada, Sweden, Switzerland, and the United Kingdom. China omitted due to lack of concurrent data.

equilibrium zone. This can happen if the hegemon only takes into account risks to its own welfare and does not internalize the global costs of systemic breakdown. It is worth recalling that in the run-up to the 2008 financial crisis, policymakers in the United States and United Kingdom (whose financial firms were big beneficiaries of financial globalization) downplayed concerns expressed by other countries that their lax financial regulation could become a global problem.

Presumably, near-term risks to significantly higher US debt issuance remain low, but nevertheless consider figure 10, which compares US borrowing in global markets to other major currency issuers. Remarkably, although the combined economic size of the other major advanced economies issuers considerably exceeds the size of the United States, the United States government has placed roughly as much public debt in global markets as all the others combined. Moreover, near term, even with Europe now issuing Eurobonds, US borrowing is likely to continue to outstrip the world.

Even if rising US debt levels eventually push it into a zone of greater fragility—that is, entering a multiple equilibria zone in a model such as that of Farhi and Maggiori (2018)—economic theory tells us little about the

timing of a loss of confidence, which could take a year or a century. Our own strong prior is that the near-term risks are likely very small and should remain so over the next several years. However, if US public debt continues to increasingly dominate global public debt markets—which are rapidly growing overall—the situation can change quickly and unexpectedly. It bears noting that Yale economist Robert Triffin famously warned the US Congress in 1960 that there was a fundamental inconsistency between the growing size of foreign reserves of US dollars and the shrinking backing in terms of gold reserves and US GDP (Triffin 1964). Yet, the Bretton Woods system lived on for more than a decade.

The collapse of the interwar gold standard in the 1930s and the breakup of Bretton Woods in the early 1970s were times of great macroeconomic duress. The same need not be true next time, if there is a breakup of extended Bretton Woods II, but the risks should not be underestimated.

Even without a breakdown at the core, the risks to emerging markets are immense, and unlike in the 1980s and 1990s, the spillovers to advanced economies, including the United States, could be much greater this time. At purchasing power parity weights, emerging markets now account for roughly 60 percent of global GDP compared to just over 40 percent in the 1980s and 1990s. Moreover, advanced economies and emerging markets today are linked by complex global supply chains that almost certainly have a big impact on productivity and prices in advanced economies, at least in the medium run. It would be hyperbole to say that emerging markets are the canary in the coal mine for global inflation and exchange rate stability, but it would be complacent to dismiss the transmission risks.

Spreads on emerging market sovereign bonds spiked in March, currencies from the Brazilian real (down 25 percent in 2020) to the Turkish lira (down 60 percent from 2016 to the end of 2020) collapsed, and several central banks expended as much as a quarter of their reserves to prop up their currencies. The Institute of International Finance's daily capital flows showed capital flowing out of emerging markets from February to April 2020 in quantities five times greater than in the similar time frame following the collapse of Lehman Brothers in 2008. Outflows have since abated and capital flows have resumed into some markets. Emerging market exchange rates have moved, but in most cases by less, so far, than in the 2008 crisis. But this could change.

Indeed, the crisis is still unfolding; even if a vaccine is found, emerging markets may not benefit for years. In the meantime, they face many of the same fiscal, social, and political stresses as advanced economies. The long period of macroeconomic stability in emerging markets is at risk. Figure 11

Figure 11. Preexisting Conditions and COVID-19 Devaluation: Emerging Markets

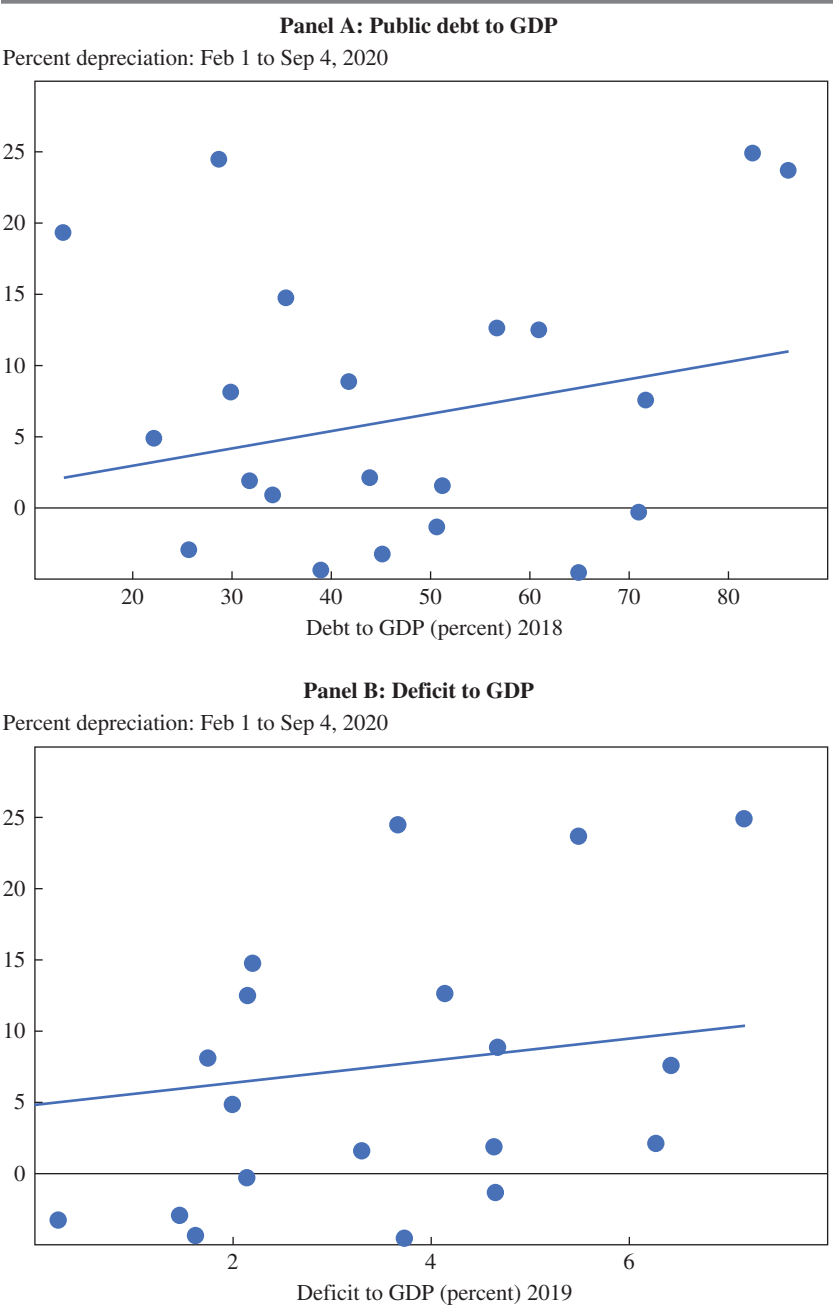
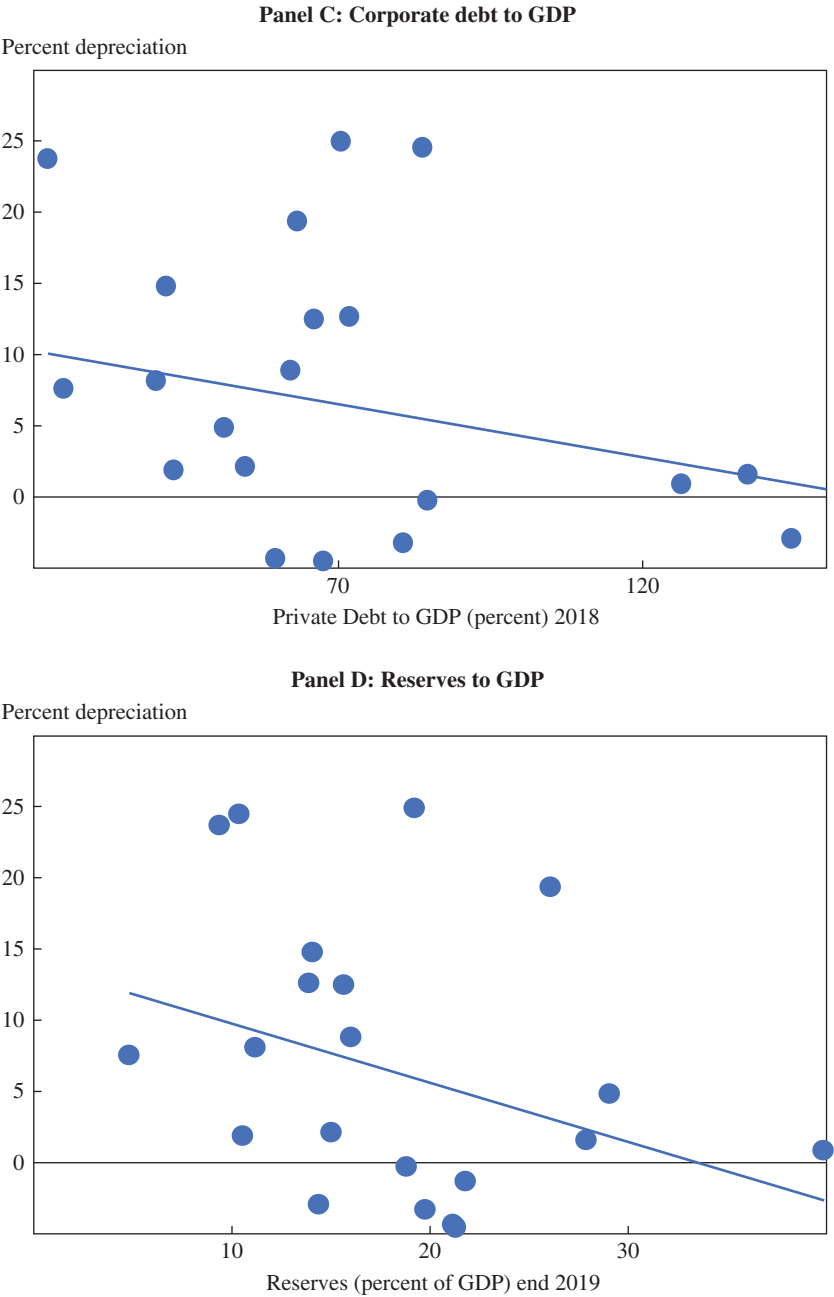


Figure 11. Preexisting Conditions and COVID-19 Devaluation: Emerging Markets
(Continued)



Sources: IMF Global Debt Database, Bloomberg, and authors' calculations.

assesses some of the risk factors hovering in the background of the relatively benign outcomes in emerging markets to date. It shows a scatter plot across countries categorized as emerging markets by the IMF, comparing the exchange rate decline from February 1 to date with a number of pre-existing conditions prior to the COVID-19 crisis. Much has been written on the importance of private sector debt as a predictor of financial crisis, but interestingly we find no correlation between the ratio of private sector debt to GDP and the currency sell-off during the COVID-19 pandemic (panel C of the figure). This is separately true for corporate debt and household debt and the growth of private sector debt in recent years (not shown in the figure).

In contrast, panels A and B of figure 11 show that fiscal conditions are correlated with the emerging market exchange rate decline in 2020. Countries with higher ratios of debt to GDP and higher deficits to GDP (both measured in 2019) saw greater exchange rate declines since February 2020. While the sample size is small and there is much variation in the data, the correlations are at least suggestive that markets are more sensitive to emerging markets' fiscal positions than they are to private sector balance sheets, at least so far.

The twenty-first century saw the greatest accumulations of central bank foreign exchange reserves on record. Central bank foreign exchange reserves have increased nearly eightfold this century from \$1.4 trillion in 2000 to \$11 trillion today. Panel D of figure 11 shows that the relative stability of emerging market exchange rates should be viewed in the context of a large deployment of these reserve holdings to prop them up. Countries entering the crisis with larger reserve holdings relative to GDP saw lower exchange rate declines, suggesting that reserves served as a buffer against exchange rate volatility. Most dramatic is the case of Turkey, whose central bank has already expended 40 percent of its foreign exchange reserves since the beginning of the year. But the reserve sell-off has been widespread with countries ranging from Egypt to Ecuador (showing foreign exchange reserves declining by 20 percent and 30 percent, respectively) to support their currency.²⁴

IV. Conclusions

This paper highlights a significant but not well-known fact about the global exchange rate system: the increasing stability at its core. The Bretton Woods II regime, first highlighted in an insightful series of papers by Dooley,

24. Figure A4 in the online appendix shows the same figure comparing emerging market sovereign spreads (over ten-year US Treasuries) and shows similar patterns.

Folkerts-Landau, and Garber (2004), stressed stability between the dollar and the rapidly growing countries of Asia. Bretton Woods II has now morphed into extended Bretton Woods II, including the United States, Europe, and Japan. By some measures, extended Bretton Woods II has surpassed Bretton Woods I in stability, durability, and breadth. One only has to recall that during Bretton Woods I, the second-largest economic region in the world, the Soviet Bloc, did not participate and was not pegged to the dollar. By contrast, not only has the euro-dollar rate become relatively stable, but exchange rate instability among the nineteen countries of the eurozone has been completely eliminated.

Just as Bretton Woods I came to a crashing end, there are risks to extended Bretton Woods II. The risks are most apparent in emerging markets, whose share of global GDP has risen dramatically since 1980 and are linked to advanced economies both through demand and through increasingly important global supply chains. External debt levels (public and private) in emerging markets were already rising to risky levels in the years prior to the pandemic and are a significant source of risk now with uncertain output and falling global trade. Although many are able to tap today's extremely liquid markets, the interest costs are high, and new borrowing has not been enough to refinance loans coming due and to replace portfolio outflows. Arguably, several debtor countries are effectively liquid (thanks especially to extraordinary actions by the Federal Reserve and the ECB) but insolvent.

Moreover, even after the full-blown health crisis is tamed, the COVID-19 crisis could well have a lasting negative effect on the supply side of the economy. Globalization could be dramatically rolled back, with some travel restrictions likely to remain in place for years, global supply chains consolidated to strengthen resilience, and political ferment threatening to amplify these effects, regardless of election outcomes. As the virus lingers, the explosion of small business bankruptcies could strengthen monopolies and reduce pressures for innovation. Although central banks have extended broad guarantees, financial fissures could start expanding. Even if the current low inflation dynamic persists for many more years, there is non-trivial risk that eventually the mix of highly expansive monetary and fiscal policy in the face of a long-term adverse supply shock could upend the inflation calm of recent decades. Massive shocks to the global economy can produce turning points. Needless to say, the risks are difficult to assess, but we have argued that despite the preternatural calm in exchange rate markets, this too can come to an end, just as the Great Moderation did in 2008 and the second great moderation did in 2020.

Enhanced stability of the global exchange rate system is hardly a problem. Indeed, the longer-term trend decline in core exchange rate volatility likely reflects the global shift to having independent, technocratic central banks. But the more recent decline in volatility since 2014 and even more so in the face of the COVID-19 pandemic still needs to be diagnosed. We have argued that the recent trend more likely reflects the paralysis of monetary policy at the zero bound and there are reasons to be concerned that today's stability might mask fragilities, not strengths. The exchange rate is a portmanteau measure of relative national macroeconomic and financial shocks, and the current low pressure reading needs to be studied further before being declared an unalloyed triumph of modern independent central banks.

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Comment and Discussion

COMMENT BY

SILVIA MIRANDA-AGRIPPINO¹ This paper by Ethan Ilizetzi, Carmen M. Reinhart, and Kenneth S. Rogoff analyzes the drivers and latent risks associated with the recent trends in exchange rate volatility among major currencies. The paper is developed along three main lines. First, using data since the end of Bretton Woods, the authors document a slow but persistent decline in average volatility among the core G3 currencies—the US dollar, the euro, and the yen. The decline is shown to have accelerated after the first half of 2014, when European interest rates moved into negative territory, and persisted throughout the first half of 2020, notwithstanding the global health crisis. Second, the authors argue that the fundamental driver of this increased exchange rate stability at the core is to be found in the “paralysis” of monetary policy. The convergence of inflation rates, and of short and long rates in particular, is singled out as the driving force behind this downward trend. Other explanations—including the rising status of the dollar as a global reserve currency, global risk cycles, and the global nature of recent real shocks—are briefly examined but ultimately dismissed. Third, the paper weighs some of the risks around this extended Bretton Woods II regime. On the one end, the supply nature of the COVID-19 shock and some of the unprecedented liquidity injections implemented in response to it may put advanced economies on a trajectory of rising inflation. On the other, large and increasing levels of private and public debt, manageable in a low interest rate environment, may generate vulnerabilities

1. I thank H  l  ne Rey and colleagues at the Bank of England for useful comments and discussions. The views expressed are those of the author and do not represent those of the Bank of England or any of its committees.

and potentially lead to a loss of confidence if monetary policy divergence arises due to inflation risk. Realization of such risks could lead to a Triffin event (Farhi and Maggiori 2018; Gourinchas, Rey, and Sauzet 2019) and have dramatic consequences for the stability of the international monetary system as we know it.

This is a very important paper and addresses one of the main outstanding challenges in international macroeconomics and finance, with fundamental policy implications. I will organize my comments around two main points. First, I will propose a complementary view of the drivers of foreign exchange (FX) volatility among major currencies. My conclusions will be that it would be unwise to discount global risk cycles altogether and that monetary policy broadly intended may have in fact played an active role as a global stabilizer over the recent months. Second, I will zoom in on the latest data and note that—differently from previous recession episodes—following the COVID-19 shock, the dollar is depreciating while other currencies are in high demand. We may already be experiencing a loss of confidence to some degree. And despite relatively benign inflation projections and guidance that monetary policy will likely remain accommodative for years to come.

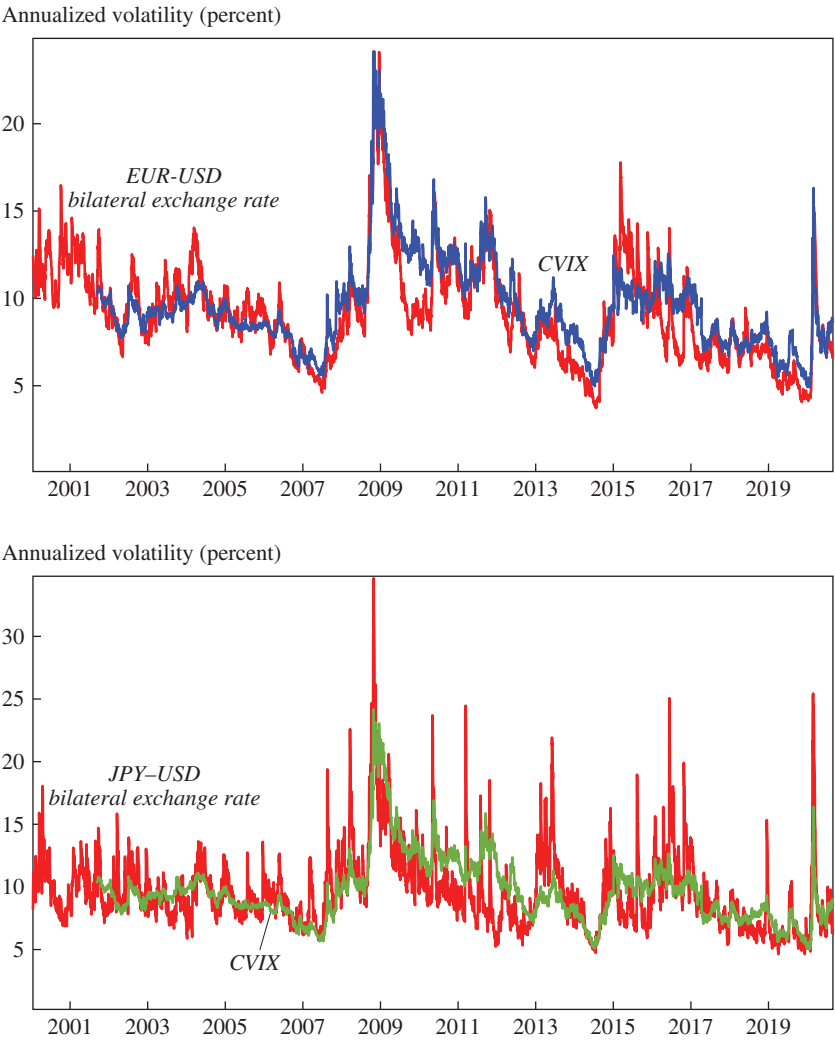
FX VOLATILITY DYNAMICS AT THE CORE I will start with looking at the time evolution of FX volatility among major currency pairs over the last two decades. In order to bring forward the dynamics relative to longer-term averages as used in the paper, for my analysis I will use the estimates provided by the NYU Stern Volatility Lab.² Figure 1 plots the estimated annualized volatility of the bilateral exchange rates for the euro (top panel) and the yen (bottom panel) against the dollar.³ In both subplots, the Deutsche Bank's Currency Volatility Index (CVIX) is also shown. The CVIX is a synthetic measure of the historical volatility of the major G7 currencies. Similar to the VIX, it can be used to assess stress levels in currency markets. Data are daily and cover the period January 1, 2000 to September 18, 2020.

There are a number of elements that are worth noting. First, across currency pairs, the years immediately following the turn of the century are indeed characterized by a certain degree of stability. This pattern, however,

2. NYU Stern Volatility Lab; <https://vlab.stern.nyu.edu/>. By construction, applying a moving average filter increases the persistence of the original data, the more so the higher the moving average order. This can have the effect of introducing trends in place of one-off peaks of different intensity and renders the interpretation of the timing of events more challenging. See online appendix A.

3. For the purpose of this discussion, the specific model used to estimate the volatility of FX currency pairs is inconsequential.

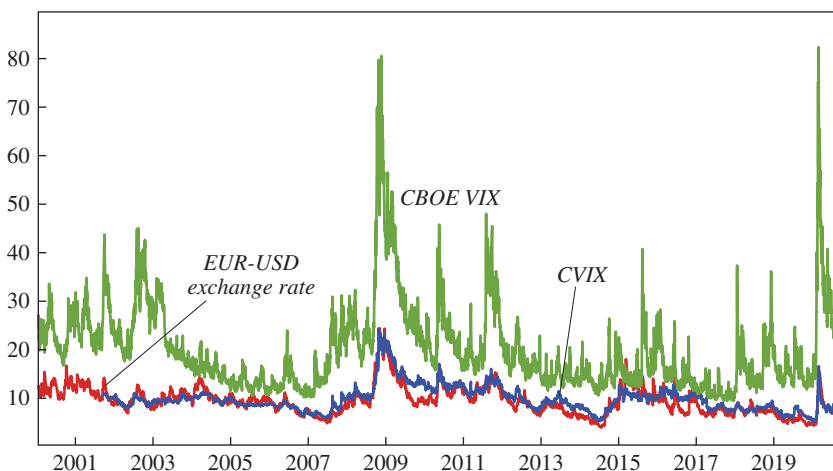
Figure 1. Estimated Volatility of Bilateral Exchange Rates against the US Dollar



Source: NYU Stern Volatility Lab.
Notes: Top panel shows the volatility of the EUR-USD bilateral exchange rate and Deutsche Bank's Currency Volatility Index (CVIX). Bottom panel shows the volatility of the JPY-USD bilateral exchange rate and Deutsche Bank's CVIX.

Figure 2. FX Volatility and Global Risk Measures

Annualized volatility (percent)



Source: NYU Stern Volatility Lab.

Notes: Estimated volatility for the bilateral EUR-USD exchange rate, Deutsche Bank's CVIX, and CBOE VIX.

was dramatically interrupted with the global financial crisis, and again in 2015. This latter period corresponding roughly to the end of the Federal Reserve's quantitative easing (QE), and to expectations of interest rates moving away from the zero lower bound. While short-lived, the COVID-19-induced volatility spike that occurred in the earlier months of 2020 also stands out as a significant and quite dramatic shift in volatility dynamics. Second, and importantly, the volatility dynamics seem to share a large common component. Abstracting from country-specific idiosyncrasies, the CVIX tracks the lower frequency movements remarkably well irrespective of the specific pair. Hence, while the existence of a clear downward trajectory over this sample is somewhat unclear, the notion that common causes may be responsible for the bulk of the movements in the volatility of the G3 currencies seems to find significant traction.

Figure 2 adds to the comparison the VIX index. Nominally a measure of the implied volatility of S&P 500 options, the index is customarily used as a barometer for market uncertainty and overall risk levels in financial markets by practitioners and academics alike. Despite the different scales and the noise embedded in daily data, the similarity of the time profiles is immediately apparent.

This correlation should not be surprising. As the authors also note, “the literature of the past decade, particularly following the influential work of Gabaix and Maggiori (2015), has argued that risk factors and financial frictions likely play a dominant role; Itskhoki and Mukhin (2017, 2019) argue that there is no other plausible way to explain the major puzzles in international macroeconomics.” Kalemli-Özcan (2019) shows how risk factors are particularly important for emerging market economies. This exercise is purely illustrative and can hardly provide a formal quantitative account. But it does indicate that dismissing the role played by risk cycles may potentially omit an important part of the story.

Of course, this should not be interpreted as indicating that macroeconomic fundamentals do not matter, or indeed that monetary policy is altogether irrelevant. On the contrary, I would argue that the fact that following the COVID-19 shock currency volatility did not reach the levels seen during the global financial crisis, and that the recent COVID-19-associated volatility episode (albeit not completely reabsorbed) was overall short-lived, may in large part be attributed to the prompt, large, and synchronized intervention of the major central banks.

In March 2020, COVID-19-related news triggered what has been dubbed a “dash for cash” (Hauser 2020). Financial markets, and particularly bond markets, showed signs of worrying dysfunction as market participants were forced to unwind some of their existing positions and sell US Treasuries to generate cash. The disorderly conditions under which bond markets were operating quickly spread to all other corners of the global financial system, quickly raising alert levels worldwide. As the threats to the global economy—and to financial stability (exacerbated by the markets’ dysfunctions)—grew, the major central banks intervened with vigorous response packages. The Federal Reserve, the European Central Bank (ECB), and the Bank of England (BoE) launched bond purchase programs on the order of 10–15 percent of national GDP.⁴ Also, large programs specifically directed at reducing stress levels in corporate financing were implemented. There is evidence that these interventions were successful in restoring confidence in bond markets and addressing the demand for liquidity.⁵ More

4. Bond purchase programs amounted to 14.9 percent of GDP in the United States (\$3.2 trillion), 11.9 percent of GDP in the eurozone (€1.35 trillion), and 13.6 percent of GDP in the United Kingdom (£300 billion).

5. Gilchrist and others (2020) show that the Secondary Market Corporate Credit Facility (SMCCF) was effective in stabilizing the corporate bond market following the COVID-19 shock. Altavilla and others (2020) show how ECB policies implemented in response to the COVID-19 crisis were crucial in guaranteeing continued bank lending and favoring the supply of credit.

important from the perspective of this comment, however, was the activation of central bank swap lines in order to address the large and rising demand for US dollars that international banks were increasingly unable to meet.

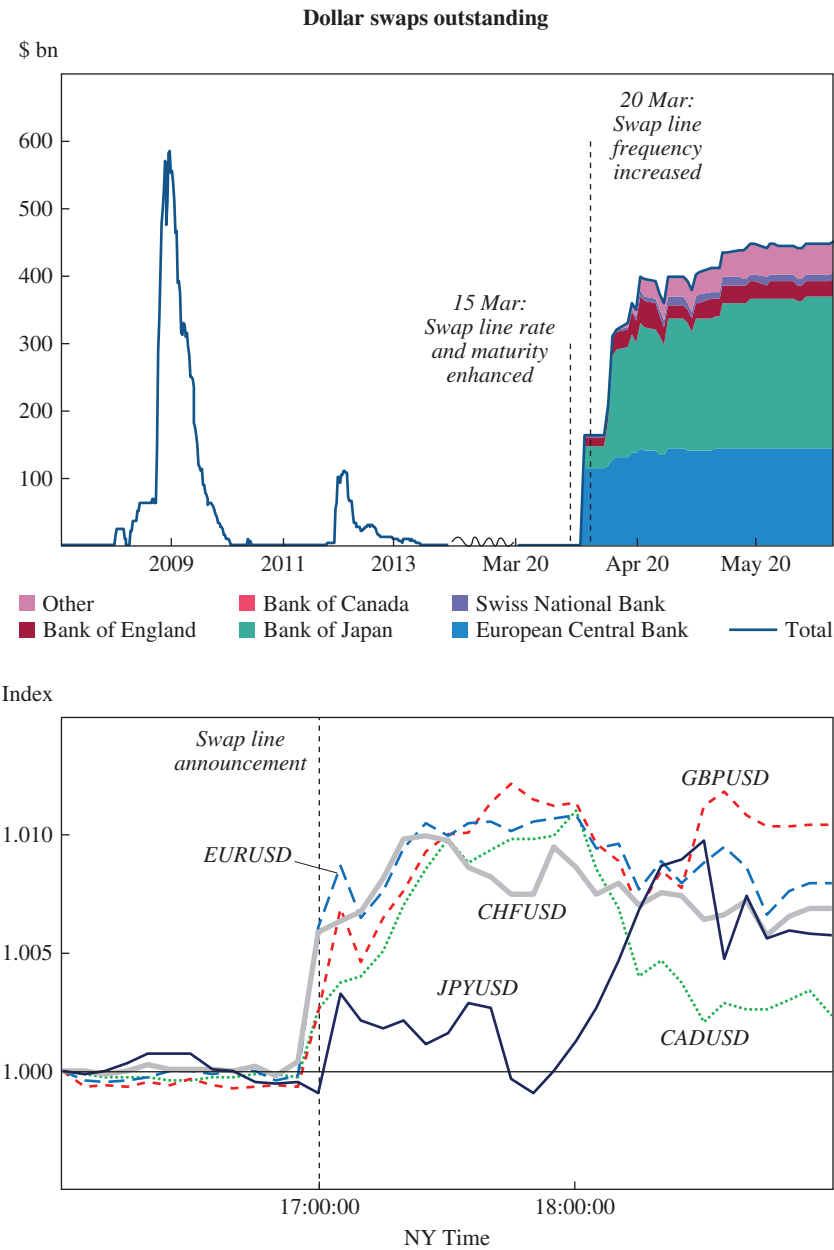
Swap lines were introduced after the global financial crisis to facilitate offshore US dollar funding in times of market disruption.⁶ Since their reintroduction in March 2020, dollar swap lines have been heavily used (figure 3, top panel).

The swap lines are an effective tool for monetary policy (Bahaj and Reis 2018). While not designed with the explicit aim of intervening in currency markets, it can be argued that by facilitating the circulation of US dollars at times when demand for them cannot be met due to other types of friction, swap lines can have second-order effects on exchange rates too. While only illustrative, the bottom panel of figure 3 shows that bilateral FX rates against the dollar reacted significantly to the reintroduction of swap lines. At least visually, movements in major bilateral exchange rates are compatible with the announcement date. Eguren-Martin (2020) shows that, if large enough, central bank swap lines are effective in attenuating the adverse effects of dollar shortage shocks, by also acting on the exchange rate channel that functions as an amplifier of such shocks. More research on the effects of swap lines on exchange rates is certainly needed. But the evidence discussed so far is at least indicative that this time around central banks were alert and reacted in a vigorous way that helped to compress the heightened volatility in financial markets. At least to some extent, monetary policy is likely to have accounted also for the quick reversals in FX volatility.

HOW IS THIS TIME DIFFERENT? Since the onset of the pandemic, commentators and scholars have debated the nature of the COVID-19 shock. While a textbook supply shock at its origin, its large second-round demand effects have become increasingly more apparent. Guerrieri and others (2020) rationalize these effects by introducing Keynesian supply shocks: supply shocks that can trigger demand shortages that lead to contractions in output and employment larger than the supply shock itself. They argue that the COVID-19 shock may be a negative Keynesian supply shock.

6. The standing swap lines allow five major central banks (BoE, Bank of Japan, ECB, Swiss National Bank, and Bank of Canada) to lend dollars to their local banks, confident in the knowledge that they can back those loans with dollars secured from the Federal Reserve, short-circuiting any market dysfunction.

Figure 3. Central Bank Swap Lines and FX Market Reactions



Sources: Hauser (2020); Eguren-Martin (2020).

Notes: Top panel shows dollar swaps outstanding. Bottom panel shows high-frequency reactions of bilateral exchange rates against the US dollar at announcement.

The data are consistent with this interpretation. Against the backdrop of sharp increases in unemployment figures, inflation in the United States has so far remained relatively subdued. And the propagation of the COVID-19 shock does not appear to differ in material ways from previous recessions, which Del Negro and others (2020a) argue have been largely the result of negative demand shocks (figure 4).

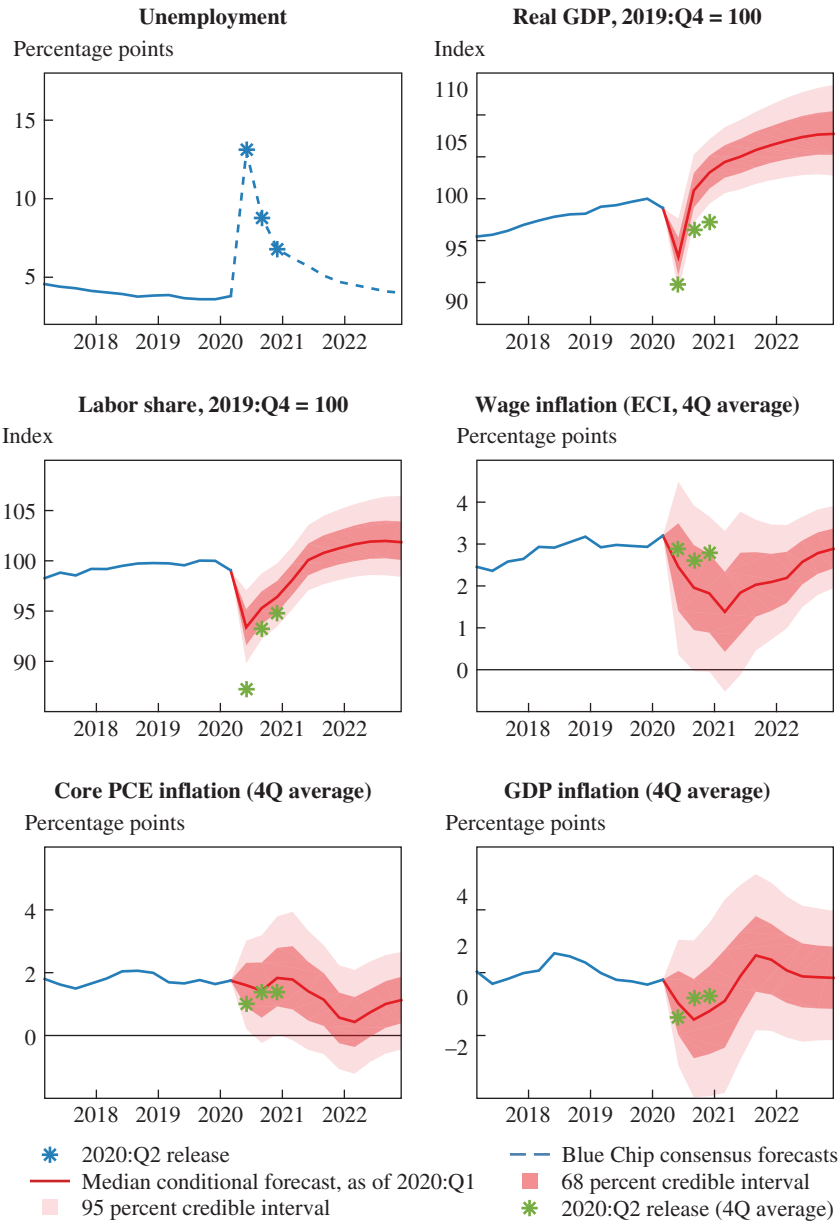
Consistently, professional forecasters attach higher probability to low inflation states for 2021 (figure 5, top panel) and over the long term (figure 5, bottom panel). Taken together, figures 4 and 5 suggest that inflation risk does not seem to be an immediate cause for concern.

At his Jackson Hole appearance last August, Chairman Powell announced the implementation of a revised operating framework for the Federal Reserve. Under the new mandate, the Federal Open Market Committee (FOMC) will “seek to achieve inflation that averages 2 percent over time” (Powell 2020). As a consequence, were they to materialize, inflation overshoots would arguably be less likely to induce expectations of immediate monetary policy tightening. In the most recent FOMC minutes at the time of writing, the guidance was reinforced by projecting no interest rate increases until at least the end of 2023. From this standpoint, it is unlikely that in the immediate future material divergence in the monetary policy stance of the major central banks would arise due to COVID-19-induced inflation risk, and that exchange rate pressures may ensue for this reason.

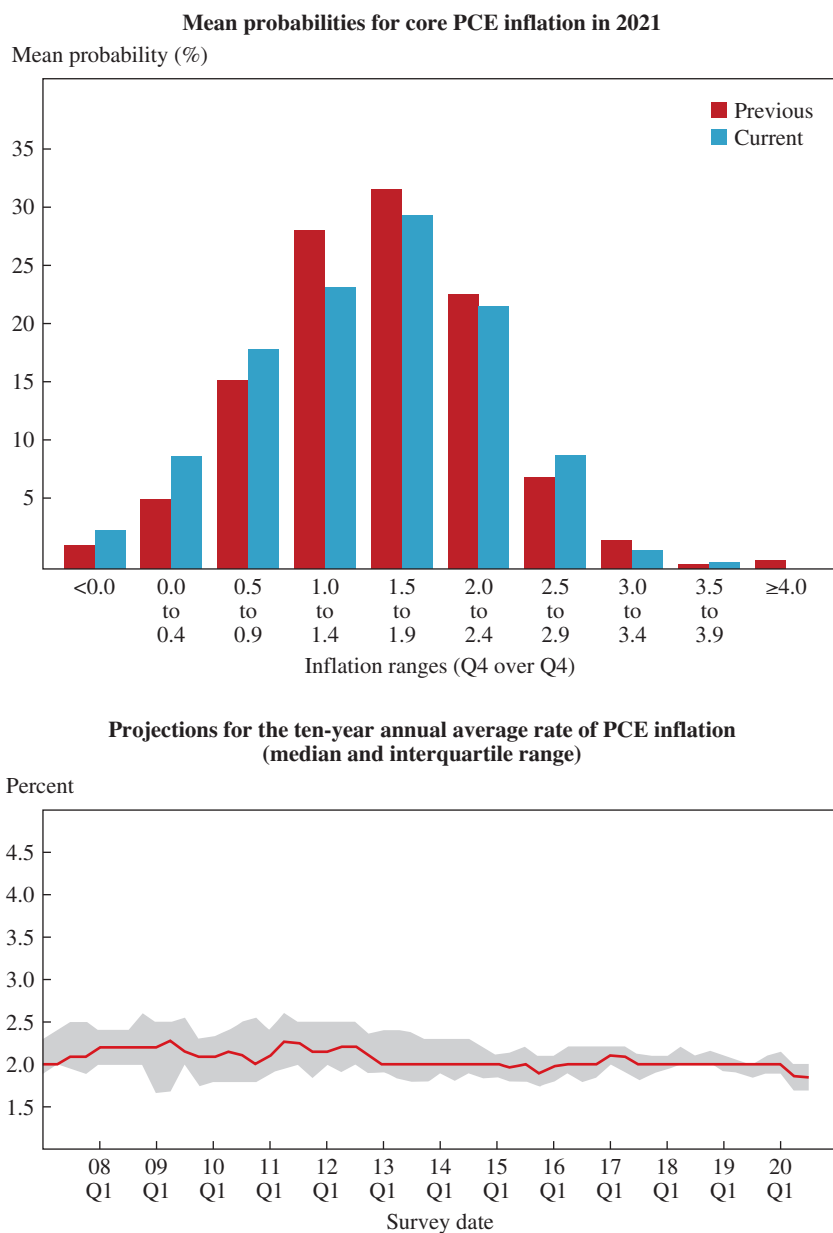
The current health crisis, however, differs from other major recession episodes, including the global financial crisis, in at least one important way: the continued depreciation of the US dollar against other major currencies. The US dollar is the safe currency par excellence, and it is the primary reserve currency and the currency of choice for invoicing and international financial transactions (Rey 2013; Gopinath 2015; Ilzetzki, Reinhart, and Rogoff 2017, 2019, 2020a, 2020b; Maggiori, Neiman, and Schreger 2020). One feature this status comes with is the fact that the dollar typically appreciates during recessions. Instead, after the initial rally in March, the dollar depreciated considerably (figure 6).

The depreciation is notable in the bilateral exchange against the euro (figure 7, left panel). The euro is the second-largest currency in global exchanges, therefore its appreciation is perhaps not entirely surprising. But the dollar depreciated also against the British pound (figure 7, right panel). It is unlikely that international markets are not keeping track of the developments around negotiations with the EU, and that the arguably higher risks of a no-deal Brexit have not been priced in. Therefore, the dollar is losing ground relative to the pound despite these significant

Figure 4. Responses of US Macro Aggregates to COVID-19 Shock



Source: Del Negro and others (2020b).
Notes: Response of GDP; unit labor costs; and wage, core PCE, and GDP deflator inflation, conditional on unemployment following the path in the first subplot, which represents the median blue chip projection; US data.

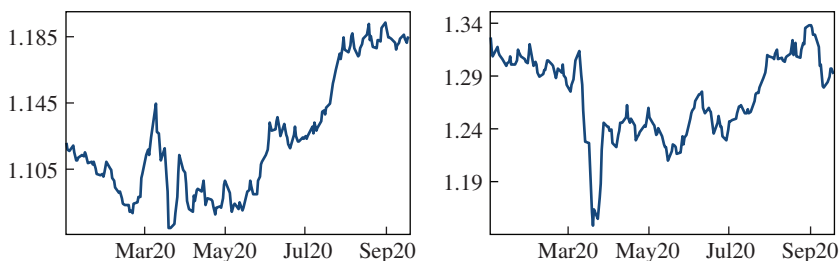
Figure 5. SPF Inflation Projections

Source: Third Quarter 2020 Survey of Professional Forecasters.

Notes: Top panel shows mean probabilities for US core PCE inflation in 2021, current SPF vintage (August 2020) versus previous quarter vintage. Bottom panel shows projections for the ten-year annual average rate of US PCE inflation.

Figure 6. US Dollar Exchange Rate Index

Source: Refinitiv.

Figure 7. Bilateral Exchange Rates against USD

Source: Refinitiv.

Notes: Left panel shows the bilateral EUR-USD exchange rate. Right panel shows the bilateral GBP-USD exchange rate.

UK-specific risks. This suggests that the motives behind this broad-based dollar depreciation may be specific to the United States.

The United States typically behaves as a world banker (Gourinchas and Rey 2007b). Issuing the international currency confers to the hegemon excess returns on its net foreign asset position in normal times (“exorbitant privilege”; Gourinchas and Rey 2007a). During global crises, however, it has typically been the case that this was associated with net wealth transfers to the rest of the world, due to the joint action of dollar appreciations and

stock market devaluations (“exorbitant duty”; Gourinchas, Rey, and Govillot 2010). In the current conjuncture, and despite the global recession, stock markets are trading at record highs, while the dollar is depreciating. As noted in Gourinchas, Rey, and Sauzet (2019), one of the key underpinnings of the international monetary and financial system is that the hegemon provides safe assets to the rest of the world. But safety is a relative concept and ultimately rests on confidence. It is entirely possible that the recent swings in FX markets may be the result of temporary speculative positioning motivated by a search for yield. However, the dollar depreciation may also signal a shift in investors’ appetite away from US assets. As the world battles its way out of the global pandemic, the United States faces the extra burden of maintaining its status as the provider of a stable and safe global currency in times of crisis. The combination of high levels of debt (public and external) and weak fundamentals resulting from the COVID-19-induced disruption may prove unsustainable. Political and global geopolitical factors could become first order. Risks to the stability of the international monetary system may be closer than they appear even in times of extremely low interest rates and subdued inflation for years to come.

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GENERAL DISCUSSION Alan Blinder started the discussion by acknowledging that the authors' explanation that exchange rate volatilities are lower than in the past due to the decline in the volatility of inflation and interest rates made intuitive sense. However, Blinder wondered whether this trend has been mainly driven by the fact that whenever the mean of a series decreases over time—as has been true of inflation and nominal interest rates—its standard deviation is also very likely to decrease. Therefore, Blinder suggested, it would be more illuminating to consider the coefficient of variation (the ratio of the standard deviation to the mean). During the presentation, he did some rough calculations which indicated that the coefficient of variation for the series hadn't changed much, as both the mean and the standard deviation decreased at the roughly same rate.

Finally, Blinder agreed with Silvia Miranda-Agrippino in finding it puzzling that, unlike during prior crises, there hadn't been a flight to quality directed at the United States and asked if anyone knew why.

In response to Miranda-Agrippino's discussion, Ethan Ilzetzki showed the audience a graph, featured in their presentation, of the exchange rate levels of the euro and yen from 1999 to 2020 in order to illustrate the markedly visible decline in exchange rate volatility after 2014. In particular, Ilzetzki contrasted the gyrations of both exchange rates following the 2008 global financial crisis with a very muted response to the COVID-19 crisis. This observation, he argued, put the decline in volatility into a broader perspective. Moreover, he emphasized that the facts discussed in the paper weren't solely about the COVID-19 crisis. The flatlining of the exchange rate levels occurred well after the swap lines of the global financial crisis were gone and before the swap lines of the COVID-19 crisis came into play. Therefore, he reasoned that the swap lines alone can't explain the break after 2014.

Next, Ilzetzki revisited Miranda-Agrippino's point that the implied volatility of currencies is highly correlated with the implied volatility of stocks.

He pointed out that while the stock market in 2020 showed the highest readings of volatility in 150 years, the increase in exchange rate volatility had been modest. In particular, he suggested the blip in volatility was comparable to the unmemorable month of February 2016. Therefore, he argued that the volatility decline was related to currency risk and not generalized risk. While admitting the swap lines explanation met that criteria, he countered that it failed to explain why January 2020, prior to the COVID-19 crisis and the resultant swap lines, was the lowest period of implied volatility on record.

Kenneth Rogoff thanked Miranda-Agrippino for her comments. Rogoff clarified that while the authors didn't believe that central bank policy had been ineffective, they drew a distinction between conventional policy—such as interest rate policy—in which central banks have independence with other policies in which central banks essentially operate as extensions of the treasury. Since exchange rates depend on both past interest rates and expectations of future interest rates he emphasized that one crucial aspect of the COVID-19 crisis was that, on top of central banks hitting the zero lower bound, markets viewed the neutral or equilibrium policy rate to be significantly negative for years to come.

Carmen Reinhart turned to Blinder's question on the depreciation of the dollar by saying she did not claim to know the answer and explaining that currency cycles are notoriously difficult to predict. On the larger question of whether the COVID-19 crisis would undermine the dollar's dominance, Reinhart argued that major alternatives to the dollar were difficult to contemplate. However, she suggested that the large outstanding debt of the United States paired with the decline in the United States' share of global GDP—largely due to the increasing share of China's GDP—could ultimately undermine the Bretton Woods II system.

Finally, Reinhart highlighted the role played by the synchronicity of policy responses in major economies during the global financial crisis and the COVID-19 crisis to the decline in currency exchange rate volatility.

Şebnem Kalemli-Özcan stated that emerging markets' interest differentials and their inflation rates have also been going down for some time—albeit not to the same extent as those of high-income countries.¹ Kalemli-Özcan then asked the authors whether, based on these trends, one

1. Şebnem Kalemli-Özcan, "US Monetary Policy and International Risk Spillovers," in *Economic Policy Symposium Proceedings: Challenges for Monetary Policy* (Jackson Hole, Wyo.: Federal Reserve Bank of Kansas City, 2019). <https://www.kansascityfed.org/-/media/files/publicat/sympos/2019/2019ozcan.pdf?la=en>.

should expect emerging markets' exchange rate volatility to go down as well. If so, she wondered whether the authors thought that the reason this hadn't happened yet had to do with emerging markets, unlike high-income countries, responding to exchange rate volatility as part of their monetary policy.

Reinhart stated that the conduct of monetary policy in emerging markets was new territory. The COVID-19 crisis was the first time in which emerging markets adopted countercyclical monetary policy across the board. In prior crises, emerging markets typically raised interest rates in order to protect their currencies. Nevertheless, Reinhart cautioned that she was leery of what to expect on the inflation front due to the lasting effects of supply shocks—which she expected to play out most imminently in emerging markets.

SESSION FOUR
Business Dynamics and Policy

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Has the Paycheck Protection Program Succeeded?

ABSTRACT Enacted March 27, 2020, the Paycheck Protection Program (PPP) was the most ambitious and creative fiscal policy response to the pandemic recession in the United States. PPP offers forgivable loans—essentially grants—to businesses with 500 or fewer employees that meet certain requirements. In this paper, we present evidence that PPP has substantially increased the employment, financial health, and survival of small businesses, using data from Dun & Bradstreet, Inc. We use event studies and standard difference-in-differences models to estimate the effect of a small business applying for larger PPP loans and of a small business being eligible for PPP based on size. While our findings are informative, we believe it is too early to issue conclusive judgment on PPP's success. We offer lessons for the future from the PPP experience thus far.

The Paycheck Protection Program (PPP) was the most ambitious and creative—and, potentially, the most important—fiscal policy response to the pandemic recession in the United States. With a \$670 billion budget from April through August 2020, the program was the largest single component of the nation's fiscal policy response to the crisis during that period, and by itself it approaches the total amount spent by Congress on the American Recovery and Reinvestment Act of 2009 in response to the Great Recession.

Conflict of Interest Disclosure: The authors did not receive financial support from any firm or person for this paper or from any firm or person with a financial or political interest in this paper. They are currently not officers, directors, or board members of any organization with an interest in this paper. No outside party had the right to review this paper before publication.

PPP was enacted on March 27, 2020, as part of the Coronavirus Aid, Relief, and Economic Security (CARES) Act, the \$1.8 trillion “phase 3” response to the pandemic crisis. An entirely new program, PPP began issuing loans seven days later, on April 3. Lending under PPP continued until August. PPP offers forgivable loans—essentially, grants—to businesses with 500 or fewer employees that meet certain requirements, including maintaining employment at prepandemic levels.

Has it succeeded? In this paper, we present evidence that PPP has substantially increased the employment, financial health, and survival of small businesses. In addition, we find that the effect of PPP on small business outcomes is increasing over time, with larger effects in August than in April or May. We also find some evidence to suggest that PPP was most effective for relatively smaller firms. We use data from Dun & Bradstreet for our analysis, employing standard difference-in-differences models to estimate the effects of a small business applying for a PPP loan of greater than \$150,000 (we only observe PPP applications for loans of that size) and of a small business being eligible for PPP based on size and using event studies to trace the dynamic effects of PPP.

Despite this finding, our ultimate conclusion is that it is too early to issue any definitive judgment on PPP’s success. The program had important short-run goals, to be sure. These include supporting employment and replacing worker wages, maintaining worker-firm attachments, boosting consumer spending, and ensuring small business continuity during the shutdown. But the program had important medium-run goals, as well, including preventing a wave of bankruptcies once the economy partially reopened; increasing productivity by preserving firm-specific human capital, worker-firm matches, and networks; and helping the economy recover faster by keeping workers off the unemployment rolls. Our data run through August, and we cannot adequately investigate any of these outcomes. The effects of PPP are unfolding, and it will be particularly important to see what happens to businesses that received PPP and the workers they employ once they have exhausted their forgivable loan.

PPP is a novel program, and many standard intuitions about fiscal policy do not apply to it. It was not a stimulus program in the sense that its purpose was not to stimulate the economy; that is, it is not a program calling for a measure of the multiplier. Instead, its purpose was to preserve the productive capacity of the small business sector and to shorten the transition to a new, post-pandemic equilibrium by supporting labor demand over the medium term, allowing for a more rapid economic recovery. It was

not a jobs program in the sense that its goal was not exclusively to preserve employment. Instead, its goals were to maintain worker-firm attachments, particularly during the shutdown, and to ensure small business continuity. It intentionally did not attempt to exclude inframarginal recipients because the unique circumstances under which it was enacted made this impractical. In the early days of the shutdown, how could the government have known which firms were inframarginal? And given the numerous goals of the program, it's not clear how *marginal* would be defined in this context. These design features affect intuitive measures of the cost per job saved, as we describe later.

In this paper, we discuss the need for, goals of, and key design features in a small business revenue replacement program (section II). We then describe PPP and contrast select features of the program to what we view as the best design (section III). We discuss the program's implementation challenges—extensively covered in the press—and offer qualitative analysis of PPP (section IV). In section V, we present our empirical analysis of PPP. In section VI, we offer a retrospective and discuss lessons for the future.

I. The Pandemic Recession and Potential Policy Responses

The pandemic recession is remarkable in both its suddenness and depth. In the week ending March 14, 2020, there were 282,000 initial claims for unemployment insurance benefits, about one-third higher than the average number of new claims over the preceding three months. The next week, there were 3.3 million initial claims, shattering the previous record of 695,000 new claims set in October 1982. The week after that, ending March 28, there were 6.9 million initial claims.

The unemployment rate in February 2020 was 3.5 percent. In March, the first month of the pandemic recession, it stood at 4.4 percent. In April, it hit its peak of 14.7 percent, the highest rate since the Great Depression.¹ In two months, the official unemployment rate increased by a factor of four.

1. The official unemployment rate reported by the Bureau of Labor Statistics for April 2020 was 14.7 percent. The household survey on which the unemployment rate is calculated showed a large increase in the number of respondents who were classified as employed but absent from work. Most of these responses should have been classified as unemployed on temporary layoff. Incorporating this change, the actual unemployment rate for April was likely 19.5 percent.

For comparison, during the Great Recession it took nearly two years for the unemployment rate to double, from 5 percent when the recession began in December 2007 to its peak of 10 percent in October 2009.²

The pandemic's economic devastation extended beyond the labor market. Real GDP contracted at a 31.4 percent annual rate in the second quarter of 2020. Using the same measure, the worst quarter in the Great Recession saw an 8.4 percent decline, and the only quarter since the Great Depression to register a double-digit contraction was 1958:Q1, at 10 percent. Relative to the same quarter one year prior, 2020:Q2 real GDP contracted by 9 percent. The peak contraction using this metric in the Great Recession was 2009:Q2 at 3.9 percent.

Some of the ways policy needed to respond to this unprecedented economic crisis were relatively straightforward. The Federal Reserve needed to support the economy and to ensure liquidity and smooth functioning in financial markets. Social insurance and safety net programs needed to be strengthened, and their gaps needed to be plugged. Large businesses, with diversified revenue streams and access to capital markets, could be supported with lending programs.

But policy to support small and midsize businesses was harder to formulate. The need for a prolonged shutdown made interruption loans for such businesses inadequate, and even with a more conventional loan many businesses would likely not be able to survive. Firms needed more equity to shore up weakening balance sheets and replace lost cash flows and many businesses would not be interested in adding to debt burdens in any case. Equity injections were not implementable for many firms of this size, and operationalizing a program based on them would be extremely difficult to do in the time needed. The best available option was a revenue replacement program for small business.

II. A Small Business Revenue Replacement Program

The pandemic recession created the need for a revenue replacement program for small businesses. In this section, we discuss that need.³ We argue that the goals of such a program should be twofold: to ensure small business continuity and prevent a cascade of small business failures, and to

2. For research on the labor market effects of the pandemic, see Bartik, Bertrand, and others (2020), Coibion, Gorodnichenko, and Weber (2020), Goolsbee and Syverson (2020), and Forsythe and others (2020).

3. This section draws on Hubbard and Strain (2020) and Strain (2020).

preserve existing employment relationships while shelter-in-place orders are in effect. We offer our view on some key program design features to achieve these goals. We also address moral hazard concerns and briefly review programs enacted by other major economies.

II.A. The Need to Replace Small Business Revenue

The pandemic itself can be thought of as a large shock to aggregate supply: businesses could no longer produce goods and services because workers could not safely go to work. The inability of workers to work caused downstream supply chain disruptions, as well.

Shelter-in-place orders ameliorated the supply shock by reducing the spread of the coronavirus. The catch is that these policies led to a precipitous drop in aggregate demand, including labor demand (Forsythe and others 2020) as businesses were temporarily closed and workers lost jobs, faced reductions in hours, and experienced nominal wage cuts (Cajner and others 2020). In the private economy, workers faced a large reduction in earned income and businesses lost revenue.

The sharp and sudden nature of the pandemic recession left smaller firms in the service sector particularly at risk. Unlike larger businesses, these firms could not readily access capital markets to shore up their balance sheets. Capital market imperfections link equity contractions to business fluctuations, and these firms were particularly vulnerable to a lack of collateralizable net worth (Gertler and Hubbard 1988). Small and midsize businesses generally do not have diversified revenue streams, as well. And they have limited cash holdings. Only half of small businesses hold cash reserves sufficient to cover fifteen days, and only four in ten have a three-week cash buffer (Farrell, Wheat, and Grandet 2019).

And unlike manufacturing firms, businesses in the service sector would not return to partial operations with a backlog of orders following the lockdowns. Nearly all of the revenue they lost during the lockdowns was lost forever—for example, diners did not eat twice as many meals out in May and June because restaurants were shut in March and April.

To summarize, the economy was at risk of a cascade of small business bankruptcies. Small businesses play a critical role in the economy. In 2019, firms with fewer than 500 employees accounted for 47 percent of private sector employees and 41 percent of private sector payroll. There were 30.7 million such businesses, 19 percent of which had paid employees (US Small Business Administration 2019). A wave of small business failures could have created an aggregate demand doom loop, in which declining incomes and employment opportunities reinforced each other.

One way to address this concern would have been to lift lockdown orders. But the public health effects of the virus and concern workers had about getting sick would have made this strategy ineffective. The best option for the federal government in a short, temporary shutdown was to make up a large fraction of revenue businesses would have generated in normal times. We return later to the challenges posed by longer-term partial shutdowns.

II.B. Goals, Cost, and Key Design Features

The specific goals of such a program are to ensure small business continuity and prevent a wave of bankruptcies and, during the period of the shutdown, to preserve employment relationships. The overarching objective is to preserve as much of the productive capacity of the economy as possible while short-term shelter-in-place orders are in effect and to help the economy transition quickly to a new, post-shutdown equilibrium by supporting labor demand over the medium term.

For firms, preventing wasteful liquidations allows the black box of productive technologies and business relationships to remain intact. Professional networks are preserved, relationships with suppliers and customers are maintained, and knowledge of local conditions and preferences can continue to be put to productive use. For workers, the value of firm-specific human capital is maintained, and maintaining employment relationships means they continue to be paid by their employer, and they are in a position to return to work immediately once shelter-in-place orders are lifted. No separation takes place, not even a temporary furlough of workers. For both workers and firms, productivity enhancing worker-firm matches are maintained. And the economy is in a position to snap back quickly because labor demand has been supported.⁴

This observation is especially true in a lockdown because the risk of mass closures is so real. Without a program to support small business continuity, a wave of closures would be followed by a period in which new businesses started. Eventually, the economy would reach a new equilibrium.

4. Papers that discuss the role of worker-firm matches include Mortensen and Pissarides (1999) and Davis and von Wachter (2011). Jackson (2013) measures match quality directly in the context of schools, estimating teacher, school, and match productivity on student outcomes. He finds that teacher-school (worker-firm) match effects are important, estimating that a one standard deviation increase in match quality increases math scores by an amount roughly equal to two-thirds of the effect of a one standard deviation increase in teacher quality. Using linked worker-firm data, Farooq, Kugler, and Muratori (2020) document an important role for match quality and find that more generous unemployment insurance benefits lead to higher quality matches. In our context, match quality likely matters the most for larger PPP-eligible firms.

But during the transition, labor demand would be depressed because there would be fewer businesses looking for workers, which would lead to lengthy spells of unemployment for millions of workers and a slower and more sluggish recovery.

Because the (aggregate, present discounted value of) social benefits of these businesses exceed their (aggregate, present discounted value of) costs, a subsidy is justified under standard economic logic. Particularly given the possibility of an aggregate demand doom loop and the lengthy period of high unemployment it would cause, we argue that in the context of the pandemic, the appropriate revenue replacement rate is large.

Once lockdown orders are lifted, partial revenue replacement may still be needed. But it is no longer necessary or economically desirable to compel firms to maintain pre-lockdown employment relationships or employment levels. After the economy has partially reopened, policy should not introduce frictions into the process of reallocating labor (and capital) to its post-lockdown most productive use, and policy should allow firms the flexibility to reorganize their post-lockdown production functions to further the key overall goal of a revenue replacement program: ensuring small business continuity.

There is an inherent tension between a revenue replacement program's goal of maintaining employment relationships and keeping firms in business and the goal of efficiently reallocating factor inputs and swiftly transitioning to a new, post-lockdown equilibrium. But for the reason we discussed earlier, there is less to this tension than meets the eye in this case. A revenue replacement program allows that transition to happen faster by preserving many otherwise viable firms during the shutdown. Once the economy has partially reopened, severing the link between program participation and maintaining prepandemic employment levels is critical to minimizing this tension. And a revenue replacement program should be of limited duration following the reopening of the economy. A revenue replacement program may also keep some businesses afloat that would have shut down in the absence of the pandemic. Presumably most businesses that were not viable prior to the pandemic will remain unviable once the revenue replacement program has ended.

These considerations emphasize the need for the revenue replacement program to focus on revenue, not simply on payroll costs. A separate reason to focus on revenue rather than narrowly focusing on payroll costs is that nonpayroll expenses, like rent in many cities, are significant. A program replacing payroll costs but not overall revenue may not be sufficient to keep many businesses in high-rent cities from closing.

Replacing small business revenue is an expensive proposition. Hubbard and Strain (2020) estimate that replacing 80 percent of revenue for twelve weeks for service sector businesses—that is, for businesses in industries other than manufacturing, finance and insurance, health care, and educational services—with fewer than 500 employees would cost \$1.2 trillion.

Expensive as such an intervention is, the counterfactual would be even costlier, with cascading business failures, wasteful liquidations, plunging incomes, soaring unemployment, and little prospect for a rapid recovery because of the devastating effects on the small business ecosystem. Another budgetary consideration is the offsetting effects of less use of social insurance programs, like unemployment insurance, and safety net programs, like food stamps.

So far, our discussion of a small business revenue replacement program has been general and could be applied to any situation in which small, service sector businesses needed to shut down for a period of several weeks. A key feature of the pandemic recession is that such a program did not exist, and Congress needed to create one quickly. Given this context, it was best for Congress to rely on the existing relationships many small businesses have (via checking accounts or loans) with commercial banks rather than to have had the government attempt to set up an entirely new direct transfer program.

The government should have treated the banks essentially as conduits to get money into business accounts as quickly as possible. Of course, such an approach requires convincing banks that they will be held harmless in the event of borrower misrepresentation, both by the current administration and by future administrations. Strong assurances are necessary.⁵

To align better with an equity infusion, the revenue replacement grants should be structured as loans that are forgivable if certain conditions are met and should be fully backed by the government; that way banks assume no risk. Banks should be allowed to charge fees, paid for by the government, as an incentive to participate and for administrative costs.

5. Prior to the 2008 financial crisis, large US banks routinely made Federal Housing Administration (FHA) loans designed to help first-time home buyers and buyers with relatively poor credit purchase houses. To reach these borrowers, the government encouraged lax lending standards. This policy shift contributed to the housing bubble, and FHA's solvency was in question following the crash. The government imposed fines on banks, arguing they did not adhere to FHA underwriting standards. The revenues from the fines helped to shore up FHA. This episode has left many large banks skittish about using anything but strict underwriting standards as part of government lending programs.

Forgivable loans (i.e., grants) are necessary for the program to succeed. The pandemic shutdown's adverse consequences for firms' collateralizable net worth and cash flows require equity contributions. Loans, even with low interest rates and long maturities, would likely be insufficient given the need for equity financing. Service sector businesses permanently lose revenue in a shutdown, and many would likely rather lay off workers than take on additional debt. Even if debt service could be deferred for a period of one or two years, many would be reluctant to take out a loan.⁶ These businesses often have low profit margins, and a loan program would likely have had an insufficient take-up rate to meet policymakers' objectives.⁷ If the only concerns were cash flow challenges and a lack of access to equity capital, then a lending program might be all that is justified. But as we argued above, the divergence between the private and social value of small business continuity suggests that subsidies are justified using standard economic logic, particularly during the shutdown period. (In section VI, we discuss how a lending program might complement grants once the economy has partially reopened.)

A revenue replacement program should be broad-based and should avoid too much targeting. In the fog-of-war atmosphere of the pandemic, policymakers have limited knowledge of the virus's spread, and crafting an effective triggering mechanism based on public health metrics is difficult. The government should avoid picking winners and losers by targeting the program to select industries.

Revenue tests or demonstrations of hardship should also be avoided. At the beginning of a sudden and unexpected lockdown, demonstrations significantly slow down the process of getting funds to businesses, putting the effectiveness of the program in jeopardy. Once the economy partially reopens, it can be argued that revenue tests target assistance to firms that need it most, as measured by revenue loss relative to normal circumstances. But forward-looking revenue tests serve as a disincentive to earn revenue by imposing implicit marginal tax rates on revenue. Backward-looking revenue tests avoid this disincentive but are less generous to otherwise

6. For a proposal that argues in favor of lending programs, see Ozimek and Lettieri (2020). Hanson and others (2020a) argue for equity-like arrangements and grants to support small business. Hanson and others (2020b) argue for payment assistance to impacted businesses to meet recurring fixed obligations (e.g., interest, rent, and utilities) during the health emergency.

7. At the time of this writing, the Federal Reserve's Main Street Lending Facility has very few loans, suggesting that even among midsize businesses taking on debt under terms that are not borrower-friendly is not an attractive prospect.

identical firms that are doing better adjusting to the post-lockdown economic circumstances.

The main appeal of revenue tests and hardship demonstrations are lower program costs and targeting aid based on “need.” The problem is that need is an amorphous concept in a partially reopened economy, and revenue tests bring their own problems. The best targeting strategy is broad-based, focusing on a large class of firms defined by size and industry type.

II.C. Addressing Moral Hazard Concerns

A program that replaces revenue for small businesses for a period of time is an extraordinary government intervention in the private economy. It is reasonable to be concerned that such a program would lead to excessive risk taking or other imprudent behavior on the part of firms by potentially creating the perception of a government “business revenue safety net.”

In normal public programs under normal circumstances, this concern is certainly real. But in this instance, we are much less concerned about moral hazard. The need to shut down large segments of the economy will occur infrequently, and without advance notice. Businesses cannot purchase shutdown insurance from private firms in the way they can insure against risks from fires and floods. Government should communicate the extraordinary nature of the assistance is driven by the extraordinary nature of the threat. This step should mitigate moral hazard concerns.

II.D. Policy Response in Other OECD Nations

Before turning to the Paycheck Protection Program, we briefly discuss programs enacted by member countries in the Organisation for Economic Cooperation and Development (OECD) during the pandemic recession. See table A1 in the online appendix for specific program descriptions and parameters for OECD countries.

Many European nations relied on a version of a wage subsidy scheme in which workers saw their hours and pay reduced and their government picked up a large part of the cost of employing them.⁸ This type of program

8. Hamilton and Veuger (2020) argue that large expenditures to address the pandemic will heighten concern about the public finances of some European Union member states, implying that a broader European approach to fiscal policy is necessary. They suggest that the eurozone issue Eurobonds to placate markets and to avoid issues associated with sovereign debt overhang.

was used by Germany (*Kurzarbeit*, or short-term work) during the Great Recession and is widely credited with keeping the German unemployment rate down during that period. The way it often worked was that firms paid the benefit to their workers, which was typically somewhat lower than wages, and the government reimbursed the firm (Blanchard, Philippon, and Pisani-Ferry 2020). Austria implemented a similar program during the pandemic, replacing up to 90 percent of covered wages.

A few examples: In the United Kingdom, the government reimbursed firms for 80 percent of the wages of furloughed workers. Germany covered 60 percent of wages for childless workers on furlough and 67 percent for furloughed workers with children. Depending on the month, the government of France covered 84 percent or 72 percent (as of June) of wages for workers on temporary layoff. Notably, these countries did not condition eligibility based on firm size, in contrast to the United States' emphasis on small and midsize firms. Some European economies conditioned subsidies on a demonstration of a significant decline in revenue (e.g., the Netherlands, Estonia, and the Slovak Republic). Slovenia emphasized state-funded bonuses for hazard pay in certain sectors.

These programs are similar to what we describe above. They maintain the worker-firm relationship during the shutdown period, making it easier for workers, firms, and the economy to recovery quickly once economic activity partially resumes. Keeping workers paid by the firms also allows government assistance to reach workers quickly. Such programs are similar to standard unemployment insurance in that the government is helping support the incomes of workers who are underemployed, but unlike standard unemployment insurance, they allow for part-time work.

At the same time, European programs have been more focused on supporting workers in their current employment matches, rather than smoothing a transition toward different employment matches. Programs generally permitted workers receiving nonwork or part-time work benefits to remain attached to the firm. As with the US Paycheck Protection Program, the state effectively assumed a portion of payroll costs for covered workers, albeit through payments made to firms.⁹ The US program formally worked as a combination of loans and outright grants to firms and wage subsidies.

9. Norway relied on layoffs, making it easier for firms to use temporary layoffs and increasing the generosity of unemployment benefits for workers. Norway also instituted a new compensation scheme for businesses that subsidized fixed costs. Alstadsæter and others (2020) find that this program reduced firms' economic distress by a similar magnitude to PPP by reducing the negative effects of the crisis on profitability, liquidity, debt, and solvency.

As we describe later, a number of administrative challenges were “unforced errors” in its implementation.

While some European pandemic unemployment or wage subsidy schemes have faced fewer administrative challenges than in the United States, they still raise concerns (to which we return later). Importantly, they were and are designed to maintain employment relationships in a temporary cyclical downturn (e.g., a moderate and short recession or a short pandemic shutdown). In a reopening of the economy, policy shifts would be needed to focus on rehiring workers and worker transitions by gradually reducing wage subsidies and the generosity of unemployment benefits.

Employment policy responses in OECD countries outside Europe during the pandemic have been varied. Canada, for example, focused on rehiring workers previously laid off due to the COVID-19 pandemic, with subsidies of up to 75 percent of all covered wages. Israel relied on relaxing requirements for unemployment benefits, direct and government-guaranteed loans to businesses of all sizes, special support for high-risk businesses, grants for small businesses, and a variety of measures to reduce the short-term burden of business taxes. Australia, like large European economies, implemented a wage subsidy for firms’ retention of employees. Japan financed wage subsidies for retained workers, but only for small and midsize firms. South Korea increased worker retention subsidies to up to 90 percent of covered wages for three months for all employers. A less generous subsidy to wages was provided in South Africa for firms whose operations were at least partially curtailed as a consequence of the COVID-19 pandemic.¹⁰ In Latin America, Chile provided partial support for wage declines, and Colombia assisted workers in firms with significant revenue declines with support of 40 percent of the minimum wage.

III. The Paycheck Protection Program

The Paycheck Protection Program (PPP) was created by the CARES Act, the \$1.8 trillion “phase 3” economic recovery package passed by Congress and signed into law on March 27, 2020. In this section, we outline the statutory design of PPP, the program’s implementation by the Department of the Treasury and Small Business Administration, and the differences between PPP and the features of a small business revenue replacement program we discussed in the previous section.

10. South African Government, “Support to Business,” <https://www.gov.za/covid-19/companies-and-employees/support-business#>; accessed August 21, 2020.

III.A. PPP's Design

PPP is a forgivable loan program. Businesses or nonprofits with 500 or fewer employees; sole proprietors, independent contractors, or self-employed individuals; and small businesses, 501(c)(19) veterans organizations, or tribal business concerns that otherwise meet the Small Business Administration's (SBA) size standards are eligible. Businesses in the accommodation and food services sector (North American Industry Classification System, or NAICS, code 72) may apply the 500 employee rule to each physical location, not to the corporation as a whole. Congress appropriated \$349 billion for PPP in the CARES Act.

Under the program, businesses can borrow up to two and a half times their average monthly payroll costs, capped at \$10 million. Loans are issued by banks and are guaranteed by the government.¹¹ The amount of the loan spent on payroll costs (including benefits), rent, utilities, and mortgage interest during the twenty-four-week period (originally eight-week period) after the loan is originated is forgiven—that is, it is converted to a grant—provided that 60 percent (originally 75 percent) of the amount forgiven is spent on payroll (a Treasury/SBA regulation not found in the CARES Act) and that the business does not reduce headcount relative to precrisis levels and does not reduce any employee's compensation by more than 25 percent of his or her precrisis level. If headcount or compensation is reduced beyond those parameters, the amount of the loan forgiven may be reduced proportionately under some (but not all) circumstances. PPP encouraged businesses that had already laid off workers due to the pandemic to rehire them quickly without penalty.¹²

11. Financial technology (fintech) played an important role, as well. Erel and Liebersohn (2020) study the response of fintech to demand for financial services created by PPP. They find that fintech was disproportionately used in zip codes with fewer bank branches, lower incomes, and larger minority share of the population, in industries with less ex ante small business lending, and in counties where the economic effect of the pandemic was more severe.

12. Rules for loan forgiveness and for loan forgiveness reduction have been evolving. At the time of this writing, loans can be fully forgiven if loan proceeds are spent and qualifying costs are incurred during the covered period of the loan, which begins when the loan is disbursed (or during an alternative covered period, depending on how the borrower manages payroll); at least 60 percent of the loan amount (originally 75 percent) was used on payroll costs; and staffing and compensation levels are maintained in the covered period relative to the reference period. The covered period is twenty-four weeks for loans made after June 5, 2020. For loans made before June 5, 2020, borrowers can choose between a twenty-four-week or eight-week covered period. Borrowers can choose one of two reference periods: February 15, 2019, to June 30, 2019, or January 1, 2020, to February 29, 2020. (Seasonal employers have different rules.) PPP also includes a safe harbor provision that allows borrowers to avoid loan forgiveness reductions due to decreases in headcount or compensation that occurred

Borrowers do not need to demonstrate hardship in order to qualify for a forgivable loan, which streamlines the process and allows banks to get money to businesses quickly. Instead, they need to offer a series of good-faith certifications, including: “Current economic uncertainty makes this loan request necessary to support the ongoing operations of the Applicant.”¹³ Borrowers must also certify that the business intends to use the funds received for payroll and other operating expenses and that they are not applying for a duplicative loan. For a loan to be forgiven, in some cases, businesses may need to present documentation to lenders demonstrating that they complied with the terms of the loan. In other cases, businesses simply need to attest to this.

To get funds to businesses quickly, PPP delegates authority to lenders to determine borrower eligibility. Given the PPP’s structure, lenders do not need to assess the ability of the borrower to repay the loan. No collateral or personal guarantees from borrowers are required, and no credit elsewhere tests are applied. Lenders simply need to establish that a business was operational on February 15, 2020, and verify its payroll.

To entice banks to participate, the program allowed them to charge generous fees—5 percent of principal on loans up to \$350,000, 3 percent on loans between \$350,000 and \$2 million, and 1 percent on loans above \$2 million up to \$10 million. Lenders can charge an interest rate of 1 percent on the portion of the loan that is not eligible for forgiveness, and loans have zero weight in banks’ capital requirements. In the statute, lenders are “held harmless” in the event of borrower misrepresentation, but the Treasury/SBA did not waive requirements under the Bank Secrecy Act and required anti-money laundering compliance programs.

The Paycheck Protection Program and Health Care Enhancement Act was signed into law on April 24, 2020, and increased PPP funding by

between February 15, 2020, and April 26, 2020, provided that headcount and compensation are restored by December 31, 2020 (originally June 30, 2020). Loan forgiveness will also not be reduced if borrowers issue written offers to rehire workers who were employed on February 15, 2020, and those offers are not accepted, or if borrowers document an inability to rehire similarly qualified workers for vacancies as of December 31, 2020. Loan forgiveness will not be reduced if borrowers cannot maintain employment levels due to an inability to return to the same level of business as of February 15, 2020, because they are complying with coronavirus-related guidance for social distancing, sanitation, or worker or customer safety requirements from various federal agencies and departments between March 1, 2020, and December 31, 2020. On October 8, the Treasury/SBA issued additional guidance that exempted borrowers with loans under \$50,001 from any loan forgiveness reductions based on failing to maintain headcount or wages.

13. Paycheck Protection Program Borrower Application Form, revised June 24, 2020.

\$320 billion. The Paycheck Protection Program Flexibility Act (PPPFA) was signed into law on June 5, 2020. The covered period of the forgivable loan was extended from eight weeks to twenty-four weeks (or until December 31, 2020). PPPFA also allowed businesses to spend 40 percent of forgivable funds on nonpayroll expenses, rather than the 25 percent previously established by Treasury/SBA regulation. The maturity of the loans was increased from two years to five years for loans issued after June 5.

III.B. Design Concerns

On the whole, PPP is well designed relative to objectives for financing during a short-term shutdown we described earlier. It was able to get an astonishing amount of money to millions of small businesses very quickly. It relied on what are essentially grants and not loans. It took measures to encourage banks to participate. It avoided revenue tests, and it did not target select industries. Its goals—ensuring small business continuity and preserving employment relationships—were the right ones.

But we have four concerns about some design elements. First, PPP is too focused on payroll expenses. The goal should have been to replace revenue, not simply to assist businesses with meeting payroll obligations. Even the payroll share for forgiveness of 60 percent after PPPFA was enacted is too high from this perspective.

Second, the program was designed with a short lockdown period in mind. This approach was reasonable given widely held expectations about the course of the pandemic in early March, and to some extent this was addressed by PPPFA modifications to the program. Even so, the program should be more flexible post-lockdown in allowing labor to be reallocated across firms and industries, a problem given a longer period of partial shutdown. PPP contains incentives that work against this needed reallocation.

Third, a major flaw in PPP's design was the original CARES Act appropriation of \$349 billion, and a major flaw in its execution was the Treasury's inability to convince banks that they would be held harmless in the event of borrower misrepresentation. Both of these flaws led to the reality and public perception that PPP funds were flowing to relatively better resourced and less vulnerable small and midsize businesses.

Finally, Hubbard and Strain (2020) estimated that the PPP's original goals would require around \$1 trillion. With only \$349 billion originally appropriated for PPP—and the intense demand for PPP loans in the early days of the program—a perception developed that only businesses with preexisting relationships with participating lenders would be able to access

Table 1. Summary of PPP Lending, April 3–August 8

<i>Cumulative lending</i>	<i>Loan count</i>	<i>Net loans (\$)</i>	<i>Number of lenders</i>	
	5,212,128	525,012,201,124	5,460	
<i>Distribution by loan size</i>			<i>% of count</i>	<i>% of amount</i>
\$150,000 and under	4,552,452	147,477,537,518	87.3	28.1
\$150,000 to \$2 million	630,694	272,228,531,130	12.1	51.9
Over \$2 million	28,982	105,306,132,476	0.6	20.1

Source: SBA Paycheck Protection Program.

the program. Lenders, in a rush to process applications and out of concern that they would not be held harmless in all circumstances, focused lending on existing bank customers.

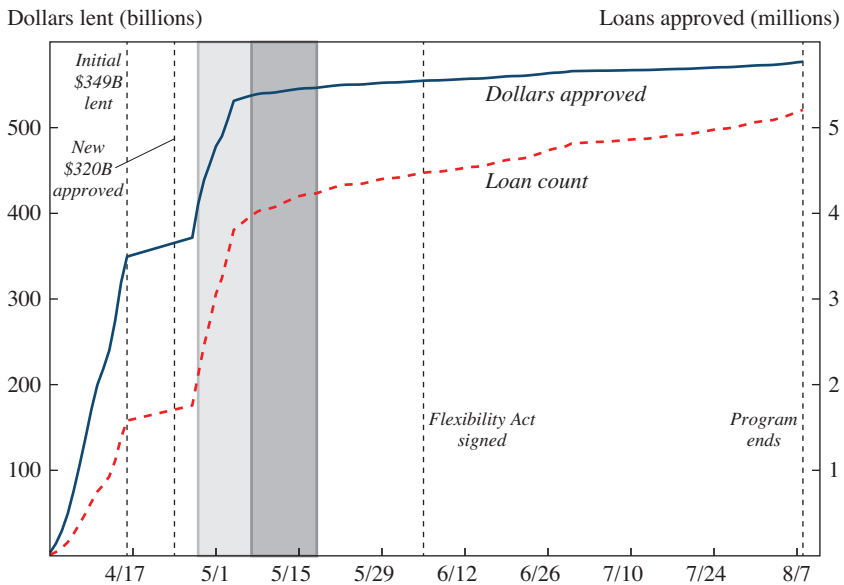
IV. Evaluating the PPP: Program Statistics, Implementation Challenges, and Existing Evidence

In this section, we present basic statistics about PPP loans and discuss implementation challenges. We also review current empirical evidence on the effectiveness of PPP.

IV.A. PPP Program Statistics

Table 1 presents PPP program statistics. As of August 8, PPP had approved 5,212,128 loans representing a total of \$525 billion provided by 5,460 lenders. The average loan size is \$101,000. The solid majority of program dollars were included in loans of less than \$2 million, and the overwhelming majority of loans were for less than that amount. Loans of over \$2 million represent 0.6 percent of all loans and 20 percent of all dollars loaned. In contrast, around 87 percent of all PPP loans were made for less than \$150,000, and 28 percent of all funds loaned were part of loans of less than that amount. Figure 1 shows loan counts and loan amounts over time.

Granja and others (2020) study the targeting of these loans across geography and do not find evidence that the first round of PPP funds went to parts of the country that saw the largest declines in hours worked or business shutdowns. Further research is needed to study the targeting of the full program. We also note that the entire country was affected by shutdowns, and the degree to which different states were affected by the

Figure 1. Cumulative Number of PPP Loans and Dollars Approved, April 3–August 8

Source: SBA and Treasury Department micro data.

Notes: This figure displays cumulative loans and dollars lent during the operation of the PPP program calculated as of August 20, 2020. Cumulative dollars lent are overstated in the micro data due to using the midpoints of loan ranges provided for loans greater than \$150,000. The shaded areas represent a period of uncertainty over audits and the safe harbor deadline. The lightly shaded area covers the total period of uncertainty over audits from April 28 (audits announced) to May 18 (final deadline to return funds under safe harbor provision). The darker area covers the period of uncertainty over the safe harbor deadline from May 7 (the original deadline) to May 18 (the final deadline).

pandemic varied at different times, particularly as the nation entered the summer months.¹⁴

IV.B. Implementation Challenges

Table 2 presents a timeline of selected PPP events and includes some implementation challenges. Before the program officially launched on April 3, banks and other industry associations were warning of a chaotic beginning to the program, arguing that borrower verification would be onerous and would hamper the government's objective of getting money

14. Figures A1 and A2 in the online appendix show loan counts and loan amounts by state and PPP loans and employment losses by industry, respectively.

Table 2. Timeline of Major Events in the PPP Program

<i>Date</i>	<i>Description</i>
March 27, 2020	CARES Act signed, appropriating \$349 billion for PPP.
April 2	Treasury/SBA releases first interim final rule; 75 percent payroll requirement; two-year repayment period; 0.5 percent interest rate; eight weeks of covered expenses; application period to June 30. Faced with complaints from small banks, the Treasury raises the interest rate on PPP loans from 0.5 to 1 percent hours before the program launch. Bank associations, JPMorgan Chase Bank, and industry associations warn of chaotic PPP launch; borrower verification requirements and payroll cost calculations are unclear.
April 3	First round of PPP officially launches; only eight of twenty-five largest SBA 7(a) lenders are taking applications. Bank of America and JPMorgan Chase begin accepting applications but only for existing customers.
April 16	First round of PPP ends; original \$349 billion appropriation exhausted. Thousands of submitted applications remain unapproved.
April 20	Small businesses sue large banks over allocation of loans. They claim that banks violated first-come, first-served rules and gave priority to larger applications that would generate more fees.
April 23	Treasury/SBA warns publicly traded companies and their subsidiaries against seeking loans; sets May 7 deadline to return funds. Treasury/SBA requires applicants to certify that the funds are necessary due to the current economic uncertainty, as well as a lack of other sources of funds to support their operations.
April 24	Paycheck Protection Program and Health Care Enhancement Act signed into law authorizing an additional \$320 billion for PPP.
April 27	Second round of PPP begins with \$320 billion in new funding. Treasury/SBA caps the dollar amount of loans that individual banks can originate at \$60 billion.
April 28	Secretary Steven Mnuchin announces full audits for loans > \$2 million and warns of criminal penalties for noncompliers.
April 29	SBA temporarily blocks large banks from submitting loans.
April 30	Justice Department launches probe of PPP. IRS confirms that PPP loans are excluded from gross income, but expenses paid for using PPP loans are not tax deductible.
May 5	Senate introduces Small Business Expense Protection Act to treat expenses paid using PPP loans as ordinary deductible business expenses. Deadline for companies to return funds without penalty under safe harbor provisions extended from May 7 to May 14.
May 8	SBA inspector general warns that the requirement of 75 percent payroll costs and two-year repayment burdens borrowers and may not reflect statutory intent.
May 13	SBA announces that loans below \$2 million would be assumed to have satisfied good-faith certification requirements; creates opportunity for larger loans to be returned without penalty. Deadline for companies to return funds without penalty under safe harbor provisions extended from May 14 to May 18.

Table 2. Timeline of Major Events in the PPP Program (*Continued*)

<i>Date</i>	<i>Description</i>
May 14	Treasury says companies must use the total number of employees to determine eligibility for PPP loans rather than full-time equivalent as indicated previously.
May 22	Treasury/SBA warn that it may review PPP loans “of any size at any time at SBA’s discretion”; borrowers required to retain documentation for six years.
June 5	PPP Flexibility Act passed; covered period extended from eight weeks to twenty-four weeks; repayment extended from two years to five years; payroll costs allowed to be 60 percent of total loan forgiveness amount, down from 75 percent.
June 12	For determining PPP eligibility, the look-back period for criminal histories for nonfinancial felonies reduced from five years to one year.
June 30	Hours before program expiration and with \$130 billion left, Congress extends the PPP application period to August 8.
July 6	Under pressure from Congress, SBA releases the names of borrowers and lenders and date of approval for loans of more than \$150,000, representing 15 percent of all approved loans and 75 percent of dollars lent. Exact loan amounts are not disclosed.
July 7	Using data released by the SBA, researchers estimate that banks will earn \$24 billion in fees from PPP loans.
July 12	New York City comptroller report alleges that the city did not receive its fair share of PPP loans.
July 17	Secretary Mnuchin asks Congress to consider automatically forgiving all loans for less than \$150,000, extending PPP, and suggesting terms for PPP in a phase 4 economic recovery package.
August 4	Businesses, lobbyists, and professional organizations ask Congress to exempt PPP income from tax reporting.
August 6	SBA releases guidelines on PPP loan forgiveness ahead of August 10 launch of forgiveness application platform. Many financial institutions delay submitting applications until regulatory and legislative uncertainty is resolved.
August 8	PPP application period closes with nearly \$140 billion in reserve as Congress debates “phase 4” economic recovery package.

Source: Authors’ compilation.

into the economy quickly, and due to confusion about basic program requirements like how lenders should calculate payroll costs. Due to confusion about the program, on the day it launched only eight of the twenty-five largest SBA 7(a) lenders were taking applications.

The early stage of PPP was also characterized by intense demand. By the end of its second week, all \$349 billion of CARES Act PPP appropriations had been exhausted. Thousands of submitted applications remained unapproved. There were accusations that large banks violated the first-come, first-served structure of the program to favor large borrowers.

Articles in the press reported that some publicly traded companies or their subsidiaries had received PPP loans. On April 23, the SBA released guidance that publicly traded companies would likely find it difficult to certify in good faith that they needed PPP loans.¹⁵ The Treasury/SBA gave businesses until May 7 (later extended to May 14 and then May 18) to return PPP funds without facing a penalty.¹⁶ On April 28, Treasury Secretary Steven Mnuchin announced that a review of PPP loans in excess of \$2 million would take place. The secretary warned of potential criminal penalties for borrowers found to have misrepresented themselves or not to have complied with the terms of the loan.¹⁷ On May 13, the SBA attempted to reassure borrowers and indicated that loans of less than \$2 million would be assumed to have made certifications of need in good faith.¹⁸

In our view, publicly traded firms or their subsidiaries should not have been eligible for PPP loans. But confusion over eligibility for PPP loans, which borrowers would be audited, and under what terms those audits would take place had a profound effect on the program.

During the period of uncertainty discussed above, shown in the light and dark gray bars in figure 1, the slope of both lines flattened. Dollars loaned have increased more slowly since this period of Treasury-sown confusion

15. See question 31, “Paycheck Protection Program Loans: Frequently Asked Questions,” <https://home.treasury.gov/system/files/136/Paycheck-Protection-Program-Frequently-Asked-Questions.pdf> (accessed August 21, 2020): “It is unlikely that a public company with substantial market value and access to capital markets will be able to make the required certification [of economic need] in good faith, and such a company should be prepared to demonstrate to SBA, upon request, the basis for its certification.”

16. See questions 43 and 47, “Paycheck Protection Program Loans: Frequently Asked Questions,” <https://home.treasury.gov/system/files/136/Paycheck-Protection-Program-Frequently-Asked-Questions.pdf>.

17. For example, Secretary Mnuchin made this statement on April 28 on CNBC: “I really fault the borrowers who made these certifications. Now, there were some banks early on who put things up on their website and prioritized their customers. We immediately told them that was wrong. They took it down. So, you know, I want to be very clear: it’s the borrowers who have criminal liability if they made this certification and it’s not true. And as I said, we’re going to do a full audit of every loan over \$2 million. This was a program designed for small businesses, it was not a program that was designed for public companies that had liquidity. Again, the certification was very clear in saying that if people had other sources of liquidity, they could not take this loan”; <https://www.cnbc.com/2020/04/28/cnbc-transcript-treasury-secretary-steven-mnuchin-speaks-to-cnbc-squawk-box-today.html>.

18. See question 46, “Paycheck Protection Program Loans: Frequently Asked Questions,” accessed August 21, 2020. <https://home.treasury.gov/system/files/136/Paycheck-Protection-Program-Frequently-Asked-Questions.pdf>: “Any borrower that, together with its affiliates, received PPP loans with an original principal amount of less than \$2 million will be deemed to have made the required certification concerning the necessity of the loan request in good faith.”

ended on May 18. New PPP loans continued to be made in the second half of May and into June and July, but at a much slower rate than in April.

Of course, implementation shortcomings were inevitable to some degree in setting up a program as ambitious as PPP in a short period of time in the midst of a pandemic. But the Treasury's muddled management of PPP's implementation is noteworthy because of its failure to take seriously the advice it was given by a range of private sector participants and policy experts, leading it to make mistakes that were both forecastable and forecasted.

IV.C. Brief Review of Existing Economic Research on the PPP

Study of the PPP by academic researchers is still in the working paper stage, but some notable findings exist that shed light on the early effects of the program. Bartik, Cullen, and others (2020) study the original \$349 billion of PPP funds. Using a survey of small businesses, they find that PPP approval increased self-reported firm survival probability by 14 to 30 percentage points. They also find that banks allocated PPP funds to firms with higher PPP treatment effects. But these firms were also more likely to have stronger connections to banks, while firms with less cash on hand were less likely to have their applications approved. They find that PPP had a positive but statistically insignificant impact on employment.

Quite modest employment effects are also found by Chetty and others (2020), who analyzed data from Earnin, a financial management application.¹⁹ Granja and others (2020) also do not find evidence that the first round of PPP had a substantial effect on employment or on other local economic outcomes. Bartik, Bertrand, and others (2020) find that states that received more PPP loans and those with more generous unemployment benefits had labor markets whose declines were relatively less deep and whose recoveries were relatively more rapid. Chodorow-Reich and others (2020) find that PPP relaxed liquidity constraints facing firms, allowing some firms to pay down existing credit line balances.

Autor and others (2020) use weekly data from ADP, Inc., payroll records to study PPP's effect on employment. Using a difference-in-differences event study framework, they compare employment at firms above and below the 500 employee PPP eligibility threshold. Through the first week

19. Autor and others (2020) discuss limitations in the study by Chetty and others (2020), including that Earnin data are focused on very low-wage workers, with median wages equal to roughly the 10th percentile of wages in their industry, and that the absence of reported standard errors makes the study results hard to interpret.

of June, they find that PPP increased employment by between 2 percent and 4.5 percent. After scaling by the take-up rate, they estimate PPP increased aggregate payroll employment by 2.3 million workers, again through the first week of June.

Autor and others (2020) divide total program expenditures by their estimate of PPP's effect on aggregate employment and report a cost per job supported estimate of around \$224,000. The paper notes that "while this is a substantial cost per job supported, it would be premature to offer a cost-benefit analysis of the PPP at this time" and points to the need to take a longer-term view of PPP's effects. We agree and would add that a short-term cost-benefit analysis should include other factors. For example, many workers who were kept on employer payrolls this spring would likely have been receiving unemployment insurance benefits in the absence of PPP. A short-term cost-benefit analysis should include cost savings from reducing the demand for social insurance and safety net benefits.

More fundamentally, we disagree with Autor and others (2020) in that we do not find cost per job supported to be a sufficient statistic to assess PPP's success. PPP is not exclusively a jobs program, and any evaluation of its effectiveness per dollar of program expense—even a short-run estimate—must include the benefit of preserving small businesses and employment relationships holistically, including social benefits in excess of private benefits and the benefits from hastening the economic recovery by supporting labor demand over the medium term.

V. Evaluating PPP: Empirical Analysis

We evaluate the effects of PPP on the employment, financial health, and continuity of small businesses. To do this, we use data from the Dun & Bradstreet Corporation (D&B), a company that provides commercial data and analytics to businesses. We are able to identify businesses in the Dun & Bradstreet data that applied for PPP loans of \$150,000 or more. We do not observe if those companies received a loan or the exact amount (above \$150,000 or more) of any loan received. We are not able to observe if a business applied for a PPP loan of less than \$150,000. Information on loan applications comes from the SBA and is merged into the D&B data.

We estimate standard difference-in-differences models of the effect of PPP application and of PPP eligibility based on size. We use several treatment control groups in our analysis. We also estimate the dynamic effect of PPP application and eligibility using event studies. We find evidence that PPP increased employment, financial health, and continuity. We also

find that the effect of PPP is unfolding, with effects on employment and financial health growing over time and reaching their peak in August, the last month for which we have data. In this section, we discuss the data, our methods, and these results in further detail.

V.A. Dun & Bradstreet

D&B is a global data and analytics company whose clients are businesses. The company was founded in 1841 as the Mercantile Agency and became Dun & Bradstreet in 1933. It has extensive coverage, with over 355 million business records and data curated from tens of thousands of sources, including public registries, newspapers, and websites, its own investigations and telephone interviews, courts and legal filings, financial statements, insolvency records, and its own network, making use of proprietary and publicly available information. It is the world's largest commercial database and counts 90 percent of the Fortune 500 companies as clients, along with every cabinet agency in the US government.

D&B is able to track whether businesses pay their bills on time through its relationships with landlords, mortgage companies, credit card companies, office suppliers, and the like. Its clients make use of D&B's ability to predict whether a particular establishment might be delinquent in order to help clients manage financial risk. D&B has significant reach. For example, the US government has historically required companies that want to receive federal contracts to register with D&B, as does Apple for companies that want to distribute applications through its App Store. The Food and Drug Administration uses a company's D&B registration number as a way to verify that importers of pharmaceutical products are legitimate businesses and to confirm that applicant contact information is accurate and complete.

V.B. Sample, Variables, and Descriptive Statistics

Our sample includes all establishments in the D&B database active as of October 2019 with one to 1,000 employees. We do not include sole proprietorships, establishments with zero reported employees, establishments with missing state and industry codes, and establishments with modeled employee counts. We assign each establishment to a business size category (one to 500 employees, 501 to 1,000 employees) based on employment in February 2020. We also stratify establishments based on whether they applied for a PPP loan worth \$150,000 or more. (We are only able to observe whether businesses applied for PPP loans of at least \$150,000.)

Table 3 presents summary means and standard deviations for key variables and the distribution of establishments over industry. Businesses that applied for a PPP loan of \$150,000 or more are nearly three times as large as those that did not. This difference is likely due to the relatively large size of the loan we are able to observe. Each group of businesses has comparable PAYDEX scores (discussed below), and over the entire sample period establishments with 501 to 1,000 employees are more likely to go out of business. The group least likely to go out of business during the sample period are establishments that we observe have applied for large PPP loans, and by a wide margin.

Key variables for our analysis include PPP application (for loans of at least \$150,000), establishment employment, state, and industry. We use Dun & Bradstreet's PAYDEX variable as our measure of a business's financial health. PAYDEX is an indicator based on whether and how a business is paying its bills. PAYDEX scores range from zero to 100. A PAYDEX score of 80 denotes that payments made to D&B have generally been made within the terms of the covered agreement. A PAYDEX score over 80 indicates that payments reported to D&B have been made earlier than their terms required. PAYDEX scores of 70, 60, 50, 40, 30, 20, or below 20 indicate that businesses are 15, 22, 30, 60, 90, 120, or over 120 days late, respectively, in paying their financial obligations. PAYDEX scores evolve slowly, and for each business a given month's PAYDEX score reflects transactions that have taken place over the previous several months.

Examples of recent papers that have used D&B data to examine changes in the financial health of small businesses include Barrot and Nanda (2020), who study the impact of the 2011 federal QuickPay reform using establishment-level employment data and PAYDEX scores from D&B. Chava, Oettl, and Singh (2019) examine the effects of state minimum wage increases on the financial health of small businesses. The authors use the D&B PAYDEX score as their primary measure of financial health for 15.2 million establishments from 1989 to 2013.

D&B's out-of-business indicator is our measure of business continuity. It is a zero-one variable. D&B determines a business is out of business if it is no longer engaging in transactions, through direct investigations, and in other ways. Two separate authorities—for example, management or owners of the company itself, the landlord at its address, its licensing body, and so on—must confirm a business has closed for it to be recorded as out of business.

Panels A and B of figure 2 plot average establishment employment per month for establishments with one to 500 employees in our analysis sample and establishments with 501 to 1,000 employees. These plots indicate that

Table 3. Summary Statistics, November 2019–March 2020

<i>Group</i>	<i>1–500 employees and applied for a PPP loan ≥ \$150,000</i>	<i>1–500 employees and did not apply for a PPP loan ≥ \$150,000</i>	<i>All establishments 1–500 employees</i>	<i>All establishments 501–1,000 employees</i>
Mean number of employees per establishment	33.8 (47.6)	11.5 (35.2)	12.5 (36.1)	722.0 (167.0)
Mean PAYDEX score	73.9 (9.57)	72.6 (14.1)	72.7 (13.1)	70.0 (10.7)
Out of business (%)	0.010 (0.985)	0.157 (3.96)	0.150 (3.86)	0.325 (5.69)
Annual sales in 2019 (\$)	5,603,688 (24,365,380)	2,168,570 (70,166,425)	2,338,007 (68,691,245)	66,242,380 (313,247,030)
Sectors (% share of employment)				
Agriculture	2.7	3.4	3.4	0.5
Construction	14.2	8.0	8.2	1.7
Finance, insurance, real estate	3.9	10.3	10.0	5.8
Manufacturing	12.4	4.8	5.2	20.9
Mining	0.5	0.3	0.3	0.7
Public administration	0.1	3.1	2.9	16.5
Retail trade	11.5	13.6	13.5	5.7
Services	41.6	46.6	46.4	40.3
Transportation, communications	4.6	4.9	4.9	5.1
Wholesale trade	8.4	5.0	5.2	2.8

Source: Authors' compilation using Dun & Bradstreet data.

Notes: This table displays means and standard deviations (in parentheses) in our pretreatment period, November–March, for the main establishment employee size groups used in our analyses. We also calculate the distribution of employment across industries at the two-digit standard industrial classification level. The sample consists of all establishments operating as of October 2019 that meet our sample selection criteria.

employment within the D&B sample is very stable. Among businesses with one to 500 employees, employment decreased by 1.42 percent in August relative to November. Panel B shows employment declines of 1.83 percent among establishments with 501 to 1,000 employees. In contrast, employment reported in official statistics shows much larger losses. The summary statistics we present suggest that employment evolves slowly among firms of all sizes, and our analysis does not indicate any relationship between the pace of evolution and PPP application. The relative stability of employment in the D&B data biases against finding a PPP employment effect, in both our treatment-on-the-treated and intent-to-treat models. We interpret all our estimates of PPP's effects relative to trends in the D&B data.

We present the average PAYDEX score per month in panels C and D of figure 2. These figures indicate that businesses' financial health in our sample is relatively stable, as well, falling in both panels by less than one point. This apparent stability is most likely due to the relatively lengthy look-back period for PAYDEX. As with the stability of employment, this biases against finding an effect of PPP on financial health.

The share of establishments that went out of business is shown in panels E and F of figure 2. The share of businesses with fewer than 500 employees that went out of business increased by a factor of 16 between November and August. Businesses with 501 to 1,000 employees saw closure rates increase by a factor of 14.

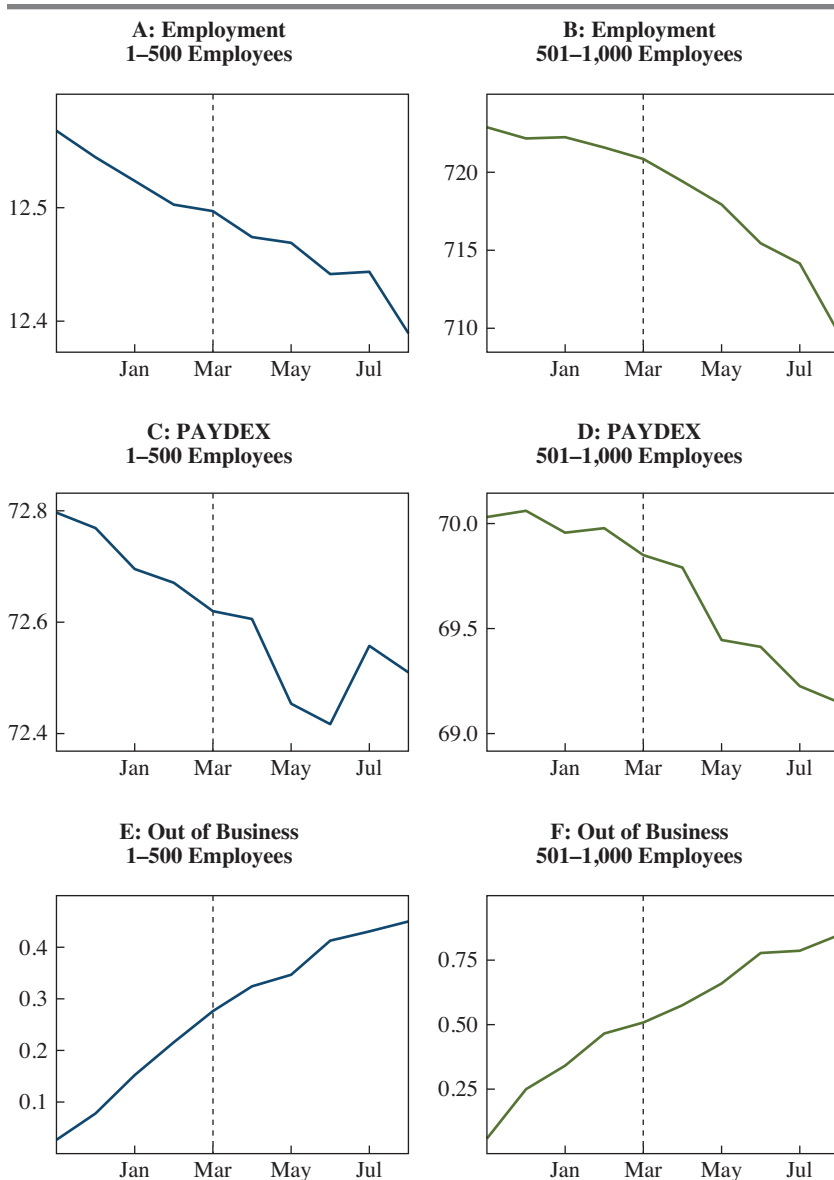
V.C. Estimation Strategy

To identify the effect of PPP on business outcomes, we estimate the following equation:

$$(1) \quad y_{im} = \alpha + \beta(PPP_{ia} \times Post_m) + \gamma PPP_{ia} + \delta_{sm} + \delta_{jm} + \varepsilon_{im},$$

where y_{im} is an outcome experienced by business i in month m . Our analysis sample covers ten months, November 2019 through August 2020, with five months of pre-PPP period (the CARES Act was signed on March 27) and five months of post-PPP period (PPP launched on April 3). PPP_{ia} is an indicator as to whether business i applied for a PPP loan of at least \$150,000. This variable is our measure of PPP—we do not observe whether businesses actually received PPP loans or, if they did receive loans, the size of the loan. The variable δ_{sm} is a state-by-month effect, and δ_{jm} is an industry-by-month effect. The result of $PPP_{ia} \times Post_m$ equals 1 if business i applied for a PPP loan and the month is April, May, June, July, or August. Standard errors are clustered by state.

Figure 2. Average Establishment Employment, PAYDEX Scores, and Out-of-Business Rates by Month



Source: Dun & Bradstreet; authors' calculations.

Note: These graphs show average employment, PAYDEX score, and out-of-business rates from November 2019 to August 2020 for establishments with 1–500 employees and 501–1,000 employees. Establishments are assigned to an employment size group using February 2020 employment. Panels A, C, and E include establishments with 1–500 employees. Panels B, D, and F include all establishments with 501–1,000 employees.

The coefficient of interest is β , which captures the effect of applying for a PPP loan of \$150,000 or greater on the outcome variable. The industry-month effects capture time varying shocks to businesses in a given industry, and the state-month effects capture time varying shocks to businesses in a given state. The effects of the pandemic and the lockdowns varied substantially across industries and states. Using within-state-by-month and within-industry-by-month variation to estimate the effect of PPP application helps ensure that our results are not driven by time varying public health or social distancing policy differences between states and industries.

To trace the dynamics of PPP over the months since the CARES Act, we estimate a difference-in-differences event study of the following form:

$$(2) \quad y_{im} = \alpha + \sum_{t=-4}^5 \beta_t (PPP_{ia} \times \varphi_t) + \gamma PPP_{ia} + \delta_{sm} + \delta_{jm} + \varepsilon_{im},$$

where β_t is a vector of nine parameters estimating the dynamic effect of PPP, φ_t is a month dummy, and everything else is the same as in equation (1). The dynamics of the effect are interesting because of lags in receipt time, the time it may take employers to bring workers back onto payroll, and treatment control differences driven by the economic outcomes of control businesses worsening over time because they do not have access to PPP funds. The trend in the pre-PPP period coefficient vector is a partial check against differential employment trends among businesses that applied for a PPP loan and those that did not.

We observe whether a business applied for a PPP loan of \$150,000 or more. If some businesses that applied were turned down, then our estimates of PPP's effect are biased downward, because the treatment group would be contaminated by control observations. Another important source of downward bias in our estimates of PPP's effect is that many businesses in our control group applied for and received PPP loans of less than \$150,000. As presented in table 1, around 87 percent of all PPP loans were made for \$150,000 or less, and these loans accounted for 28 percent of all funds disbursed. These are treatment-on-the-treated estimates and do not control for selection into applying for PPP. Firms that did not apply could be very different from those that did, perhaps thinking that they did not need the funds to continue operating or, alternatively, perhaps thinking that the situation was hopeless. They might have also been less financially savvy, which could be correlated with other outcomes and characteristics.

Knowing how PPP affected firms that selected into participating is interesting and important, but it confounds demand for PPP with PPP itself. To

address this distinction, we estimate intent-to-treat models. In these models, we do not use information on whether a business actually applied for a PPP loan. Instead, we compare outcomes for establishments that were eligible for PPP based on their size to establishments that were ineligible in a difference-in-differences framework. Specifically, we estimate the following equation:

$$(3) \quad y_{im} = \alpha + \beta(PPP_{ie} \times Post_m) + \gamma PPP_{ie} + \delta_{sm} + \delta_{jm} + \varepsilon_{im}.$$

All variables in equation (3) are the same as in equation (1) except PPP_{ie} , which equals 1 if a business is eligible for PPP based on its size, and equals 0 otherwise. We also estimate intent-to-treat event studies analogous to equation (2).

V.D. Results

RESULTS FOR EMPLOYMENT Table 4 presents estimates of equations (1) and (3) for (the log of) employment. The specification in the first column compares establishments with one to 500 employees that applied for a PPP loan of \$150,000 or more to establishments in the same size class but that did not apply. PPP application is associated with a 0.90 percent increase in employment. Columns 2 and 3 present the same specification, but on smaller samples of establishments. Column 2 looks at establishments with one to 250 employees and similarly finds a 0.94 percent increase in employment from PPP. Column 3 analyzes a sample of establishments with 251 to 500 employees. Here, the effect on employment is negative, -3.2 percent. This result might be driven by greater demand for larger PPP loans within that size class among the treatment group, confounded by many control firms taking out PPP loans that we do not observe. But in evaluating the program as a whole, it is worth noting that there are approximately 81 million establishment-months with one to 500 employees in our sample, and around 360,000 of those are establishment-months with 251 to 500 employees.

These estimates are valuable in part because they implicitly control for establishment size category. But they are likely biased downward because the treatment effect is defined as a business applying for a PPP loan of \$150,000 or greater, while most PPP loans were for less than this amount, so PPP-treated establishments are in the control group. The specification in column 4 attempts to address this by defining the treatment group as establishments with less than 500 employees who applied for a PPP loan of at least \$150,000 and the control group as establishments with 501 to 1,000 employees. Here, we estimate a PPP employment effect of 1.78 percent, substantially larger in magnitude than the coefficients discussed previously.

Table 4. Estimating the Effect of PPP Loans on Establishment-Level Employment

	(1)	(2)	(3)	(4)	(5)	(6)
Treated $\times$ Post $\times$ 100	0.902*** (0.0656)	0.936*** (0.0655)	-3.20*** (0.470)	1.78*** (0.234)	0.0772 (0.366)	1.38*** (0.258)
Treatment	1-500; loan	1-250; loan	251-500; loan	1-500; loan	400-475; all establishments	1-500; all establishments
Control	1-500; no loan	1-250; no loan	251-500; no loan	501-1,000; no loan	525-600; all establishments	501-1,000; all establishments
Observations	81,404,032	81,043,431	360,601	3,980,677	110,712	81,523,211
R ²	0.1390	0.1373	0.0432	0.2343	0.3783	0.0966

Source: Authors' compilation using Dun & Bradstreet data.

Note: This table reports difference-in-differences estimates for the impact of PPP on establishment-level employment. The sample consists of establishments operational as of October 2019 that meet our sample selection criteria. For all regressions, the pretreatment period is November-March and the posttreatment period is April-August. Each column uses a different treatment and control group, indicating the size of the establishment by employment in February; "loan" indicates that we observe that the establishment applied for a PPP loan of at least \$150,000; "no loan" indicates the opposite; "all establishments" indicates that we include all establishments in the analysis sample regardless of whether they applied for a loan. All regressions include state, month, and two-digit standard industrial classification fixed effects as well as state-by-month and industry-by-month fixed effects. Standard errors are clustered at the state level. Coefficients and standard errors are multiplied by 100 for ease of interpretation.

*** $p < .01$

The estimates reported in columns 1–4 are treatment-on-the-treated estimates. In the context of evaluating PPP, this is interesting because estimating program outcomes conditional on selection is important and relevant (program participation is voluntary) and survey evidence finds that over 70 percent of small businesses participated in PPP.²⁰ But the estimates do confound the effect of demand for PPP with the effect of PPP, in addition to the limitation that we only observe PPP loans of at least \$150,000.

To address these limitations, column 6 reports intent-to-treat estimates in which we define the treatment group purely based on size eligibility—that is, we do not use information on whether a business applied for a PPP loan—and the control group is establishments with 501 to 1,000 employees. We estimate that PPP size eligibility increased employment by 1.38 percent. This result might suggest an important role for smaller PPP loans in supporting employment.

Column 5 also reports intent-to-treat effects but for firms close to the 500 employee cutoff (eliminating firms near the cutoff). The advantage of this specification is that it directly controls for firm size. Comparing firms in the 400–600 employee window, we do not find a PPP employment effect. This result, along with the estimates reported in column 6, might suggest that PPP was most effective in supporting employment among smaller firms, at least through August.

The specification that estimates the effect of PPP within the 400–600 employee window arguably offers the strongest basis for causal inference assuming that the effect of PPP loans on employment is similar for firms of different sizes. But this assumption is very strong, and it is quite likely that PPP loans have effects that vary by firm size. The estimates reported in table 4 suggest this is the case, and the \$10 million maximum for PPP loans also suggests that PPP would offer relatively more assistance to smaller firms. In the D&B data, 2019 average annual sales for firms with one to 500 employees were \$2.4 million, while those for firms with 400–475 employees were \$46.4 million. This consideration suggests that a holistic evaluation of PPP should include estimating its effects on firms of all eligible sizes. Therefore, our preferred specifications are presented in columns 4 and 6.

Our results contrast with Autor and others (2020), who find employment effects for larger firms using ADP data. It is interesting to note that their

20. The Small Business Pulse Survey of the US Census Bureau finds that 72.7 percent of small businesses received financial assistance from PPP since March 13, 2020, as of August 22, 2020.

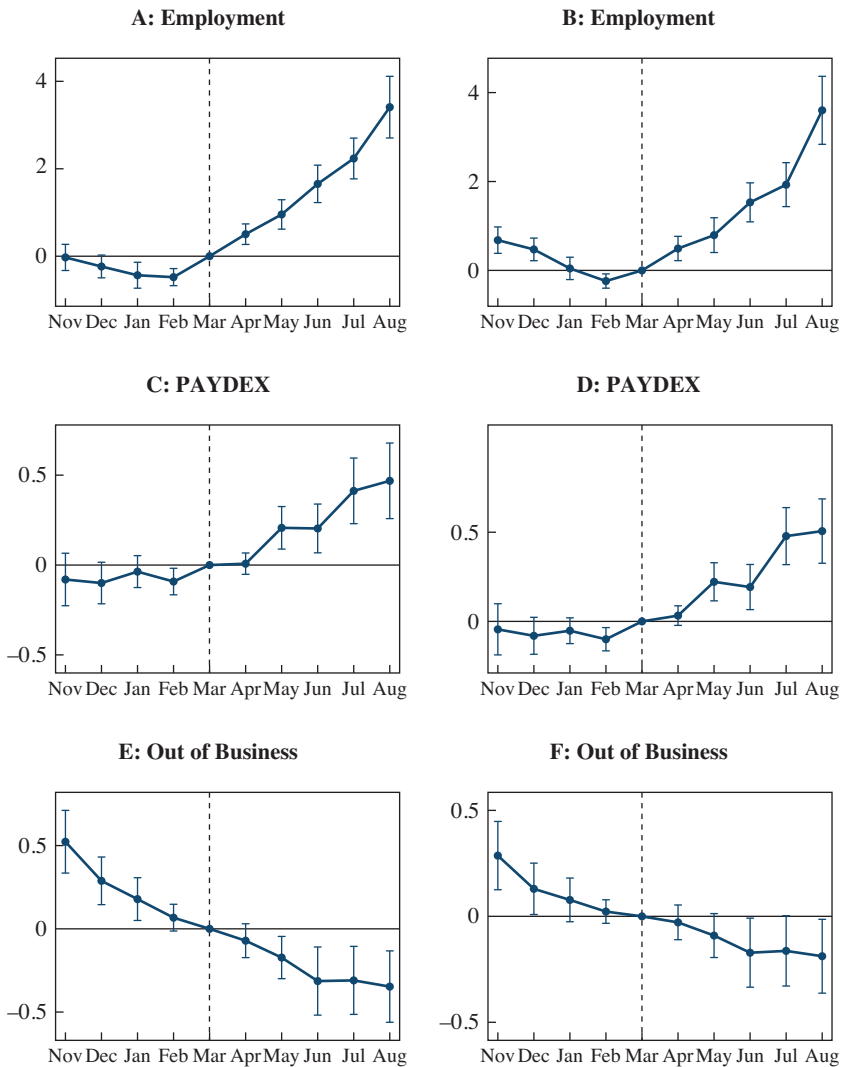
estimates become less precise as the window around the 500 employee eligibility cutoff shrinks. This finding may be due to sample size, or it could indicate that PPP is relatively less effective at supporting employment for larger firms in the ADP data.

We present event study graphs using our two preferred treatment and control groups. Figure 3 presents results from equation (2). Panel A shows the dynamic effect of PPP on employment when the treatment group is establishments with one to 500 employees who applied for a PPP loan of at least \$150,000 and the control group is establishments with 501 to 1,000 employees. There is no trend in the pre-PPP period coefficients, although the confidence interval on the negative coefficient in February does not include zero. The absence of a pre-PPP period trend supports a causal interpretation of the estimates. In the post-PPP period coefficients, the effect of PPP increases over time, rising to 3.13 percent in August.

Panel B shows a similar effect of PPP on employment. Here, the dynamic effect captures intent to treat, comparing establishments with 500 or fewer employees to those with between 501 and 1,000 employees, regardless of whether the firms applied for a PPP loan. Like panel A, there is no noticeable trend in the pre-PPP period, and the strength of the effect increases in the post-PPP period with each month. In August PPP eligibility is found to increase employment by 3.83 percent.

To interpret the magnitude of these effects, consider that average establishment employment fell by 1.6 percent in the D&B data for establishments with one to 1,000 employees over the sample period, between November and August. In light of this change, the 1.78 percent increase in employment reported in column 4 of table 4 and the 1.38 percent increase reported in column 6 of table 4 are both substantial increases. The effects for the month of August specifically—3.13 and 3.83 percent, respectively—are even more substantial.

RESULTS FOR FINANCIAL HEALTH Table 5 reports results for which the outcome variable is financial health, as captured by Dun & Bradstreet's PAYDEX score. Table 5 is the same as table 4, except for the outcome variable. The first three columns of table 5 report results from specifications where the treatment and control groups are the same firm employee size class. Taken together, they suggest that financial health worsened for firms with one to 250 employees that applied for PPP loans of at least \$150,000. We think this puzzling finding is most likely the result of PPP-treated observations (that is, establishments with less than 250 employees that applied for loans of less than \$150,000) contaminating the control group.

Figure 3. Event Study Regressions

Source: Dun & Bradstreet; authors' calculations.

Note: These graphs show the results from event study regressions in equation (2) examining the impact of the Paycheck Protection Program on establishment employment, financial health, and survival. Panels A, C, and E examine PPP's effect on employment, credit scores, and survival rates for establishments with 1–500 employees that applied for a PPP loan of \$150,000 or more compared to establishments with 501–1,000 employees. Panels B, D, and F examine the effect of PPP eligibility on the same outcomes, comparing all establishments with 1–500 employees to all establishments with 501–1,000 employees (i.e., dynamic intent-to-treat effects). Establishments are assigned to an employment size group using February employment. Coefficients and standard errors for panels A, B, E, and F are multiplied by 100 to ease interpretation. Error bars represent 95 percent confidence intervals.

Table 5. Estimating the Effect of PPP Loans on Establishment-Level Credit Scores

	(1)	(2)	(3)	(4)	(5)	(6)
Treated $\times$ Post	-0.0392* (0.0220)	-0.0379* (0.0219)	-0.0349 (0.0969)	0.305*** (0.0686)	0.01 (0.154)	0.349*** (0.0616)
Treatment	1-500; loan	1-250; loan	251-500; loan	1-500; loan	400-475; all establishments	1-500; all establishments
Control	1-500; no loan	1-250; no loan	251-500; no loan	501-1,000; no loan	525-600; all establishments	501-1,000; all establishments
Observations	32,139,590	31,889,423	250,167	3,731,639	81,644	32,225,515
R ²	0.013	0.013	0.021	0.024	0.027	0.012

Source: Authors' compilation using Dun & Bradstreet data.

Note: This table reports difference-in-differences estimates for the impact of PPP on establishment-level employment. The sample consists of establishments operational as of October 2019 that meet our sample selection criteria. For all regressions, the pretreatment period is November–March and the posttreatment period is April–August. Each column uses a different treatment and control group, indicating the size of the establishment by employment in February; “loan” indicates that we observe that the establishment applied for a PPP loan of at least \$150,000; “no loan” indicates the opposite; “all establishments” indicates that we include all establishments in the analysis sample regardless of whether they applied for a loan. All regressions include state, month, and two-digit standard industrial classification fixed effects as well as state-by-month and industry-by-month fixed effects. Standard errors are clustered at the state level. Coefficients and standard errors are multiplied by 100 for ease of interpretation.

* $p < .1$, *** $p < .01$

For reasons discussed previously, our preferred specifications are reported in columns 4 and 6. The specification in column 4 compares firms with 500 or fewer employees that applied for PPP loans of at least \$150,000 to firms with 501 to 1,000 employees that were not eligible for PPP. PPP predicts a PAYDEX increase of about 0.31 points. Column 6 presents results from an intent-to-treat specification. Here, PPP eligibility boosts PAYDEX by about 0.35 points. Similar to our results for employment, PPP seems to have had a larger impact on firms with fewer than 400 employees, as suggested by comparing the results in column 5 with column 4.

Figure 3, panels C and D, present event study graphs that trace out the dynamic effect of PPP for our two preferred specifications. As with employment, the effect of PPP on financial health (as measured by PAYDEX) grows over time. Both figures show a flat trend centered on zero for the pre-PPP period coefficients estimating the effect of PPP in November through February relative to March. As with employment, this supports a causal interpretation of our estimates. The effect of PPP application on financial health was estimated imprecisely in April and precisely every month after. The magnitude of the effect increased considerably over time, more than doubling between June and August.

The dynamic intent-to-treat estimate is shown in panel D. As with the results in panel C, PPP's effect on financial health is estimated imprecisely in April but precisely for the following four months. The magnitude of the effect in August is more than double the effect in May. PPP eligibility is estimated to have increased PAYDEX in August by 0.51 points.

The magnitude of the effect is substantial. For all firms with one to 1,000 employees, average monthly PAYDEX fell by 0.28 points from November to August. A PPP PAYDEX effect of 0.31 (column 4) and 0.35 (column 5) represents a significant increase relative to the change in financial health of all firms during our sample period. As with employment, the effect of PPP on PAYDEX in June is substantially larger than the post-PPP period average, suggesting that the effects of PPP on financial health may be increasing over time.

RESULTS FOR BUSINESS CONTINUITY Table 6 reports results for D&B's out-of-business variable. Everything in table 6 is the same as in tables 4 and 5, except the outcome variable. PPP eligibility or application is estimated to have reduced business closure in every specification at conventional levels of statistical significance, except for column 5. Column 4 presents results from the specification that compares firms that applied for a PPP loan of at least \$150,000 to firms with 501 to 1,000 employees, which were ineligible for PPP. PPP application is estimated to have reduced

Table 6. Estimating the Effect of PPP Loans on the Probability an Establishment Goes Out of Business

	(1)	(2)	(3)	(4)	(5)	(6)
Treated $\times$ Post $\times$ 100	-0.237*** (0.0222)	-0.236*** (0.0224)	-0.616*** (0.0836)	-0.471*** (0.0853)	0.0562 (0.124)	-0.219** (0.0683)
Treatment	1-500; loan	1-250; loan	251-500; loan	1-500; loan	400-475; all establishments	1-500; all establishments
Control	1-500; no loan	1-250; no loan	251-500; no loan	501-1,000; no loan	525-600; all establishments	501-1,000; all establishments
Observations	81,625,920	81,262,585	363,335	3,982,131	111,512	81,745,730
R ²	0.00805	0.00804	0.02154	0.00344	0.0166	0.00789

Source: Authors' compilation using Dun & Bradstreet data.

Notes: This table reports difference-in-differences estimates for the impact of PPP on establishment-level employment. The sample consists of establishments operational as of October 2019 that meet our sample selection criteria. For all regressions, the pretreatment period is November–March and the posttreatment period is April–August. Each column uses a different treatment and control group, indicating the size of the establishment by employment in February 2020; “loan” indicates that we observe that the establishment applied for a PPP loan of at least \$150,000; “no loan” indicates the opposite; “all establishments” indicates that we include all establishments in the analysis sample regardless of whether they applied for a loan. All regressions include state, month, and two-digit standard industrial classification fixed effects as well as state-by-month and industry-by-month fixed effects. Standard errors are clustered at the state level. Coefficients and standard errors are multiplied by 100 for ease of interpretation.

** $p < .05$, *** $p < .01$

the odds of business closure by 0.47 percentage points. Column 6 presents results from our intent-to-treat model. Here, PPP eligibility is estimated to reduce business closure odds by 0.22 percentage points. Column 5 reports intent-to-treat results for a smaller window around the 500 employee cutoff. As with employment and financial health, we do not find a significant effect of PPP on business closure among firms with 400–475 employees.

Panels E and F of figure 3 present event studies for those two models. The pre-PPP period coefficients show a trend, and these results should be interpreted cautiously. The confidence interval on pre-PPP period coefficients includes zero in several cases. In the post-PPP period, the magnitude of the effect is larger in June than in April or May. This pattern is similar to our employment and PAYDEX results. The magnitude of these effects is large.

To place the difference-in-differences estimates and June event study coefficient estimates in context, the average establishment out-of-business indicator in August was 0.42 percentage points higher than in November for firms with one to 1,000 employees.

V.E. Discussion and Conclusions

Our results point to PPP playing a significant role in the health and viability of small businesses. Both applying for a PPP loan of \$150,000 or more and PPP eligibility as determined by firm size increase employment, financial health, and business continuity. In addition, we find that it may have taken a month or two for PPP to kick in. An alternative interpretation is that PPP was more effective in a partially reopened economy (that is, June–August) than during the lockdowns.

Several caveats are in order. We avoid making strong statements about the success or failure of PPP because the program is so young, and we are only analyzing the first five months of the program. PPP did have important short-run goals, which included maintaining employment relationships during the lockdowns and supporting consumer spending by allowing workers to continue to be paid. But PPP has important medium-run goals as well, and it is too early to say anything definitive about its success or failure. Those goals include mitigating business closures after the economy had partially reopened (which we observe for about one month), supporting employment and reducing unemployment, and increasing productivity by preserving firm-specific human capital, worker-firm matches, and networks. Crucially, by preserving the productivity capacity of the small business sector, PPP stands to quicken the recovery by supporting labor demand over the medium run. In addition, the firms in the D&B data are not nationally

representative, and they exhibit employment and financial health indicators that are likely more stable than typical firms. We also want to stress the tentative nature of our conclusions. As shown in the dynamics of the effect (in figure 3), the effect of PPP on employment, financial health, and business continuity is evolving and is much stronger in July and August than in April and May. The effects of PPP are unfolding, and it will be particularly important to see what happens to businesses that received PPP and the workers they employ once they have exhausted their forgivable loan.

VI. Retrospective and Lessons for the Future

Many of the common criticisms of the PPP as failed by design and effect were too strong. Banks were skittish about participating, particularly in the early days of the program. But program demand by lenders was sufficient to allow the government to transfer funds in an amount roughly equal to 10 percent of a typical quarter's GDP to small businesses. With the vast majority of loans and the sizeable majority of program dollars going to loans of less than \$2 million, media coverage suggesting that PPP was in the main offering grants to large and well-connected firms was overblown. Many of the anecdotes in the media implying fraudulent participation in the program actually pointed to firms that were eligible for PPP loans under the statute. The criticism that the original CARES Act appropriation of \$349 billion was too small, obvious from the outset, was quickly proven valid by events, but Congress rectified that swiftly.

Could policymakers have designed a more effective and cost-effective intervention than a small business revenue replacement program? In theory, one could argue that relying on the unemployment insurance (UI) system to replace workers' income and using a PPP-like program to help small businesses with nonpayroll cost has appeal to some economists and analysts. But that plan would require worker-firm separations, albeit temporary, to take place. It would change the default for small businesses from keeping workers employed (as under a revenue replacement program) to recalling workers following a separation, which is the wrong place for the default to be during the shutdown. The UI system in many states was simply and troublingly unable to handle the demands placed on it during the shutdown—increasing those demands would not likely lead to the most successful outcomes. Finally, having both UI and a small business revenue replacement program is good policy design because it allows for redundancy, with multiple programs operating to replace workers' incomes.

For the reasons we discussed previously, we do not view a loan program as an adequate substitute for a small business revenue replacement program. Many businesses would not want to add to their debt burdens, even under very favorable lending conditions. Many would resort to layoffs, which would disrupt other businesses, deepen the recession, and hurt workers' employment and earnings opportunities.

Even though a small business revenue replacement program may have been the best available option, the PPP could have been better designed and better implemented in ways we previously discussed: it is too focused on payroll expenses; banks should have been given stronger assurances that they would be held harmless; and its initial appropriation was too small. Much of the confusion about the program was driven by chaotic Treasury/SBA management which weakened the program's effectiveness, limited its reach, and ultimately led to a falloff in demand for PPP funds.

PPP was designed for a short shutdown that would be followed by a strong and rapid recovery. But the shutdown was longer than anticipated and the recovery decelerated after a burst of improvement in May and June. In addition, partial shutdowns may remain in some regions for an extended period of time. Subsequent changes to PPP addressed these concerns, but the program needed to facilitate the transition from the "freeze the economy in place" stage to the "allow labor to reallocate across firms and industries" stage. The economy overall, including workers, will benefit from a fast transition from the pre- to post-lockdown equilibrium. PPP could facilitate this transition by eliminating any link between PPP loan forgiveness and precrisis employment levels.

We have argued that many small businesses needed equity or grants, and not loans. But a lending program could—and in the future perhaps should—exist alongside a revenue replacement program, particularly for a partially reopened economy. An advantage of a lending program is that businesses that expect to be nonviable in the post-pandemic economy would be less likely to take out a loan than to accept a grant. This feature would keep the cost of the program lower, channel funds more effectively, and allow for a swifter transition to the post-pandemic equilibrium. A disadvantage—and the reason we do not support this during the shutdown period—is that some firms that might be viable in the absence of the loan could be tipped over into insolvency by taking out a loan. More practically, in the shutdown, we are concerned that few firms would participate in a lending program.

One way to structure such a lending program could be in two stages, following a venture capital model preceded by a broadly available loan. In the first stage, the Treasury Department could issue a small loan to firms

using limited underwriting standards, knowing that the loan will have a high default rate. In the second stage, surviving firms could have access to additional funding. This financing would help to give many firms a lifeline for survival, while still well-stewarding taxpayer funds.²¹

An alternative approach would be a federal business interruption insurance program for small and midsize firms (analogous to the federal terrorism risk insurance program) layered on top of private business interruption insurance. Linking a trigger to a pandemic shutdown could require a shutdown order by a public official (for example, the governor of the state).

Looking forward, there are broader lessons as well. For a situation in which the government is shutting down large sections of the economy, Congress and the White House need to be willing to tolerate stories of “undeserving” beneficiaries of economic recovery programs. The alternative is upfront targeting measures that slow down aid and worsen the downturn. Another alternative is that programs are much less effective. PPP stands a chance at succeeding because its relief was broad based. The Treasury Department was much more conservative with putting taxpayer dollars at risk when approving the terms of the PPP, limiting early take-up. The Treasury’s conservative approach has extended to the Federal Reserve’s Main Street Lending Facility, which received capital funds (along with other Federal Reserve facilities under the CARES Act). As a consequence of the Treasury’s aversion to putting that capital at risk, potentially driven in part by concern about stories of undeserving borrowers, the facility is not supporting the economic recovery yet because it, essentially, is not making loans.

Another broader lesson is the need for government at the state and federal levels to upgrade computer systems. Banks were needed as intermediaries in part because the government’s IT constraint would not have allowed for it to lend directly to banks in a timely fashion. Finally, the government’s attempt to support small and midsize businesses in the pandemic recession calls into question the nature of the division between the Federal Reserve and the Treasury. Following the Dodd-Frank Act, the Treasury is required to approve the terms of 13(3) lending programs, including the Main Street lending programs. But these are labeled as Federal

21. The Federal Reserve’s Main Street Lending Facility offers another lending vehicle for small and midsize firms. While the facility’s design remains in flux, its structure could also mimic better patient equity financing. Terms could include much longer maturity and very low interest rates, for example.

Reserve programs, creating confusion about which agency is ultimately responsible for their success or failure. Furthermore, Congress appropriated \$454 billion in the CARES Act to the Treasury to support Federal Reserve lending programs. At the time of this writing, little of those funds have been put to use to support the recovery, despite congressional intent. If the Treasury is unwilling to risk capital losses as part of Federal Reserve lending programs, then Congress should consider whether an alternative structure to support small and midsize businesses is advisable.

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Comment and Discussion

COMMENT BY

ERIC ZWICK Hubbard and Strain offer a clear and comprehensive assessment of the initial months of the Paycheck Protection Program (PPP). My comment has two goals. First, I want to place the PPP into a framework for evaluating the welfare effects of such programs. Second, I want to place this analysis in the context of what we know from contemporaneous work about whether the PPP succeeded. While I agree with the authors that it is too soon to provide a complete grade of the PPP, we know enough now to offer a provisional assessment that can guide ongoing policy debates and future research on the program.

GRADING THE PPP: A RUBRIC What kind of policy is the PPP? Many popular commentators have described the program as fiscal stimulus, but this view is mistaken. The goal of the PPP was not to increase economic activity immediately. In fact, if the initial crisis response was aimed at suppressing the virus by reducing public interactions, the goal may well have been the opposite: to encourage everyone to stay home to slow the virus's spread while supporting workers and firms during the lockdown.

Thus, the goal of the PPP was more to enable future economic activity—by preserving firm-worker links and preventing permanent failures—than to stimulate immediately. Hubbard and Strain are right to point out that in this case we should not use metrics like cost per job or fiscal impact multipliers to grade the program.

One might alternatively think of the program as support for capital markets in the spirit of liquidity support programs aimed at the financial system, which were pursued by the Federal Reserve and the Treasury both during this crisis and during the Great Recession. Again, this is not the right way to view the PPP. In particular, the lender-of-last-resort motivation for policy intervention is not the right model when output evaporates and

there are real losses. In this world, loans are unattractive from a private and public perspective because repayment is nonviable for many firms despite having positive long-term prospects.¹ In such a case, and in stark contrast to the Great Recession, banks may be more unwilling than unable to lend to firms that were hard hit by the crisis.

In my view, the closest policy analogy to the current situation is disaster relief and insurance. Firms face a severe noneconomic shock that entails an unusually low correlation between their short-run and long-run performance. If these firms close, society will risk losing valuable firm-worker matches, fixed startup costs already paid, and sweat equity already accumulated. At the aggregate level, there is risk that congestion externalities in bankruptcy courts and in the labor market could exacerbate economic losses.

In all of these respects, the pandemic is similar to a large storm that devastates a local area, though this time the devastation is geographically widespread, of uncertain duration, and wrought with lost revenues instead of lost capital. Still, I believe that conceptualizing the PPP as a kind of social insurance program helps to illuminate the framework we ought to use to evaluate design and implementation.

REVENUE REPLACEMENT VERSUS BUSINESS CONTINUITY INSURANCE An important part of the paper is a discussion of the key design elements of a business support program. If we think of the PPP as insurance, then we can fruitfully debate these elements in terms of their insurance value beyond being mere transfers. Let me contrast some of the authors' preferred design elements to our business continuity insurance proposal (Hanson and others 2020a), which was itself inspired by Hubbard and Strain's earlier writing on the program and by Emmanuel Saez and Gabriel Zucman's buyer of last resort proposal (Saez and Zucman 2020).

First is the question of what expenses to permit. The authors argue for including payroll in the category of eligible expenses to be covered by the PPP. Supporting payroll might help firms retain workers, thereby preserving valuable firm-worker matches. It also might keep workers from claiming unemployment insurance (UI) at a time when the risk of overwhelmed UI systems is a concern. Both arguments amplify the insurance value of the program.

1. Hanson and others (2020b) argue why it makes more sense to think of the government's role as "venture capitalist of last resort," that is, as needing to take on significant credit risk in this crisis.

Nevertheless, I have several concerns with this element. First, including payroll dramatically raises the cost of the program, thus limiting the amount of time firms might be able to benefit from additional funds. Second, many of the hardest hit firms were bars and restaurants in the service sector, for which high rates of turnover in normal times imply the value of firm-worker matches might be low. Third, it is somewhat unnatural to expect firms to pay workers to be idle, when accounting and payroll systems are based on hours worked and when many firms have some workers that can still work. Fourth, though there were plenty of hiccups in the initial rollout, the UI system actually worked pretty well in supporting more than 30 million workers! Last, as the authors note, including payroll deters reallocation of workers across firms and industries by subsidizing newly inefficient matches.

The second design question concerns how to deploy PPP funds. The authors argue in favor of using banks as conduits to access the program. Preexisting relationships between banks and firms might accelerate the transfer of funds, and the underwriting infrastructure could help detect fraud. These arguments speak to the efficiency and timeliness of the program, both key aspects of good insurance.

At the same time, because banks do not have the same incentives as the government, we have to pay them to participate. And banks might steer preferred clients in one direction and new clients in another. While true that many firms are connected to banks, there are many others without prior relationships or whose banks were themselves disrupted by the lockdown orders. My view is that the IRS could have been more involved in implementing this policy, given its track record for large-scale stimulus in other contexts (such as economic impact payments, refunds for net operating losses, or the first-time homebuyer credit).

A third question concerns targeting. The authors argue that the program should feature little or no targeting. Their logic is that, given the unknown shock severity and duration, trying to narrow eligibility for the program in a sophisticated way would fall prey to lobbying by connected industries. They also worry that conditioning loan forgiveness on revenues might discourage firms from reopening by subjecting them to high marginal tax rates.

Here, viewing the program through the lens of insurance is especially instructive. Providing little or no targeting is both expensive and by definition allocates funds to low-insurance-value types. To the extent there is a budget constraint at the federal level (which is debatable these days), we are now in a position where benefits have been exhausted though help is still needed. Moreover, it will surely strike many as unfair that firms that

were able to continue operating, or that operated in defiance of best public health practices, received the same level of support as those that temporarily closed.

I should note that we agree on many design features and general principles. For example, though the authors describe their proposal as “revenue replacement,” it is better thought of as “net value added” replacement. In other words, we agree to exclude profits, intermediates, and depreciation in the list of eligible expenses. More fundamentally, we agree that the loans should be closer to grants. We also agree that placing the demands solely on the Small Business Administration (SBA) to implement this program would not have made sense, given the agency’s size and the infrastructure in place prior to the crisis.² And we agree that the largest firms should be treated less generously.

The bottom line in this discussion is that this area deserves more formal study. Economics has a natural opportunity to contribute in this time of crisis by improving our understanding of the optimal features of business support policy.

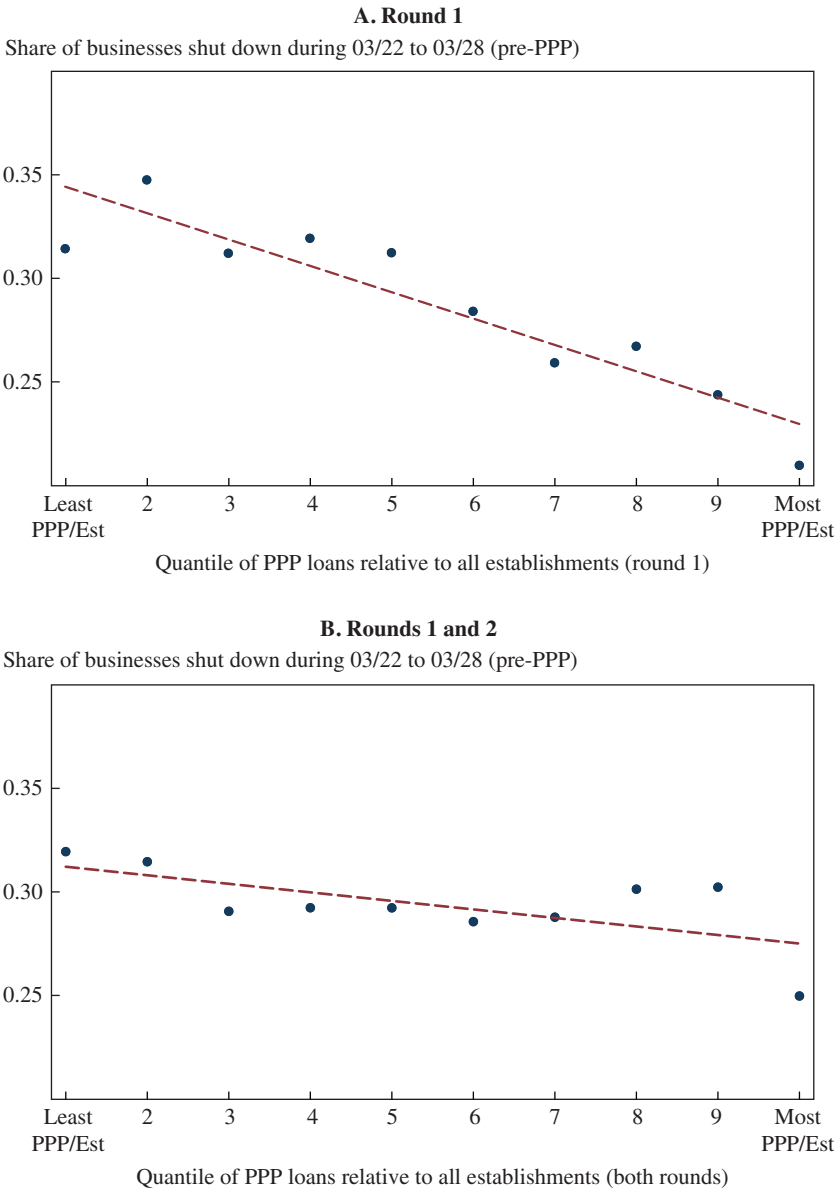
DID FUNDS GO TO HIGH-INSURANCE-VALUE TYPES? Ideally, we would grade the PPP in terms of insurance value provided relative to the program’s cost, but defining the notion of insurance value for firms is beyond the scope of my discussion. As a first pass, let’s consider what we know about program targeting and how firms used the funds.

Judged by its timeliness, the program receives high marks. More than \$500 billion in funds were distributed in just six weeks!

One reason why funds could be deployed so quickly is that nearly all firms could apply. As a consequence, the targeting of the program was poor. In work with João Granja, Christos Makridis, and Constantine Yannelis (Granja and others 2020), I found that more of the program’s initial funds actually flowed to regions that were less hard hit by the shock (figure 1, top panel). This distribution is to a large extent due to differences across lenders in their participation in the program. For example, the top four banks alone account for 36 percent of total pre-policy small business loans but disbursed less than 3 percent of all PPP loans in the first round of funding. Ultimately, we find a weak correlation between initial shock severity and funding levels, reflecting the program’s broad eligibility criteria (figure 1, bottom panel).

2. Recently, the SBA inspector general released a report finding that the “unprecedented demand for COVID-19 EIDLs [relief loans] and the equally unprecedented challenges SBA had in responding to this pandemic combined with lowered controls resulted in billions of dollars in potentially fraudulent loans and loans to potentially ineligible businesses” (SBA 2020, 2).

Figure 1. Weak Geographic Targeting of the PPP



Source: Granja and others (2020).
Notes: The figure stratifies all businesses in Homebase in ten bins based on the fraction of establishments in their zip code receiving PPP during the first round and during both rounds combined. The figure plots for each bin the share of Homebase businesses that shut down in the week of March 22–March 28, that is, prior to the PPP.

Additional evidence on targeting and design elements comes from firm surveys (Alekseev and others 2020). Drawing on data from a large survey of business owners on Facebook, Alekseev and others (2020) find that 30–40 percent of small businesses did not experience sales declines in the first month of the crisis. Among the businesses that did experience declines, the severity of the decline varies widely from declines of 10–20 percent to nearly complete shutdowns. Moreover, only half of firms surveyed reported struggling to pay obligated expenses (though presumably this share increased over time). Such heterogeneity in experiences is at odds with the one-size-fits-all design of the program’s forgiveness formula.

The evidence also points to other issues with the PPP’s rollout. First, firms that do report struggling to make payments appear to struggle equally to pay rent, wages, and interest on loans. This fact suggests the initial weight of 75 percent on payroll expenses was likely too high. Second, half of firms report not having preexisting relationships with banks as borrowers (Alekseev and others 2020), which appears to have led to such firms initially struggling to access the program and eventually switching lenders in order to receive funds (Rudegeair 2020). Data from the SBA show that, across participating banks, larger firms received funding first, and many smaller borrowers had to wait several months to access the program (Granja and others 2020).

WHAT DID FIRMS DO WITH THE MONEY? The authors focus on a second approach to evaluating the PPP’s success to date. They use data from Dun & Bradstreet and a series of research designs to evaluate the impact of the program on employment, financial performance, and business closures. Their most compelling research design exploits the eligibility threshold of 500 workers; with some exceptions, firms above this threshold could not apply for PPP loans, providing a natural control group.

The authors find modest but statistically significant effects on employment that appear to grow over the six-month period their data cover. These employment effects are largely consistent with Autor and others (2020) and Chetty and others (2020), who use the same research design and data from different payroll processors. Using a bank exposure design at the regional level, Granja and others (2020) find null effects of the program in April that grow to modest effects in May and June. Across studies, the results appear to imply very high cost-per-job estimates (about \$200,000 per job), though recall this metric is probably the wrong way to evaluate this program.

The authors find modest impacts of the program in reducing financial vulnerability and business closures. These findings contrast somewhat with Granja and others (2020), who find no impact on business shutdowns and

large effects on firms' reported cash on hand and propensity to miss obligated loan and other payments. On the other hand, Bartik and others (2020) use a bank exposure design and find that the PPP had large effects on firms' own forecasts of failure probabilities. Reconciling these contrasting findings is a task for future research, as more data become available.

I do have a few concerns with the authors' approach. First, in some analyses, they report differences that compare loan applicants to non-applicants. These differences will tend to overstate program impacts because they do not isolate loan demand effects, which are likely to be correlated with business expenditure plans. For these reasons, I prefer estimates using the worker threshold as an instrument.

Second, the aggregate time series in the Dun & Bradstreet data are extremely stable and indicate very limited aggregate impact of the pandemic and lockdowns on firms in the sample. These patterns stand in sharp contrast to pretty much every other real-time data set available, in which employment appears to fall by between 20 and 60 percent depending on the sample of interest. I worry that the patterns in the Dun & Bradstreet data are an artifact of stale or incomplete measurement and updating. Moreover, if such measurement issues are more pronounced for small firms, this problem will confound estimates that compare firms across size thresholds. My bet is the Dun & Bradstreet data will ultimately be more useful for evaluating the question of permanent closures, once data are comprehensively updated.

PENCILS DOWN The ultimate grade for the PPP will depend on the medium-term impacts that have yet to materialize. We see modest short-term employment effects but more significant improvement in firm balance sheets. The PPP's success will hinge on whether the cost of limited targeting is ultimately offset by the gains from preventing a large number of firm failures. If instead a large share of the funds prove inframarginal, the economic incidence of the program will fall largely on business owners, many of whom would have been able to weather the storm without this support.

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GENERAL DISCUSSION Caroline Hoxby began the discussion by thanking the authors for a terrific paper and Eric Zwick for his excellent discussion. She agreed with Zwick's concern that the Dun & Bradstreet data used in the paper are not very sensitive and are infrequently updated

in comparison to other monthly sources of data. Hoxby then remarked that the specification in column 5 of tables 4 through 6, which compare firms with 400 to 475 employees to firms with 525 to 600 employees, was most persuasive because the control group and treatment group are similar and therefore most comparable. Her concern, however, was that the results for this specification showed very little. Hoxby closed her comments by lamenting that the eligibility threshold was 500 employees because that doesn't allow the authors to identify the effects on very small firms, such as restaurants and small family businesses. She wondered whether any eligibility or identification strategy would allow the authors to look specifically at very small firms.

Joshua Gotbaum asked, via the teleconferencing chat function, whether shifting the program from a wage subsidy to a revenue subsidy made the distributional effects of the Paycheck Protection Program (PPP) regressive, at least in comparison to the European programs.

Gabriel Chodorow-Reich thanked the authors and the discussant and followed up on Zwick's question regarding what firms did with the PPP money. He described his ongoing research with Darmouni, Luck, and Plosser that finds midsize firms were making large repayments on credit lines in the second quarter of 2020, which may be tied to PPP receipt.¹ Chodorow-Reich wondered whether the authors' view of the program's success might be affected if it is true that the same businesses who were getting PPP loans were paying down credit lines.

Jason Furman stated that he would like to see the employment impact of the PPP in December before gauging the PPP's success. He noted that workers could have been given unemployment insurance (UI), which would have saved the firms the cost of their employment. Furthermore, assuming employment is determined by comparing the marginal cost of hiring someone to the firms' marginal revenue product, then the PPP from earlier in the year will have no effect on employment in December. Furman stated that the effects the authors found could have been achieved more cheaply and efficiently through UI. For the PPP to have a lasting effect, he argued, it would need to keep some firms from going bankrupt such that the firm is employing more people in December than they otherwise would have. He concluded that whether a firm is hiring someone in December

1. Gabriel Chodorow-Reich, Olivier Darmouni, Stephan Luck, and Matthew C. Plosser, "Bank Liquidity Provision across the Firm Size Distribution," Working Paper 27945 (Cambridge, Mass.: National Bureau of Economic Research, 2020).

is more likely to relate to the firm's demand than whether they received a lump sum transfer many months earlier.

Austan Goolsbee praised the authors' work but cautioned them on the potential confounds correlated with size. He described recent work with Syverson using phone data of consumer visits to millions of businesses which finds a strong trend of people shopping at smaller, less busy stores correlated with the rise of the pandemic.² Goolsbee noted that, given the paper's use of size to separate treatment and control groups, this would confound the result of the paper; it may look like PPP is benefiting smaller firms when in fact this is an unobserved effect related to increases in relative demand. Goolsbee concluded by offering to share the phone record data with the authors and suggesting they might be able to match some firms in their sample.

Steven Davis began by following up on Furman's point regarding the cost of the PPP program relative to other systems of distributing support to workers. He restated that the cost per worker of using the PPP to support workers is much larger than it would have been through the UI system. He asked whether the PPP was better than UI at preserving worker-firm matches in some way, and if so in what way. Relatedly, he pointed out that it's not clear that retaining worker-firm matches is valuable given the kinds of employees who work for PPP-targeted firms. Davis noted that the displaced worker literature largely focuses on mass layoff events affecting high-tenure workers at large firms, typically in industrial jobs. He contrasted this with the jobs lost in the pandemic, which he argued are very different, involving much less match-specific capital and match-specific rents than workers studied in the displaced worker literature.

Davis went on to note that he knows little about the value of business continuity for the population targeted by the PPP. He suggested that if there is great evidence that business continuity is of high value beyond the value to the business owner, the discussion should emphasize this. Davis also wondered if the PPP, by sustaining incumbent firms, crowds out new firms. He noted that the Census Bureau now draws on administrative records to tabulate monthly business formation statistics by state and by industry. He suggested it would be interesting to use these data to investigate whether industries and states that received more PPP support show evidence of crowding-out effects in the form of weaker business formation.

2. Austan Goolsbee and Chad Syverson, "Fear, Lockdown, and Diversion: Comparing Drivers of Pandemic Economic Decline," Working Paper 27432 (Cambridge, Mass.: National Bureau of Economic Research, 2020).

Davis concluded by noting that the PPP, the \$600 federal benefit supplement, and other recent expensive fiscal programs have been motivated by the need to compensate for administrative weaknesses in the UI system. To that end, he wondered what the cost of fixing the administrative weaknesses would be and posited it might cost a few tens of billions of dollars, which is much less than the trillion dollars spent on the current programs. Davis remarked that this would likely belong in a separate paper from the authors' current one.

Katharine Abraham seconded Davis's point regarding the administrative capacity of the UI system, noting that the system infrastructure is fragile and inflexible. She lamented that many states' UI systems still use COBOL software and many more couldn't easily be modified to pay workers a higher replacement rate rather than a flat supplement to their benefit amount.

Abraham then followed up on Furman's and Davis's comments stating that it would have been cheaper to allow individuals to be laid off and get UI than to keep them attached to their jobs through the PPP. Besides the value of business continuity and increasing the likelihood of workers still being employed in December, she stated, there is also value in reducing unemployment. Even beyond the associated loss of income, unemployment imposes significant mental and physical costs on affected individuals. Abraham argued that the value of the PPP thus includes the value to workers of having a job, even if the job eventually ends. She concluded that this should affect how the authors consider the policy's effectiveness.

Glenn Hubbard thanked the discussant and the audience for their questions. In response to the comments regarding alternatives to the PPP, he reiterated that the value of worker-firm matches and business continuity is still unknown, making it difficult to decide whether it would have been better to put people on UI, irrespective of the UI system's administrative deficiencies.

Hubbard then agreed that the authors hoped to find an effect using the specification Hoxby noted she most preferred, found in column 5 of the results tables. Hubbard added that the authors suspect this specification did not show any significant results because this specification focuses on relatively larger firms and the effects are mostly found in much smaller firms.

Hubbard concluded by addressing a question in the teleconferencing chat function regarding targeting. Hubbard noted that it would have been preferable to know exactly who could have been helped because that would have been more efficient, but there is no way to know. Given that the value of worker-firm matches and business continuity are also unknown, Hubbard stated that it isn't obvious what the alternatives to the PPP were.

Michael Strain also thanked the discussant and audience for their comments. He then noted that the authors attempted to evaluate the program empirically, using specifications with different treatment and control groups, using treatment-on-the-treated effects and intent-to-treat effects. One such specification, he notes, is comparing only firms with one to 250 employees, using loan application as the treatment. Strain argued that this specification addresses some of the concerns about comparing firms with one to 500 employees to firms with 501 to 1,000 employees. However, he also acknowledged that their data only show firms that applied for a loan greater than \$150,000, which muddles the control group. Strain added that there could also be issues with comparing groups based on eligibility because the PPP likely affected firms with 450 employees very differently from firms with 15 employees. The authors attempted to navigate these empirical challenges accordingly, he said.

Strain then turned to Furman and others' point regarding alternatives to the PPP. He stated that part of the program's goal was to preserve the productive capacity of the economy over the medium term until the pandemic had subsided. Moreover, the program was promoted as an employment program which would make comparisons to UI natural, but he argued it was more along the lines of a continuity program for businesses. For example, a restaurant might survive the economic downturn due to the PPP, Strain said. He added that it's reasonable to believe that the PPP loan doesn't affect how many workers the restaurant hires in nine months; however, the conclusion shouldn't be that the PPP failed, he argued, because the business survived. Perhaps without the revenue replacement the restaurant received from the grant the business otherwise wouldn't be there at all, he said.

Strain concluded that when comparing the costs of the PPP to UI, it is crucial to consider whether the period of economic weakness was shorter because the PPP supported labor demand over the medium term during the transition by averting millions of business closures that otherwise would have happened. He noted that while this is difficult to quantify, comparing UI costs to the PPP would need to account for these concerns holistically.

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Sizing Up Corporate Restructuring in the COVID-19 Crisis

ABSTRACT In the wake of the COVID-19 pandemic, the financial and legal system will need to deal with a surge of financial distress in the business sector. Some firms will be able to survive, while others will face bankruptcy and thus need to be liquidated or reorganized. Many surviving firms will need to be downsized or acquired. In normal times, this triage is supported by the court system, banks, and financial markets. The goal of this paper is to size up the coming surge of financial distress, list the challenges it presents in the current environment, and offer potential policy solutions. Overall, our analysis suggests that the two key issues will be court congestion and excess liquidation and failure of small firms.

The 2020 coronavirus pandemic is an economic shock of unprecedented magnitude. In the first two quarters of 2020, US GDP contracted by 9.5 percent, with many forecasters anticipating at best a slow recovery and persistent output gap for years to come.¹ Even if the most acute effects of the shock turn out to be temporary, the consequences for many businesses

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1. While, as of February 14, 2020, economic forecasters polled by the Survey of Professional Forecasters anticipated cumulative growth over 2020–2022 of 5.8 percent, as of August 14, they expect growth over 2020–2023 to be 3.5 percent. Thus, even though they expect a clear rebound in 2021, professional forecasters anticipate an output gap (compared to earlier forecasts) lasting well into 2023.

will be severe. Many have failed already, others will have to undergo major changes in order to survive. Failure may mean acquisition by a rival, voluntary exit, or liquidation. Even surviving firms may have to renegotiate debt, raise fresh funds, or downsize.

In normal times, the triage between dying and surviving firms is implemented by bankruptcy courts and financial markets. This architecture is generally suited to the job but gets stretched during recessions. This time around, the size of the task appears daunting.

The goal of this paper is to estimate how many firms will fail, evaluate how effective the triage will be, and what, if anything, should be done to help it occur efficiently. We size up the coming surge of financial distress, list the challenges it presents to the legal and financial architecture in the current environment, and close by describing potential policy solutions.

To set the stage, we estimate the upcoming increase in financial distress. To do so, we first show that the impact on firm profits and revenues so far is comparable to the worst quarter of the 2008–2009 financial crisis. But analyst forecasts beyond 2021 suggest the intermediate-term consequences will be milder. We then turn to forecasting the impact on corporate leverage, which will rise as a function of the severity and length of the recession. Using a methodology similar to Crouzet and Gourio (2020), but using data on smaller firms, we forecast the impact of reduced revenues and profits on corporate balance sheets.² Unsurprisingly, the effects will be particularly acute for the smallest firms in the economy because they have weaker initial balance sheets and, to a lesser extent, larger fixed costs. Then, relying on analysis by Ma (2020) and Altman (2020), we forecast bond ratings downgrades and defaults. The number of defaults can be expected to increase substantially in the coming year. We perform a similar analysis to forecast business bankruptcy filings based on unemployment rates. Based on the unemployment rate at the time of writing, we expect overall bankruptcies to increase by as much as 140 percent in the current year.³ By all metrics, corporate financial distress is set to increase.

In section II, we discuss the challenges posed by this surge to the legal and financial infrastructure that deals with corporate distress. This

2. See also Gourinchas and others (2020) for a related analysis.

3. Despite the economic headwinds, the pace of business bankruptcy filings in 2020 has been modest, with a strong uptick among the very largest US companies but little change among small businesses. Among the largest US public companies, bankruptcy filings have been concentrated in industries and companies in distress well before the pandemic (retail, energy). See Wang and others (2020) for details on bankruptcy filing trends during the pandemic.

infrastructure usually triages among financially distressed firms, filtering those that will disappear (liquidate) from those that will reemerge (restructure). This time, because of the unprecedented amount of distress as well as the uncertainty created by the pandemic, this triage may be difficult to implement, leaving some firms wrongly liquidated, while other firms remain artificially alive.

First, we investigate the oft-cited claim that the COVID-19-led recession will require a large amount of cross-industry or cross-regional reallocation of capital, reducing the need for the bankruptcy system to cull those firms worthy of restructuring. To be sure, the short-run impact of COVID-19 has had a significant industry component: airlines and hospitality, among other industries, have been hard hit. But reallocation depends on longer-term prospects of these industries. To test this, we calculate the dispersion of equity analyst forecasts of firms' future earnings at various horizons. Such expected dispersion is in general a reliable indicator of *ex post* realized dispersion. Since the crisis, it has, if anything, decreased. Second, we quantify court capacity constraints. We predict that the coming surge of bankruptcies could increase the judge caseload by 158 percent from 2019 levels, well beyond the caseloads seen in 2009–2010. Third, we contrast the fates of small and large firms. Looking at the data, we show that small firms restructure very rarely. This is especially worrisome as the balance sheets of small firms are hit the hardest by the current recession. Fourth, we discuss the availability of financing for firms undergoing restructuring. When in the process of redrafting their capital structures, firms typically need to rely on debtor-in-possession (DIP) financing (DeMarzo, Krishnamurthy, and Rauh 2020). Relying on analysis by the Bankruptcy and COVID-19 Working Group (2020), we appraise the amount of such financing needed to handle the coming wave of restructuring. We find the required amount to be very small relative to the size of the corporate debt market. Fifth and last, we note that to handle default, banks must be able to absorb large losses on their corporate loan portfolios. Our estimates suggest that, for the moment, US banks have sufficient capacity to absorb losses on commercial loans. Overall, our analysis suggests that the two key issues will be court congestion and excess liquidation of small firms.

Building on the growing list of proposals that have circulated in the wake of the crisis, section III discusses policy options that could make the triage of distressed firms more efficient. We focus on two key issues: alleviating court congestion and targeting smaller firms. A first form of solution consists of encouraging out-of-court restructuring for smaller firms. We discuss moratoria and payment deferral schemes, which essentially

freeze debt repayment for a limited amount of time. Such moratoria have been implemented in many countries around the world and could be implemented in the United States. Another approach has been suggested by Greenwood and Thesmar (2020), who propose a tax credit for lenders and landlords who accept a haircut on existing loans to small businesses. Overall, restructuring subsidies and payment deferrals are options that target the frictions associated with the liquidation of small businesses. At the same time, even in ordinary times, just over half a million establishments per year close, suggesting that these programs must be tailored to avoid subsidizing too many inefficient firms.

A second set of policy options consists of changing the bankruptcy process itself. Iverson, Ellias, and Roe (2020) focus on court staffing. They estimate that, by recalling between 50 and 250 judges, the US court system would ensure that caseload by bankruptcy judge stays at the level of the 2009 crisis. Other policies are related to bankruptcy law. We discuss a recent provision enacted right before the pandemic, Subchapter V of the bankruptcy code, which offers an off-the-shelf streamlined process for small businesses to access restructuring. In recent months, Subchapter V filings have been increasing, but take-up is still limited with only 506 total Subchapter V filings as of June 2020 (Epiq 2020). We also discuss recent proposals by Stiglitz (Coy 2020), who suggests a large-scale, administrative procedure to substitute debt for government-sponsored equity, and by Blanchard, Philippon, and Pisani-Ferry (2020), who propose that the government accept larger haircuts than other creditors, conditional on the firm reemerging from bankruptcy.

Our paper complements a growing number of studies on the impact of the COVID-19 crisis on firms. Gourinchas and others (2020) calibrate a model in order to forecast the number of bankruptcies among small to medium enterprises (SMEs) in Europe; our forecasting approach is based purely on the statistical correlation between unemployment and failures. Brunnermeier and Krishnamurthy (2020) discuss the notion of excess leverage and the effect of the Federal Reserve policies on debt overhang. Hanson and others (2020) and Saez and Zucman (2020) emphasize direct government support to firms via grants. Compared to these papers, our focus is on how to deal with firms once they are in extreme distress or have already failed. To be sure, if the crisis is short and the landscape of economic activity looks similar post-pandemic, it may well make sense to keep as many firms as possible alive, with the government subsidizing firms to avoid macroeconomic scarring. But the longer the crisis, the more the burden should be shared between the government and private creditors and equity holders.

I. The Impact of the COVID-19 Shock on US Businesses

As of September 2020, the ultimate length of the economic crisis is still highly uncertain. However, it seems clear that the most acute effects of the crisis on US firms occurred in the second quarter of 2020, when some industries—including airlines, restaurants, and hotels—came to a virtual standstill. This section seeks to estimate the impact of the pandemic on creating distress and restructuring among US businesses, large and small.

I.A. Revenues and Earnings for Small and Large Firms

Early in the pandemic, the US Census administered weekly surveys to small and medium-sized enterprises on the impact that COVID-19 had had on their business. Panel A of figure 1 plots data from the most recent of these surveys, administered in late July 2020. We show the percentage of small firms, by NAICS sector, that report the pandemic having a large negative effect on their business. The figure reveals the well-known pattern that entertainment, restaurants, and hotels were the most severely affected sectors. In the next group, more than 40 percent of firms in the mining, oil and gas, transportation, and health care sectors reported severe adverse impact on their business. Overall, with the exceptions of utilities, construction, and finance and insurance, all sectors have a significant share of firms that have experienced negative effects of the pandemic.

More detailed measures of firm impact can be constructed for public firms, which report quarterly revenues. Panel B of figure 1 presents the percentage change in revenue between the second quarter of 2019 and the second quarter of 2020, weighted by 2019 revenues, for the same two-digit NAICS sectors shown in panel A based on data from Compustat. To preserve comparability across firms and sectors reporting at the same time, we limit the sample to firms with US headquarters and fiscal years that end in December, March, June, or September. As can be seen, the sectors experiencing the greatest impact for smaller firms are also hit among larger companies: entertainment, restaurants, and hotels. But there are differences: smaller firms are hit more severely than the typical Compustat firm.

Panel C of figure 1 shows the distribution of revenue changes for the full universe of public firms. For larger firms, the shock is big, but so far, its magnitude is similar to the Great Recession of 2009. Revenues for the median firm dropped by 9.4 percent between 2019:Q2 and 2020:Q2, while median growth between 2008:Q1 and 2009:Q1 (the trough of the 2009 crisis) was –8.1 percent, based on our calculations on the universe of public firms.

Figure 1. Impact of the Pandemic on US Businesses

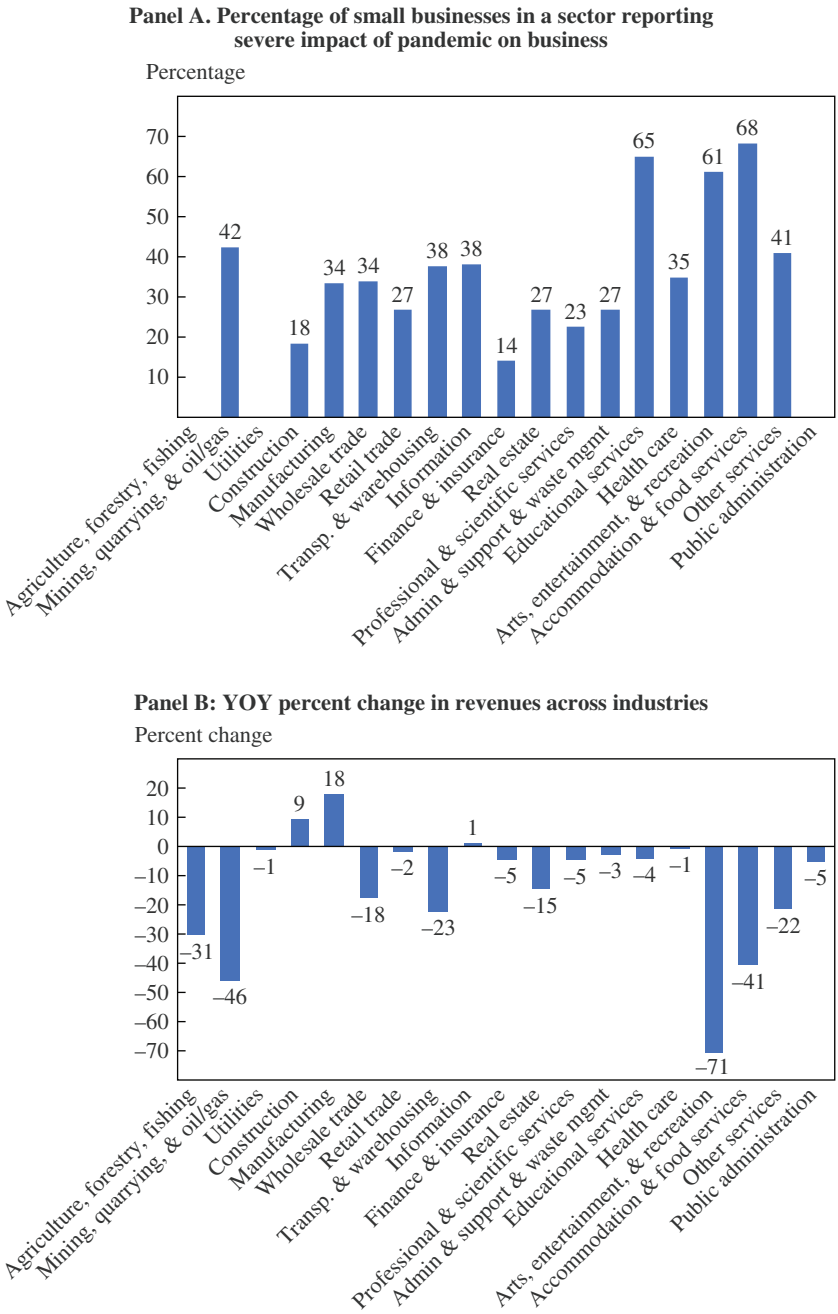
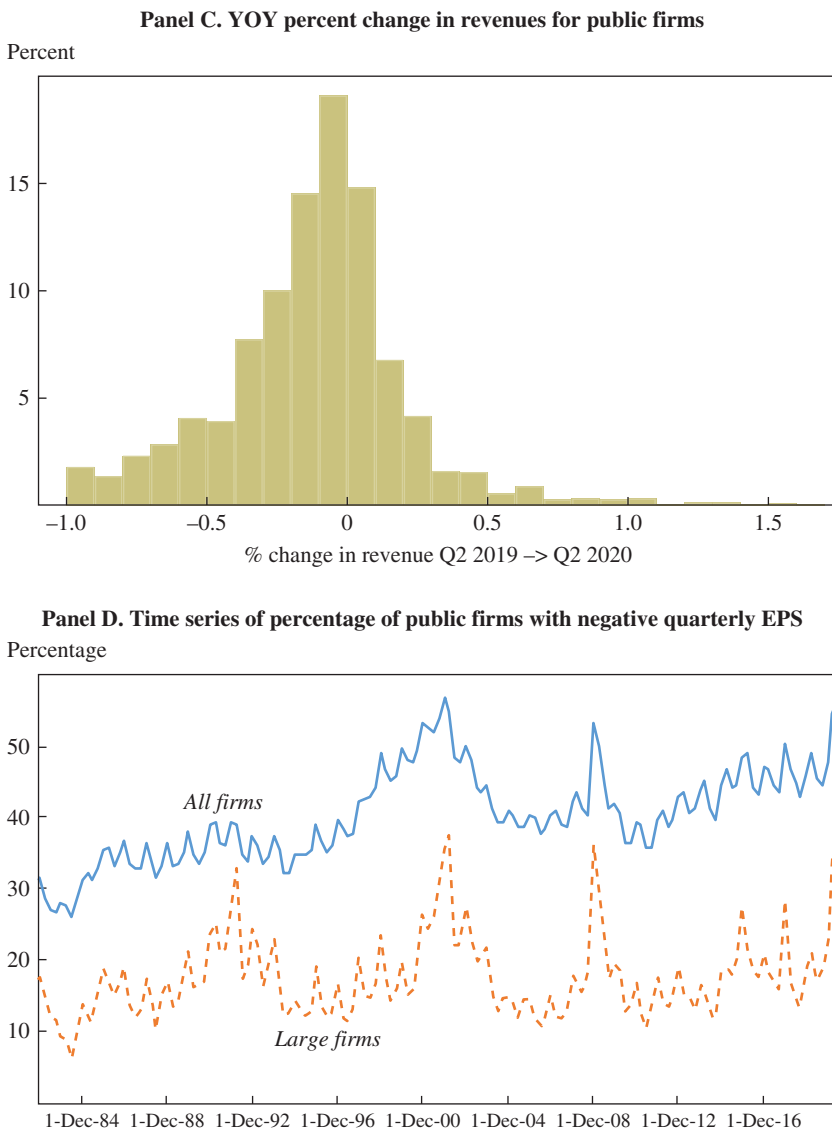


Figure 1. Impact of the Pandemic on US Businesses (*Continued*)

Sources: June 2020 Census Bureau Small Business Pulse Survey; Compustat.

Note: This figure displays various measures of how the pandemic has affected revenues and earnings of US businesses. Panel A displays the share of small businesses who report a severe negative impact of the pandemic on their business. Panel B shows the average percentage change in revenues from 2019:Q2 to 2020:Q2 by two-digit NAICS industry, weighted by 2019 revenues, from Compustat. Panel C displays a histogram of these same year-over-year percent changes in revenues across all firms in Compustat. Panel D shows the percentage of public firms with negative earnings per share in that quarter. For panels C and D, we exclude financials.

Compared to the Great Recession, the effect of the COVID-19 crisis on sales is more left-skewed than the financial crisis. As can be seen from panel C, more than 10 percent of firms lost over half their revenues in 2020:Q2, while only about 5 percent of firms lost half their revenues at the trough of the 2009 crisis. Suspecting that this strong left tail could have been magnified by (operating and financial) leverage effects, we zoom in on the share of firms reporting negative earnings, shown in panel D of figure 1. Among the largest firms, 37 percent report negative earnings in 2020:Q2, a number strikingly similar to the first quarter of 2009 and the first quarter of 2001. While the shock on sales is more left-tailed compared to the financial crisis, the share of firms with negative earnings is not larger (so far). This suggests that the most severely hit firms had more flexible cost structures. The length of the crisis is still unknown, however, limiting the value of this comparison.

To help make the comparison between 2020 (which is ongoing) and 2009 (which is completed), we turn to analyst forecasts, which allow us to go further into the future. We use the same data as Landier and Thesmar (2020), which contain, for the largest 1,000 firms, analyst forecasts of earnings for years 2020, 2021, and 2022 from data provider Refinitiv.⁴ Table 1 summarizes the revision of earnings forecasts for different sectors since mid-February. For each industry, we compute the unweighted average of the growth in earnings forecasts between February 2020 and May 2020. We exclude firms for which the beginning-of-period forecast of earnings is negative. We compare these estimated growth rates to the beginning of the Great Recession. Specifically, for the earlier period we compute the percentage revision between June 2008 and March 2009. The table shows that, from the point of view of large public firms, equity analysts do not believe that either the short- or long-term effects will be even half of what they believed would happen at the beginning of the Great Recession. Second, the short-term dispersion of revision is modest compared to 2009, at both short and longer horizons. This is consistent with the idea that the COVID-19 shock is expected to have a relatively

4. For these larger firms, we show in online appendix table B.1 that these forecasts have been reliable (i.e., unbiased) at a one-year horizon, while slightly optimistic at longer horizons. It is well known that analyst forecasts at a one-year horizon used to be biased toward optimism in the 1990s on the universe of Institutional Brokers' Estimate System (IBES) firms. But even on this sample, short-term optimism has essentially disappeared since the late 1990s (Kothari 2001).

Table 1. Impact of COVID-19 on Earnings of Public Firms

<i>Forecast horizon</i>	<i>Growth in Expected Earnings between Jun 2008 and Mar 2009 (%)</i>		<i>Growth in Expected Earnings between Feb 2020 and May 2020 (%)</i>	
	<i>FY 2009</i>	<i>FY 2011</i>	<i>FY 2020</i>	<i>FY 2022</i>
<i>Revision of industry forecasts</i>				
Communication	-50	-35	-19	-13
Consumer discretionary	-75	-47	-25	-17
Consumer staples	-13	-15	-10	-7
Energy	-40	-24	-19	-20
Financials	-16	-21	-25	-13
Health care	-18	-31	-15	-5
Industrials	-37	-32	-24	-15
IT	-44	-19	-12	-9
Materials	-47	-28	-19	-9
Real estate	-71	-32	-33	-7
Utilities	-17	-13	-3	0
<i>Aggregate statistics</i>				
Mean	-39	-27	-19	-10
Cross-sectional dispersion	22	10	8	6

Source: IBES.

Note: Industry forecasts of the impact of COVID-19 on earnings, contrasted with the Great Recession. For each industry, we compute the unweighted average of the growth in earnings forecasts between the beginning and the end of the period. We exclude firms for which the beginning of period forecast of earnings is negative.

homogeneous impact across these large firms. In section II, we will use a version of this dispersion to appraise the extent of future expected reallocation.

To sum up, based on looking at current and expected earnings and revenues, large public firms have experienced less impact than is commonly supposed, both in terms of realized and expected earnings. For these large firms, the effect of the recession can be expected to be relatively homogeneous. Meanwhile, for smaller firms, the Census Bureau Small Business Pulse Survey suggests that the shock seems to be stronger. We explore this further below.

1.B. Is the COVID-19 Crisis Biased toward Industries with Predominantly Smaller Firms?

We lack timely and granular data on the financial position of small firms, but we can study indirect measures of small firm exposure by asking

whether industries and sectors that are disproportionately populated by small firms (agriculture, construction, restaurants) are also those industries and sectors that are having the most impact by the COVID-19 shock. Panel A of figure 2 provides a simple depiction of this by plotting the sector-level unemployment rate in July 2020 against the share of total employment in that sector represented by small businesses. As can be seen, leisure and hospitality suffered the largest increase in unemployment, but overall this industry falls in the middle of the distribution in the mix of small and large firms (restaurants are mainly small firms, but hotels include many large firms, for example). Overall, there is no discernible correlation between sector-level unemployment and the small business employment share.

Panel B of figure 2 shows a related analysis. The solid line shows the national unemployment rate. The dashed line shows the unemployment rate based on the sum of sector-level unemployment rates in every month, weighted by small business employment. As can be seen, these two series track each other closely, including in the most recent period.

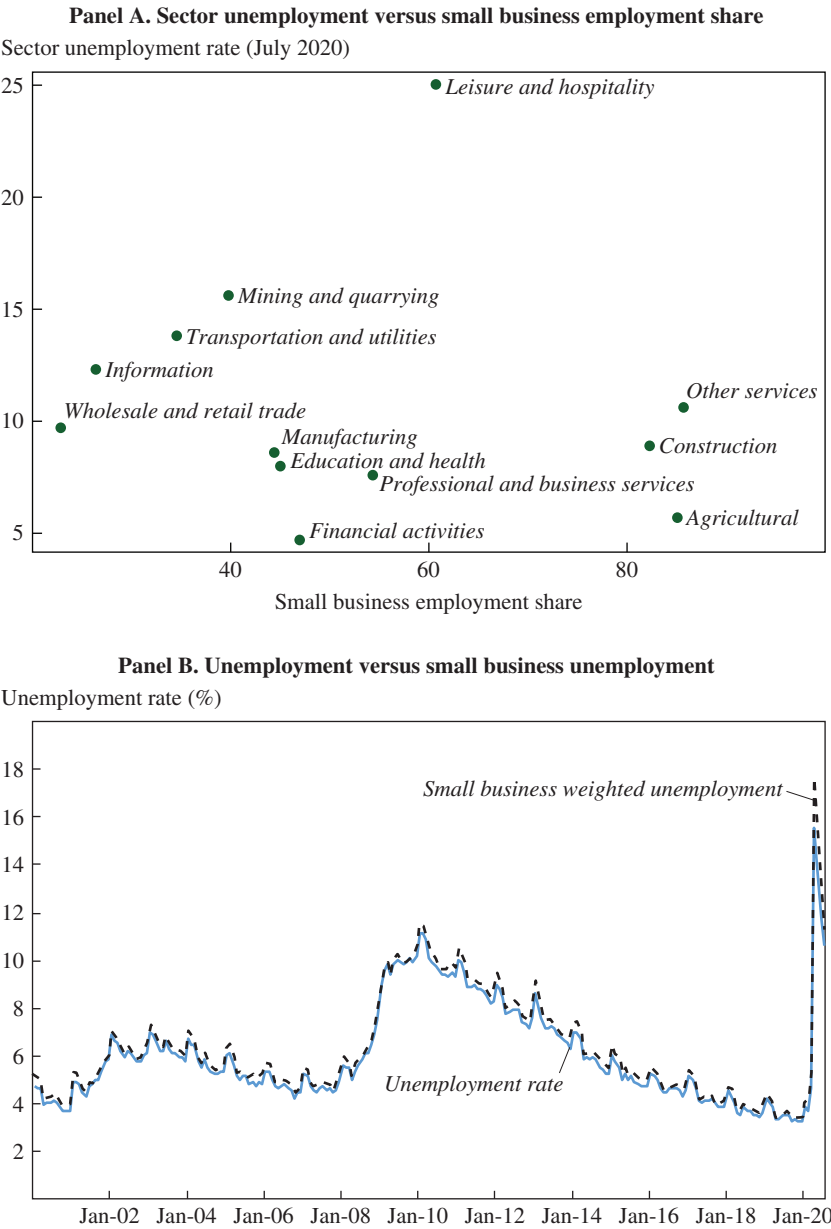
1.C. Impact on Leverage Ratios

Crouzet and Gourio (2020), in a series of Federal Reserve blog posts, explore the financial position of US public firms as they enter the pandemic and make forecasts of their leverage in the coming year. Many nonfinancial publicly traded companies entered 2020 with elevated leverage compared to the historical average, but only slightly. However, they suggest that the fragility is tempered by their low level of interest expense and high cash positions.

Crouzet and Gourio (2020) forecast the future liquidity position of public firms using assumptions about the impact of COVID-19 on operating cash flows and holding fixed payouts and investment. Although they forecast 30 percent of firms exhausting their cash buffers by the third quarter of 2020, the implications are softened by the heightened availability of credit for public firms.

There is much less information available on the financial structure of smaller, unlisted businesses. However, for selected years the IRS publishes aggregate income statement and balance sheet data by size class through the Statistics of Income (SOI) data set. Table 2 summarizes statistics from these data for the most recent year available, which is 2013. Shareholders' equity is the sum of capital stock, paid in capital, and retained earnings. Leverage is one minus the ratio of shareholder equity to assets. Smaller

Figure 2. Where Does the Burden of the Covid-19 Shock Fall?



Sources: US Small Business Administration 2018 Small Business Profile; Bureau of Labor Statistics.
Note: Panel A plots sector-level unemployment in July 2020 against the small business share of employment. Panel B plots the national unemployment rate (solid) alongside the unemployment rate weighted by the small business share of employment in that sector (dashed).

Table 2. Forecasting the Impact of COVID-19 on Balance Sheet Health

	Firm assets					
	0.5–\$1 million	< \$5 million	< \$10 million	< \$25 million	< \$50 million	< \$100 million
Equity (\$ billions)	264	881	497	755	667	828
Assets (\$ billions)	78	305	183	304	250	366
Equity/assets (%)	30	35	37	40	37	44
Revenues/assets (%)	252	208	194	181	140	106
Cost of goods sold/revenues (%)	51	59	66	70	69	67
Other expenses/revenues (%)	45	37	31	27	28	30
Debt/assets (%)	70	65	63	60	63	56
Forecasts after 30 percent revenue drop						
Debt/assets (after) (%)	97	84	77	71	72	63
Δ Debt/assets (after – before) (%)	+27	+19	+14	+11	+9	+7

Sources: Authors' computation using the Internal Revenue Service 2013 Statistics of Income Data; 2019 Compustat.

Note: The last line shows the simulated debt-to-assets ratio if firms in the group were in aggregate to experience a 30 percent revenue drop but hold their fixed (non-COGS) expenses fixed over the same interval. We exclude businesses with under \$500,000 of total assets. "Other expenses" equals total expenses minus cost of goods sold. The last column shows the same exercise for all public nonfinancial firms with US headquarters listed in Compustat.

businesses have dramatically higher leverage ratios, relying heavily on bank debt and loans from shareholders.⁵

In the spirit of Crouzet and Gourio (2020), we ask what would happen if businesses in each size class experienced a 30 percent decline in revenues with no decline in fixed expenses, except for cost of goods sold, which scales with revenues. For simplicity, in this exercise we assume no investment. Table 2 shows these results. For the smallest businesses (less than \$1 million in revenue), a 30 percent drop in annual revenue with no offsetting change in fixed expenses is enough to effectively wipe out the equity in the business. This comes from two forces: smaller firms have higher leverage to start with but also much larger ratios of fixed expenses to sales and higher asset-to-sales ratios.⁶

1.D. Predicting Credit Downgrades and Defaults

Ma (2020) draws on seventy-two years of historical data from Moody's Default and Recovery Database to forecast default and downgrade rates for firms rated by Moody's. Across rating classes, she finds that increases in the unemployment rate and declines in real GDP growth strongly predict higher probabilities of a rating downgrade. Drawing on recent forecasts of the unemployment rate and real GDP growth for 2020–2022 from professional forecasters, she predicts significant increases in downgrades, rating withdrawals, and default.

Of the 4,476 issuers overseen by Moody's at the start of 2020, 1.4 percent had defaulted and 3.4 percent had had their rating withdrawn by June 2020. Ma forecasts that an additional 4.9 percent will default and an additional 8.8 percent will have their rating withdrawn by the end of 2020. According to her estimates, as of July 2020 the US economy is through only about a fifth of the predicted number of defaults for this year, not to mention the additional defaults in the following years. Using different methodologies, Altman (2020) also forecasts default rates in 2020, using

5. Some caution is warranted in interpreting financial statements for the very smallest firms in the economy, those with total assets under \$0.5 million. These firms have low book assets, typically no external shareholders, and limited retained earnings because they are pass-through corporations. For the slightly larger small firms, these concerns are somewhat alleviated. We focus on the next larger set of firms, those with assets between \$0.5 million and \$1 million.

6. Carletti and others (2020) implement a similar analysis on Italian firms. They estimate that the lockdown will lead about 17 percent of Italian firms to end up with negative book equity. These firms are disproportionately smaller firms. We cannot conduct the same analysis since we do not have details about the distribution of small firms' balance sheets.

data at the bond and issuer level. His conclusions are similar, forecasting an aggregate bond default rate of 5.75 percent.

1.E. Predicting the Rate of Bankruptcy

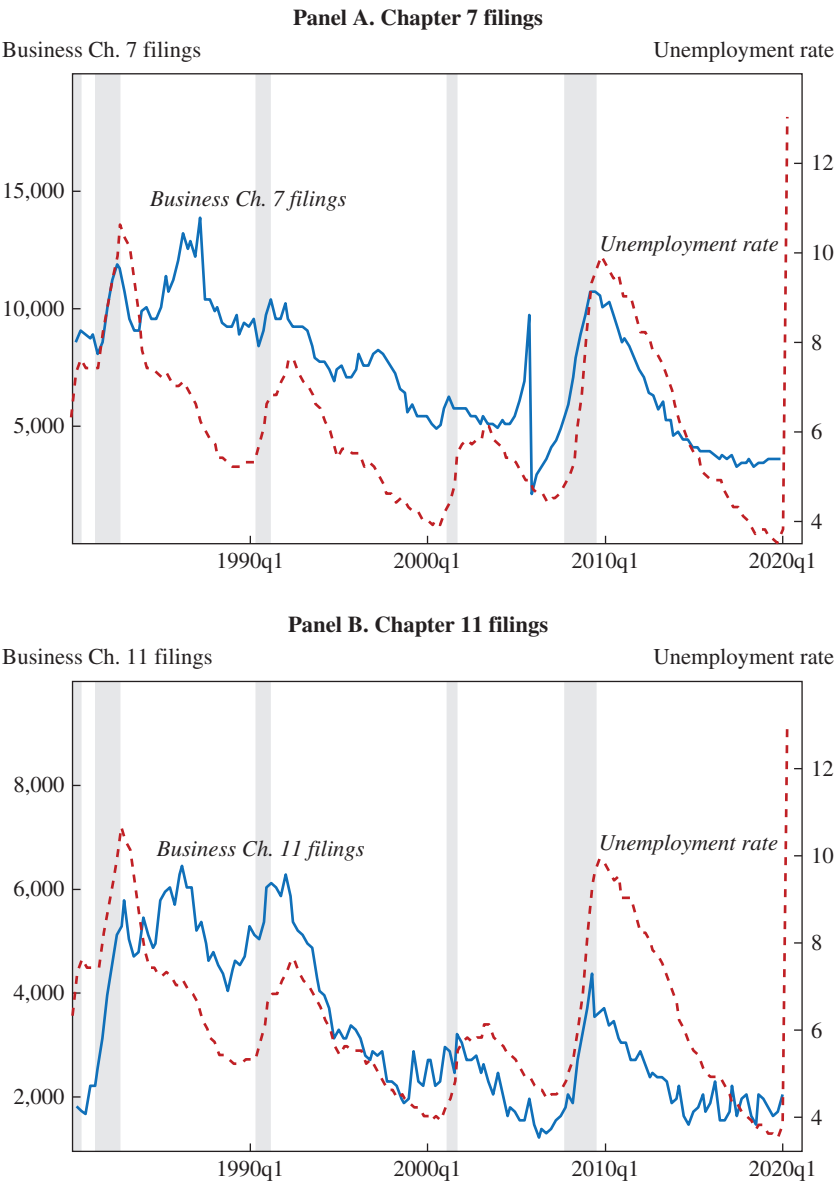
The most severe form of financial distress is firm failure or bankruptcy. Despite the economic headwinds, the pace of business bankruptcy filings in 2020 has been modest, with large increases among the largest US companies but little change among small businesses (under one hundred employees). Through August 2020, overall business bankruptcies are actually 1 percent *lower* than the same time frame in 2019. However, larger firms have been entering bankruptcy at higher rates, with overall Chapter 11 bankruptcies up 35 percent relative to 2019 and bankruptcies of firms with more than \$50 million in assets rising by 194 percent (Wang and others 2020). But bankruptcy filings by the largest US public companies have been concentrated in industries and companies that were experiencing distress well before the pandemic or lockdown period. Among the largest twenty firms by assets filing for bankruptcy in the first two quarters of 2020, five were in retail and apparel sectors and seven were in oil and gas and mining (Shen 2020).

There is a strong and intuitive historical relationship between unemployment rate—as a high-frequency measure of economic conditions—and the frequency of business bankruptcy. Figure 3 shows the close historical relationship between business bankruptcy filings nationally and the national unemployment rate, based on official filing statistics from the Administrative Office of the US Courts. Panel A plots the relationship for business Chapter 7 (liquidation) filings, which are dominated by small businesses. Firms that file for Chapter 11 (reorganization), shown in panel B, are generally larger than those that enter Chapter 7, but still contain many small firms as well. If historical trends are repeated, an unprecedented number of bankruptcies is on the horizon.

Following Iverson, Ellias, and Roe (2020), we forecast business bankruptcies based on an expected unemployment rate from 2020:Q3 to 2020:Q4 of 9.2 percent from the Survey of Professional Forecasters.⁷ Based on the historical relationship between bankruptcies and unemployment, a 9.2 percent unemployment rate predicts that the pace of business bankruptcy filings can be expected to increase by 140 percent relative to its

7. Federal Reserve Bank of Philadelphia, “Survey of Professional Forecasters,” <https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/survey-of-professional-forecasters>.

Figure 3. Business Bankruptcy Filings as a Function of Economic Conditions



Sources: Bureau of Labor Statistics (unemployment rate); Administrative Office of the US Courts (Chapter 7 and Chapter 11 filings).
Note: This figure displays time series plots of the US unemployment rate (both panels) against total business Chapter 7 filings (panel A) and Chapter 11 filings (panel B).

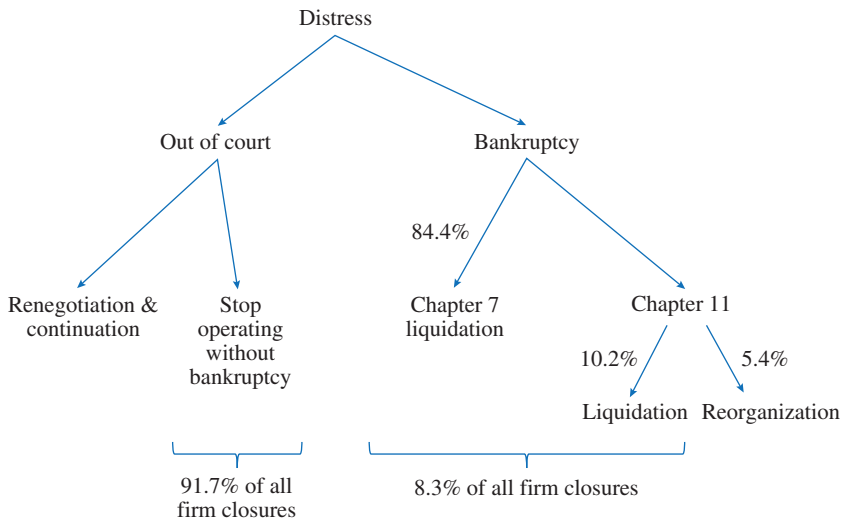
2019 level. Importantly, this forecast uses unemployment rate forecasts while ignoring the recent path of unemployment rates of 14.7 percent, 13.3 percent, 11.1 percent, and 10.2 percent in April, May, June, and July 2020. Even though much of this spike reflects temporary shutdowns, it is likely that the stresses of the initial lockdown period will lead to bankruptcy for some firms.⁸

These forecasts raise the question of why current business bankruptcy filings are so low. One reason could be policy, including the Coronavirus Aid, Relief and Economic Security (CARES) Act, Paycheck Protection Program (PPP), Main Street Lending Program, and the extension of unemployment insurance. Second, many of the triggers that force restructuring and bankruptcy have been relaxed. In the lead-up to the pandemic, loan covenants for public firms were notably light, resulting in fewer technical defaults and hence fewer renegotiations (Chappatta 2020). And, when firms have defaulted, lenders and landlords have been relatively lenient in allowing excess time to cure missed payments. Evidence suggests that missed payments have been quite common. For example, the Census Bureau Small Business Pulse Survey shows that 11.5 percent of all small businesses had missed a loan payment by the first week of May, and 23.6 percent had missed other payments such as rent. If lenders have been willing to be lenient thus far, many firms that have missed payments may avoid bankruptcy, at least in the short run. If these factors are only temporary, low bankruptcy numbers seen so far are a period of calm before the storm. On the other hand, if these factors actually prevent financial distress for many firms, our forecasted number of bankruptcies could be too high.

II. Triage of Distressed Firms in the Recession

In this section, we first describe the triage-type process by which distressed firms shut down, liquidate, or get reorganized. Within this framework, we lay out several frictions that could prevent efficient liquidation or restructuring from occurring. Our overriding goal is to identify the specific restructuring frictions that COVID-19 could exacerbate as well as those which might not be as concerning.

8. Iverson, Elias, and Roe (2020) explicitly adjust bankruptcy forecasts for temporary unemployment. Even with this adjustment, their methodology results in forecasted bankruptcy increases of close to 100 percent. Further, forecasts of the unemployment rate arguably already account for the temporary nature of the unemployment seen in the second quarter of 2020.

Figure 4. The Triage Process of Bankruptcy

Sources: Federal Judicial Center Bankruptcy Petition Database; 2000–2016 Census Bureau Business Dynamics Statistics.

Note: This figure displays a schematic of how firms deal with financial distress. Percentages listed under the bankruptcy branch represent the number of firms that go through each process. We classify as liquidated all firms that enter Chapter 11 and are either converted to Chapter 7 or dismissed from court. Percentages listed at the bottom of the diagram are estimates of the share of firm closures that occur in and out of court. We compute these figures using the total number of firm exits and comparing this number in each year to the number of firms that liquidate in bankruptcy.

II.A. Triaging Distressed Firms in a Wave of Corporate Distress

How does the bankruptcy process triage distressed firms? To fix ideas, consider a firm with continuation value V , liquidation value L , and debt repayment D . The firm is financially distressed: V is close to D . It has barely enough future cash flow to pay back its debt. The flow chart in figure 4 describes the different outcomes of financial distress and the empirical probabilities associated with each branch of the tree.

CONTINUATION If $V > D$ and $V > L$, the firm has enough resources to pay back its debt. It can and seeks to continue to operate. But because V is close to D , it may underinvest. This is the classic problem of debt overhang: debt holders absorb a disproportionate share of the value created by new projects, so that junior investors—especially shareholders—are reluctant to fund them.⁹ The solution in this case would be an informal, out-of-court restructuring to reduce D , though this rarely happens in practice.

9. See Brunnermeier and Krishnamurthy (2020) for a recent presentation.

EXIT If $L > D$ but $V < L$, the firm simply stops operating without filing for bankruptcy. The entrepreneur liquidates the firm, pays lenders, and pockets the residual. This often occurs for small businesses such as restaurants. For small businesses, such voluntary exit also happens when $D > L$, that is, liquidation proceeds do not cover existing obligations. Technically, the firm should file for bankruptcy, but for small firms the fixed cost of doing so often outweighs the potential benefits for claimants such as landlords or lessors.

Exiting out of court is incredibly common. Statistics from the Census Bureau's Business Dynamics Statistics database show that, in the past twenty years, 91.7 percent of firms that exit do so outside of bankruptcy.

BANKRUPTCY WITH STRAIGHT-OUT LIQUIDATION When $V < D$ and $L > V$, the firm defaults on payments, places itself under the authority of a court of justice, and is liquidated. In some instances, the entire firm is sold off. In others, assets are sold separately (piecemeal liquidation). This is the most common path for bankrupt firms, particularly for smaller businesses. US Courts bankruptcy filing statistics show that, among firms going through a formal bankruptcy process, 84.4 percent of the firms go through this process as opposed to the Chapter 11 filing that we describe below.¹⁰

CHAPTER 11 FILING When $V < D$, but the relationship between V and L is unknown, that is, when there is uncertainty about the continuation value of the firm, the business may file for protection from creditors under Chapter 11 of the bankruptcy code. This occurs in 15.6 percent of bankruptcy filings. The court seeks to estimate the continuation value of the firm. If the court estimates that $L > V$, it sends the firm to liquidation, either by converting the case to Chapter 7 or dismissing it outright (leaving the firm to liquidate out of court). Alternatively, if the business is estimated to be viable ($V > L$), it is reorganized. In a reorganization, equity holders and some junior creditor claims are usually wiped out, with senior debt holders becoming owners of the new firm.¹¹

10. For ease of explanation, we assume that all firms for which $V < D$ and $L > V$ choose liquidation in bankruptcy. In practice, firms of this type could also liquidate outside of court as long as creditors agree to take a loss without need for court intervention.

11. Increasingly, mergers and acquisitions (M&A) in bankruptcy is blurring the lines between continuation and liquidation. Sales in Chapter 11 could be an efficient way to quickly redeploy assets in bankruptcy. However, existing evidence on the rise of M&A in bankruptcy, such as shown by Gilson, Hotchkiss, and Osborn (2016), focuses on the largest firms in Chapter 11. M&A for the smallest firms is likely quite rare.

Conditional on Chapter 11 filing, the majority of firms are liquidated. Based on case outcomes reported by the Federal Judicial Center we estimate that, among the 15.6 percent of bankruptcy filings that happen under Chapter 11, 10.2 percent end up liquidated, and 5.6 percent reemerge. As we discuss below, the vast majority of the reemerging firms are large.

II.B. Frictions to Efficient Triage in the Pandemic

The triage described above does not occur in a vacuum; it is organized by a financial and legal architecture. It requires support from courts, including bankruptcy judges and trustees, and lawyers who sometimes intervene ahead of the formal filing by drafting out-of-court restructuring proposals, which take place under the shadow of the law, or prepackaged bankruptcy proposals to speed up the process after filing.

On the financing side, different types of investors play important roles. First, firms may need funding during the negotiation itself (debtor-in-possession, or DIP financing), which is often provided by senior lenders. Second, firms may need funding to emerge from bankruptcy. Such funding can be provided by current claimants as well as external investors. Last, investors may assist firms out of court in various capacities: providing risky funds (distressed investors), financing the takeover of the firm by an acquirer, or accepting out-of-court renegotiation of their claims (usually in exchange for a share of the upside of the company).

The triage implemented by the financial and legal infrastructure is likely to become less efficient in times of acute crisis. In theory, to be efficient, sorting should lead to continuation whenever $V > L$ and to exit whenever $L > V$. In the COVID-19 crisis, however, the accumulation of corporate distress will impose stress on the legal and financial infrastructure, potentially reducing the quality of the triage. We have in mind four mechanisms.

UNCERTAINTY ABOUT WHETHER THE COVID-19 CRISIS IS TEMPORARY OR STRUCTURAL If it is temporary, this corresponds to an increase in D (obligations that arose due to the temporary shock to revenue). V does not change as cumulative future cash flows are virtually unchanged. In this case, continuation is best when the firm was viable before (i.e., $V > L$). Alternatively, if COVID-19 leads to permanent reallocation across US regions or industries, this corresponds to a reduction of V (as the firm's prospects are diminished) and an increase in L (as the firm's assets should be deployed elsewhere).

CONGESTION: JUDGES AND LAWYERS ARE OVERWHELMED BY THE LARGE WAVE OF FINANCIAL DISTRESS As a result, their estimates of V and L are noisier, and wrong decisions happen more often. Also, the duration of the process

is longer and part of V is destroyed in the process, making it more likely that $L > V$ due to restructuring costs.

THE COVID-19 CRISIS HAS A DISPROPORTIONATE IMPACT ON SMALLER FIRMS, WHICH ARE HARDER TO CONTINUE For smaller firms, the estimate of V is noisier. Further, for small businesses a larger part of the continuation value V is not pledgeable to outside investors (for example, the entrepreneur's know-how). Suppose that only value $V' < V$ is pledgeable to investors. Then, investors value the continuation of the firm at V' and will thus choose liquidation whenever $V' < L$. Lastly, the fixed costs for restructuring small firms may be quite large relative to their size, forcing V down and resulting in $L > V$ for these firms, even though V would be larger if restructuring were not needed.

CRITICAL OUTSIDE FUNDING MAY BE LACKING IN A CRISIS Firms typically need funding during the process and after emergence. The funding need is greatest among firms with large working capital balances, such as restaurants and retail, which are highly distressed due to the pandemic. As above, this may create a wedge between the actual continuation value of the firm V and what outside investors are able to fund. This can tilt the process toward excess liquidation.

II.C. Costs of Financial Distress in the COVID-19 Recession

Before discussing the extent to which these frictions are exacerbated by the COVID-19 crisis, we perform a back-of-the-envelope estimate of the aggregate costs of financial distress that could occur during the pandemic. Even in regular times, bankruptcy and other milder forms of financial distress can be costly. For example, Andrade and Kaplan (1998) estimate that the costs of financial distress are between 10 and 23 percent of enterprise value.

Data from the Federal Judicial Center's Integrated Database (IDB) give the amount of liabilities owed by bankrupt firms from 2008 to 2017. Over this ten-year period, the average firm in Chapter 7 had \$4.6 million in liabilities at the time of filing while the average Chapter 11 firm owed \$64.8 million, and these distributions have been very stable over time. The bankruptcy forecasting exercise we discussed earlier suggested an estimated 15,638 Chapter 11 bankruptcies and 37,374 Chapter 7 bankruptcies over the next year. Given the average size of firms that enter bankruptcy, this yields \$1.01 trillion of liabilities will go into Chapter 11 and \$171.9 billion will enter Chapter 7.

How much value could be lost from these bankruptcies? Financial distress costs are notoriously hard to estimate. We base our estimates on the

midpoint of Andrade and Kaplan's (1998) estimates but also recognize that there are many distress costs which occur well before a firm enters bankruptcy (Elkamhi, Ericsson, and Parsons 2012), which are not included in our calculations. Assuming that 16.5 percent of firm value is lost due to financial distress, we estimate that frictions to restructuring could result in a loss of \$195.5 billion, equal to 0.9 percent of US GDP.

An alternative, more finely tuned calibration is obtained by predicting the number of bankruptcies for different size ranges of firms using the IDB. We estimate:

$$Bankruptcies_{st} = \alpha + \beta Unemp_t + \gamma_m + \varepsilon_{st},$$

where $Bankruptcies_{st}$ is the number of bankruptcies in size bucket s in month t , $Unemp_t$ is the national unemployment rate, and γ_m are calendar month fixed effects to soak up seasonality. We run this regression separately for each size bucket s using data for 2008–2017.¹² Based on these estimates, we can forecast the number of bankruptcies in each size range if the unemployment rate were 9.2 percent, as expected in the Survey of Professional Forecasters. This exercise yields an expected 91,254 business bankruptcies over the next year (online appendix table B.1), substantially higher than we forecast when using the longer time series from 1980 to 2019. From this projection, we estimate aggregate costs of financial distress of \$282 billion (1.3 percent of US GDP). Of these losses, roughly 20 percent are estimated to come from firms with less than \$100 million in liabilities (Andrade and Kaplan 1998).

The exercises above assume that all firms experience a 16.5 percent loss of value due to financial distress, but this estimate is based on large public companies. There is evidence that suggests that smaller firms may experience substantially higher losses. Bris, Welch, and Zhu (2006) estimate that direct fees alone could be as high as 30 percent of firm value for small businesses. In addition, smaller firms are much more likely to be liquidated, and Bris, Welch, and Zhu (2006) estimate that liquidation in Chapter 7 destroys significantly more value than Chapter 11, even after accounting for selection of firms into each chapter.

In addition to the firm value losses we just estimated, we can also estimate the costs of employee separations and reduced wages. To do so, we start from Bernstein, Colonnelli, and Iverson (2019), who show that the

12. The results of this estimation are in online appendix table B.1, and we find essentially identical results if we use year-over-year differences instead of levels in the regression.

random assignment of a bankruptcy judge can exogenously move a firm from Chapter 11 to Chapter 7, resulting in a 34 percent drop in the number of employees at the establishments owned by the bankrupt firm. They also show that a surprisingly large fraction of firms—58 percent—are sensitive to the assignment of the judge, meaning that a large fraction of firms could easily be shifted across bankruptcy procedures. Based on average employment per establishment of thirty-six, this suggests that assigning the most lenient judge to the average bankrupt firm could save seven jobs: 58 percent times 34 percent times 36. Multiplying this figure with our bankruptcy forecasting exercises above would lead to some excess destruction of 220,000 to 480,000 jobs, or about 0.15 percent of the US workforce.¹³

II.D. Evaluating Frictions in the COVID-19 Crisis

In this section, we evaluate the frictions listed above and provide evidence on whether the pandemic has made them more severe.

IS THE COVID-19 CRISIS TEMPORARY OR STRUCTURAL? How much reallocation should we expect in the current crisis? If the crisis leaves the economy essentially unchanged except for a temporary, albeit very large shock, business fundamentals are unchanged and few firms should be liquidated. If, however, the crisis is going to deeply affect the productive structure of the economy, liquidation should become the norm so that capital and labor can be reallocated.

It is obviously very hard to gauge the expected allocative effect of the current crisis. Jaimovich and Siu (2020) document how recent business cycles have led to permanent shifts in capital-labor substitution, indicating durable changes in the structure of the economy, but the current crisis is different in nature. Barrero, Bloom, and Davis (2020) use firm-level one-year-ahead forecasts of employment to derive a measure of expected reallocation and find it to be quite large. This, in addition to other evidence, notably on stock returns dispersion and working from home, points to durable labor reallocation in the economy, consistent with the view that the crisis will permanently destroy some jobs.

We complement these analyses with an additional analysis based on equity analyst forecasts. We analyze the dispersion of equity analysts' earnings

13. While many of these workers will be reallocated to new firms, there is extensive evidence that job losses lead to permanent reduction in earnings. Looking at all mass layoffs in recessions, Davis and von Wachter (2011) find that workers experience a 20 percent reduction in long-term wages. Focusing on bankruptcy-related layoffs, Graham and others (2019) find similar long-term wage reductions.

forecasts during the spring of 2020 using the same data described in section I. We compute the following reallocation index:

$$R_{t,h} = \sum_i w_i |FG_{i,t,h}|,$$

where w_i is a firm weight and $FG_{i,t,h}$ is the expected earnings growth for firm i , at date t , at horizon $h \in \{2020, 2021, 2022\}$. The reallocation index $R_{t,h}$ captures the cross-sectional dispersion of expected earnings growth.¹⁴ We compute w_i as the earnings share of firm i in 2019 (we restrict ourselves to firms with positive 2019 earnings). Following Landier and Thesmar (2020), forecasted earnings growth of firm i , as of date t , and for horizon h are given by $FG_{i,t,h} = 1/h ((F_t EPS_{i,t} + h/EPSt_{i,2019}) - 1)$.

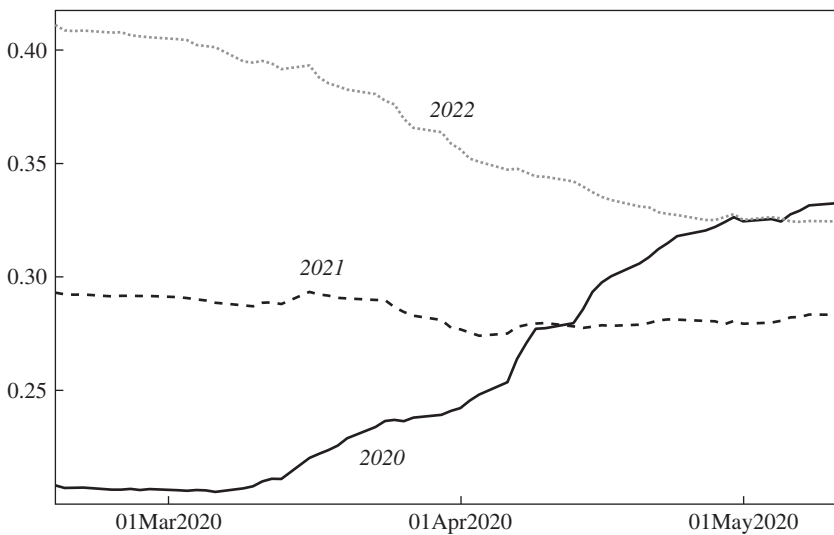
Barrero, Bloom, and Davis (2020) study smaller firms and conclude that the COVID-19 shock will lead to substantial reallocation. Our approach differs from theirs in several ways. Its advantage is that it can leverage analyst forecasts, which are reasonably accurate and available at long horizons (until 2022, and even 2024 for a smaller set of firms). One drawback is that we focus on larger, publicly listed firms. Another limitation of our approach is that it *does not* rely on actual forecasts of decisions, but on expected profits from these decisions.¹⁵

In the online appendix we check how accurately our measure of expected reallocation tracks actual reallocation for the 1990–2018 period. During this period, expected reallocation has tracked ex post realization. The only exception is for forecasts issued in April 2007, that is, *before* the financial crisis, when analysts underestimated the amount of reallocation that would eventually happen. But as soon as the crisis unfolded, their forecasts jumped to more closely match ex post realizations.

In figure 5, we show the evolution of our reallocation measure between February and May 2020, for each of the three horizons 2020, 2021, and 2022. While expected dispersion for 2020 went up dramatically, this is not the case for longer horizon forecasts. Expected dispersion has not increased for 2021 and has actually decreased for 2022. Analyst forecasts have been revised downward very strongly, but all in the same direction, making firms more similar to one another. Another explanation for this somewhat

14. The reallocation index $R_{t,h}$ can also be interpreted more structurally. Online appendix A shows, within a Cobb-Douglas production technology, that $R_{t,h}$ captures the share of capital that will move across firms, provided that investment tracks future profits.

15. Barrero, Bloom, and Davis (2020) look at hiring plans.

Figure 5. Expected Reallocation during the COVID-19 Crisis

Source: Authors' calculations from the Institutional Brokers' Estimate System (IBES).

Note: This figure plots an index of industry reallocation based on the earnings forecasts of the largest 1,000 firms by stock market capitalization as of December 2019. We further require that these firms have positive earnings in 2019 and December fiscal year ends. Every day t , we calculate horizon h expected reallocation as: $R_{t,h} = \sum_i w_i |FG_{i,t,h}|$, with $FG_{i,t,h} = (F_t EPS_{i,h} / EPS_{i,2019}) - 1$. We compute w_i as the firm's share in 2019 earnings. We plot lines for $h = 2020, 2021$, and 2022 .

counterintuitive result is that, while some firms have benefited from the crisis (seeing their forecasted earnings growth, $FG_{i,t,h}$, going up and thereby contributing to increase the index), their weight in aggregate earnings is relatively small. Most firms experienced a reduction in expected 2021 and 2022 earnings, which made firms more similar to one another. Overall, the shock will make firms more different in the short run but less different in the longer run, reducing the need for capital reallocation. In short, industry reallocation is forecast to be lower than is commonly supposed.

CROWDING OF THE BANKRUPTCY COURT SYSTEM Iverson (2018) estimates the effects of court congestion on several bankruptcy outcomes using the 2005 bankruptcy reform as a shock to court caseloads. First, looking at creditor recovery rates, Iverson (2018) estimates that a 5.8 percent increase in caseloads results in a 10 percent increase in bank business loan charge-offs. Extrapolating these estimates to a caseload shock of 30 percent (the typical increase seen in a recession), we might expect recovery rates to drop by 47 percent.

As discussed above, we use a simple forecasting model based on the unemployment rate to forecast business bankruptcies. The same bankruptcy judges who oversee business cases also deal with consumer bankruptcy cases, and consumers constitute about 80 percent of the total workload for an average bankruptcy judge. We can use the same process to forecast consumer bankruptcies outlined in section I.E to estimate how overall bankruptcy court caseloads might react to the COVID-19 recession.¹⁶ If unemployment is 9.2 percent over the next year, caseloads are forecasted to rise by 158 percent, close to five times the rise seen in a typical recession.

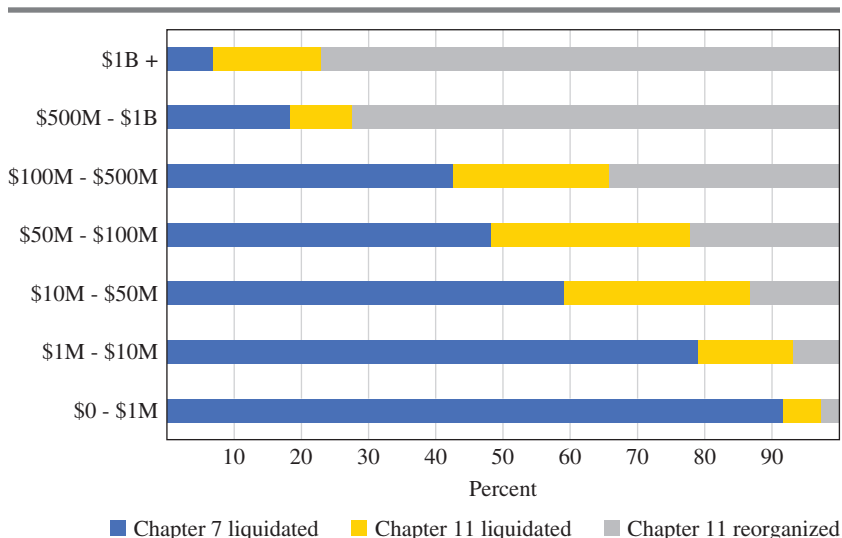
The evidence in Iverson (2018) also suggests that as bankruptcy judges become busier, they focus their effort on larger firms, possibly at the expense of smaller firms. As caseloads rise, larger firms are actually more likely to emerge from bankruptcy, although the process takes longer. Meanwhile, smaller firms are more likely to be dismissed from court, leaving many of them to liquidate without court protection.

If courts become congested, one possibility is that distressed firms will endogenously respond by taking measures to shorten the workload required of judges. For example, firms may work to create pre-negotiated bankruptcy plans or avoid bankruptcy altogether. In addition, as distressed debt markets have become more liquid and sophisticated, M&A activity in bankruptcy has led to shorter bankruptcy durations (Gilson, Hotchkiss, and Osborn 2016). A combination of these forces has seen the median Chapter 11 bankruptcy duration decline from eighteen months in the early 2000s to ten months in recent years, according to durations calculated from the Federal Judicial Center bankruptcy database. To some extent, asset sales and out-of-court negotiations can compensate for congestion in court, but this creates burdens for firm managers and financial markets.

THE SMALL FIRM PROBLEM Small firms are especially vulnerable to the crisis, not because the pandemic has especially affected industries dominated by small firms (section I.B), but instead because small firms' balance sheets are more vulnerable to losses in revenues (section I.C).

Figure 6 confirms that large firms in need of restructuring have multiple options available, while small firms have no other option but to liquidate. Above \$500 million of liabilities, close to 80 percent of the bankruptcy filings end up as a Chapter 11–backed reorganization. The contrast with small businesses is striking: below \$1 million of liabilities, 90 percent of the filings are straight-out liquidations, while less than 5 percent of bankruptcies

16. A detailed explanation of this forecasting exercise and the calculation of court caseloads is given in Iverson, Ellias, and Roe (2020).

Figure 6. Liquidation versus Reorganization as a Function of Firm Size

Source: Federal Judicial Center Bankruptcy Petition Database.

Note: This figure displays the share of firms that liquidate directly in Chapter 7, liquidate after filing for Chapter 11, or reorganize in Chapter 11, separated by the size of the firm, as measured by reported total liabilities at the time of the bankruptcy filing. We classify as Chapter 11 liquidated all firms that enter Chapter 11 and are either converted to Chapter 7 or dismissed from court.

end up as reemergence from a Chapter 11 filing. For a small firm, failure typically means liquidation.

For larger firms, Chapter 11 is reasonably efficient in normal times. While academics have pointed out large frictions in the Chapter 11 process, in particular with regards to failures to fully rehabilitate distressed firms (Hotchkiss 1995) and long delays in bankruptcy courts (Dou and others 2020), the majority of large firms that enter Chapter 11 successfully emerge, and most estimates of inefficient continuation or liquidation are small (Djankov and others 2008; Dou and others 2020). One exception to these findings is Antill (2020), who estimates that 22 percent of large firms are inefficiently liquidated. We further note that, even if the firm itself is efficiently continued, many contracts within the firm may be inefficiently terminated. For example, Graham and others (2019) show that, on average, employees who work for large corporations that enter Chapter 11 experience a 10 percent decline in wages over the next seven years. Inefficient reallocation of workers plays a role in these losses.

Frictions to restructuring small firms are substantially larger. Even small disruptions to cash flow can trigger restructuring as many of these firms

maintain low cash buffers and lack access to lines of credit (Bartik and others 2020). Based on the June 27 Census Bureau Small Business Pulse Survey, including financial assistance and loans, only 30 percent of small businesses reported having enough cash to maintain operations for another three months. Thus, even when $V > L$, it is possible that forced, inefficient restructuring can occur simply because smaller firms run out of financing to continue to operate. Second, when restructuring does occur, smaller firms have fewer options available. Chapter 11 bankruptcy imposes costs that can be as high as 30 percent of a small business's total value (Bris, Welch, and Zhu 2006), making it close to prohibitive for many small businesses even if they wish to continue. Consistent with this, small firms are more likely to simply shut down: data from the Census Bureau's Business Dynamics Statistics database show that, on average, from 2000 to 2016, 412,209 firms close annually. Meanwhile, only 36,783 businesses file for bankruptcy annually during the same time period, according to the Administrative Office of the US Courts filing statistics. In the end, while only 5.6 percent of all firms going bankrupt survive the process, these firms are predominantly large firms, so in liabilities-weighted terms, about 43 percent of the dollars of claims reemerge.

High liquidation rates among small businesses are not inherently inefficient; it depends on how well labor and capital can be redeployed to new uses. Most evidence suggests that after liquidation, reallocation is difficult. Graham and others (2019) show that workers experience large wage losses after liquidation, especially in thin markets. Capital reallocation appears even harder than labor reallocation. Eisfeldt and Rampini (2006) show that capital reallocation is lower during recessions, indicating stronger search and financing frictions precisely when liquidations tend to happen. Bernstein, Colonnelli, and Iverson (2019) estimate the effects on capital utilization when a small business is forced to Chapter 7: a business establishment that is forced to liquidate is 17 percentage points more likely to be unoccupied five years after the bankruptcy, relative to an identical establishment that remained in Chapter 11.¹⁷

17. This is not because Chapter 11 firms are inefficiently continued. Roughly 75 percent of all business establishments that stay in Chapter 11 are reallocated to other uses (Bernstein, Colonnelli, and Iverson 2019), so even in Chapter 11 there is a large amount of reallocation. But because the liquidation is not forced, it allows for reallocation that leads to higher utilization rates overall. Moreover, these effects are driven entirely by forced liquidation in "thin" asset markets, defined as areas with few other businesses in the same industry or areas with low amounts of small business financing available.

FINANCING RESTRUCTURING To deal with the upcoming large flow of bankruptcies, and in particular to handle debt restructuring, the financial system will be needed at several levels. Brunnermeier and Krishnamurthy (2020) fear that banks will have a propensity to interrupt lending to firms in financial trouble, and they propose policies designed to avoid this. DeMarzo, Krishnamurthy, and Rauh (2020) fear a lack of DIP financing for firms in the process of restructuring (DIP) financing and propose setting a government-sponsored special purpose vehicle to fill that gap.

Corporate Debt Restructuring Will Have a Small Effect on Banks' Balance Sheets We explore here how much banks' balance sheets would be affected by the upcoming wave of defaults and also large-scale debt restructuring. Our main finding is that the effect of a large wave of defaults or debt restructuring would be modest, since small to medium enterprise (SME) loans are only a small fraction of banks' assets.

In the first step of this analysis, we predict corporate loan charge-offs using unemployment data. To do this, we use call reports to compute aggregate charge-off rates; we use charge-off rates on commercial and industrial (C&I) loans and secured loans to corporations, which we aggregate over all banks covered in the call reports. Historically, charge-off rates closely track the unemployment rate. Following Blank and others (2020), we exploit this relationship to build an econometric model linking the innovation of charge-off rates and unemployment rate. We obtain an R^2 of 0.87 for secured loans and 0.55 for C&I loans.

We then use forecasts of unemployment for 2020, 2021, 2022, and 2023 from the Survey of Professional Forecasters, which, combined with our models allow us to make forecasts of charge-off rates until 2023. We expect charge-off rates on C&I loans to be as high as 3 percent and on secured loans to increase to 2 percent. These projections are less dramatic than during the 2009 financial crisis because, as of this writing in August 2020, professional forecasters anticipate that post-pandemic unemployment will return faster to normal than in the aftermath of the 2009 financial crisis.

Do these projections have the power to shock banks' balance sheets in a meaningful way? Current data suggest they do not. In table 3, we report the results of this analysis, separately for all banks, the twenty largest ones by assets, and the rest. The first takeaway is that SME loans are already just a fraction of equity (slightly less than 40 percent for all banks, and a much smaller fraction of about 12 percent for the top twenty, a priori systemically more important, banks). As a result, a 2 percentage point increase in the fraction of charge-offs has only a very small impact on aggregate equity

Table 3. Impact of Firm Failure on Bank Balance Sheets

	<i>Corporate loans/ equity in 2019</i>	<i>Predicted charge-off rate for 2020</i>	<i>Predicted charge-offs/ equity in 2019</i>	<i>Pre-provision revenue/ equity in 2019</i>	<i>Dividends/equity in 2019</i>
<i>All banks</i>					
Total loans	638	2.38	15.15	54.81	26.41
SME secured loans	16.51	2.10	0.35		
SME C&I loans	22.15	2.57	0.57		
Secured business loans	89.42	2.10	1.88		
C&I loans	124.05	2.57	3.19		
<i>Top 20 banks</i>					
Total loans	342	2.58	8.82	39.02	21.44
SME secured loans	2.75	1.55	0.04		
SME C&I loans	9.38	2.34	0.22		
Secured business loans	26.42	1.55	0.41		
C&I loans	95.14	2.34	2.23		
<i>Smaller banks</i>					
Total loans	1,473	2.32	34.22	99.35	40.43
SME secured loans	55.32	2.06	1.14		
SME C&I loans	58.20	2.91	1.69		
Secured business loans	267.14	2.06	5.50		
C&I loans	205.59	2.91	5.98		

Sources: Call reports; Bureau of Labor Statistics; Survey of Professional Forecasters.

Note: This table shows the impact of firm failure on bank balance sheets. Small business secured loans are secured business loans (loans secured by nonfarm nonresidential properties) with original amounts of \$1 million or less. Small business C&I loans are commercial and industrial (C&I) loans with original amounts of \$1 million or less. The charge-off rate of small business secured loans is proxied by the charge-off rate of secured business loans. The charge-off rate of small business C&I loans is proxied by the charge-off rate of C&I loans. Forecasts of charge-off rates are based on historical unemployment rate and unemployment rate forecasts, using the regression: $Rate_t = \alpha + \beta_1 Rate_{t-1} + \beta_2 Unemployment Rate_t + \epsilon_t$ (see online appendix figure B.3). We calculate the ratios of outstanding balance of loans in 2019, pre-provision revenue in 2019, and dividends in 2019 to total bank equity capital in 2019. Predicted charge-off rate for 2020 and loan balance in 2019 are used to calculate the amount of charge-offs in 2020, and its ratio to total bank equity capital in 2019 is calculated. Smaller banks are those not in the top twenty.

(2 percent times 40 percent), an order of magnitude smaller than 2019 dividend payouts which were 26 percent of book equity (table 3). The overall lesson of this quantification exercise is that SME loan defaults will not meaningfully affect bank balance sheets in aggregate, even if they were as big as, or even twice as large as the global financial crisis.

The main reason for this small effect is that banks—in particular the largest ones—are not lending much to small businesses, as noted by Chen, Hanson, and Stein (2017) and Gopal and Schnabl (2020). This is due to the rise of nonbanks, notably fintech, which have replaced bank lending over the past few years.

DIP Financing: Will There Be Enough DIP Financing? Firms that restructure need financing to operate during the negotiation phase. Such debtor-in-possession (DIP) financing is critical to allow the firm to function and make sure capital structure restructuring happens effectively. DIP financing is typically supplied by senior debt holders. Using various data sources covering bankruptcies of more than \$50 million in constant dollars, the Bankruptcy and COVID-19 Working Group (2020) estimate that, over 1996–2014, about 60 percent of the firms receive DIP financing. Looking at all ninety-nine “large” Chapter 11 filings from January to June 2020, they find that such bankruptcies raised some \$10.8 billion in DIP financing or about 5.9 percent of the \$182 billion of liabilities involved. Smaller bankruptcies are much less likely to receive DIP financing. Overall, these amounts are reasonably small compared to total nonfinancial corporate debt securities of \$5.475 trillion, based on the June 2020 Financial Accounts of the United States.

In addition, it is not entirely obvious why DIP financing would be lacking. A classic problem with debt overhang is that new investors are not granted priority over existing ones. If they are, in theory this solves the problem of overhang, since overhang arises from legacy lenders having priority over the present value of new investments. But DIP is by definition senior in bankruptcy, so this problem should not arise. In addition, DIP is typically provided by senior lenders. If these are banks, the above analysis suggests that their balance sheets might be more resilient than commonly expected.

In sum, we do not consider it likely that there will be a scarcity in DIP financing, but the situation should be monitored closely; if needed, setting a government-sponsored special purpose vehicle dedicated to DIP financing, as suggested by DeMarzo, Krishnamurthy, and Rauh (2020), could prove useful and relatively cheap for the US taxpayers.

Distress Investing: High Elasticity to the Incidence of Distress Bankruptcy and liquidation are not the only mechanisms to reallocate assets.

Another mechanism for reallocation is merger or acquisition by a firm in a stronger financial position or by a financial buyer such as a private equity firm. Consider the role of M&A in saving struggling public firms during the Great Recession. Out of approximately 5,600 firms listed as of June 2008 in the Center for Research in Security Prices (CRSP) database, about 7 percent were acquired between September 2008 and December 2009. For comparison, about 8 percent were delisted for reasons other than exchange or merger, usually because they were headed toward bankruptcy. But acquisition is not a common path for firms that are struggling to survive: the market for corporate control is a more viable exit path for firms experiencing only moderate distress. For example, two of the largest acquisitions during the global financial crisis were the March 2009 purchase of Genentech by Roche and the October 2009 purchase of Wyeth by Pfizer. Neither of these were distressed, with both acquisitions occurring at valuations that exceeded their valuations in June 2008.

Gilson, Hotchkiss, and Osborn (2016) document a rise in M&A in bankruptcy in recent years. They show that post-bankruptcy survival rates are similar whether bankrupt firms sell businesses as going concerns versus reorganizing independently, consistent with redeployment of asset via sales.

Specialized financial buyers also play a role. Distressed bond investors seek to benefit from the resolution of financial distress by buying debt at discounted values with the expectation that the company will reemerge. Distressed equity investors bring in managerial skills to develop a strategy in order to benefit from the company's strengths and weaknesses. Ahead of the current crisis, assets under management held by distressed investors were at an all-time low (for instance, the assets under management of hedge funds investing in distressed securities were about \$20 billion in 2020:Q1 according to the data provider BarclayHedge).¹⁸ But the supply of funds in that industry is highly elastic to the state of the economy. Beyond the strict specialty of distressed investing, there is much "dry powder" in the private equity industry that could be deployed to rescue struggling but viable businesses. Bain Capital documents in its 2020 report that the amount of funds raised by the private equity sector was about \$400 billion in 2019, the second highest level since 2017 (MacArthur and others 2021).

18. BarclayHedge, "Hedge Fund Industry Assets under Management," <https://www.barcleyhedge.com/solutions/assets-under-management/hedge-fund-assets-under-management/>.

III. Policy Options

A series of policy proposals address the frictions listed in the previous section. These proposals fall into roughly three categories, tabulated in table 4. First, several proposals involve straight-out grants to firms to keep them alive through the initial lockdowns and subsequent downturn. The second category of proposals consists of steps to encourage out-of-court restructuring, including payment moratoria and debt restructuring subsidies. The third category consists of modifications to bankruptcy procedures—such as increasing the number of judges and easing DIP financing—to make it easier to restructure or liquidate in court. We focus our discussion on proposals dealing in the two latter categories.

III.A. Encouraging Out-of-Court Restructuring

Although bankruptcy is the most extreme outcome of financial distress, it is not the only one. Some businesses, after having accumulated obligations during the lockdown, will remain functional (like a restaurant becoming a food delivery operation), yet the accumulation of legacy debt will lead to debt overhang and underinvestment. Many firms will seek to deleverage progressively, by cutting investment and possible equity payouts, but this could be too slow, leading to a protracted period of underinvestment, in a sense similar to the slow recovery of consumption after the 2009 financial crisis. Debt overhang may arise not just from financial debt but also from fixed expenses coming from utility bills or rents, the focus of Hanson and others (2020). A number of policies can help with restructuring this debt out of court, thereby avoiding bankruptcy. The proposals below focus on smaller firms.

MORATORIA AND PAYMENT DEFERRAL PROGRAMS FOR SMES One simple option is for the government to temporarily stop contractual payments to claim holders. Most moratoria have historically applied to individuals (for rents) and government (for public debt). For instance, during the First World War, French landlords did not receive rent from certain occupants by decree until 1920. Since the beginning of the COVID-19 crisis, various states and cities have implemented eviction moratoria. In mid-April, the G20 suspended debt payments for many developing countries. The CARES Act allows borrowers to suspend or reduce payments on federally backed mortgages but interest and principal still accrue. So this provision is more of a payment deferral program.

As shown by Coelho and Zamil (2020), many countries have implemented loan payment deferral programs since the beginning of the crisis.

Table 4. Policy Options to Fight Financial Distress

<i>Policy/proposal</i>	<i>Friction</i>	<i>Instruments</i>
<i>Straight-out grants to fund firms</i>		
Hanson and others (2020)	Financial constraints	Grants to cover fixed obligations only (rents, utility bills)
	Input reallocation frictions	
Saez and Zucman (2020)	All reallocation frictions	Grants to cover all firm expenses
<i>Non-bankruptcy financing policies</i>		
Payment deferral schemes (already implemented in several countries)	Financing constraints Credit supply shock	Moratoria/forbearance (no accrued interest) Payment deferrals (accrued interest) State guarantees of payment deferrals by banks Voluntary versus mandatory participation SME targeting
Brunnermeier and Krishnamurthy (2020)	Financing constraints Credit supply shock	Federal Reserve to set up SME loan refinancing facility at subsidized rates Regulators to actively encourage evergreening loans
Greenwood and Thesmar (2020)	Debt overhang Lack of out-of-court negotiation	Tax credit to haircut-consenting claimants
<i>Bankruptcy-specific policies</i>		
Iverson, Ellias, and Roe (2020)	Bankruptcy court congestion	Recall retired judges Create new temporary posts
Skeel (2020)	Fixed cost of restructuring	Create a standard “prepacked” restructuring process
Subchapter V of Chapter 11 (already enacted as part of SBRA)	Fixed cost of restructuring	Expedited procedure to restructure small firms No need for a creditor vote, easy to cram down
Blanchard, Philippon, and Pisani-Ferry (2020)	Wedge between private and social value of restructuring in bankruptcy	Government takes higher haircut than other creditors
DeMarzo, Krishnamurthy, and Rauh (2020)	Undersupply of DIP funding	Government to set up a DIP funding SPV, with equity from the treasury and Federal Reserve backing, to lend senior at Fed discount rate (0%)
Bankruptcy and COVID-19 Working Group (2020)	Uncertainty of viability of bankrupt firms	Extend deadlines for all small businesses that enter Chapter 11 by six months

Source: Authors' compilation.

Programs targeting SME lending were implemented in Australia, Hong Kong, Italy, Singapore, and South Africa. Although the details vary, in most of these programs firms can reschedule both interest and principal, and in no case are interest and principal forgiven. In some of them, banks have been required to accept companies' requests to reschedule payments. In others, banks are not mandated to do so but the government coordinates with professional associations to encourage compliance. In some countries (like Italy), banks can request state guarantees for loans whose payments are suspended. Overall, this crisis has revealed how reluctant most countries are to arbitrarily modify private contracts without the consent of participants without providing implicit or explicit subsidies.

A key challenge facing payment moratoria is the pain these inflict on lenders, primarily banks. We already addressed the effect of SME loans on US banks' balance sheets in section II. Overall our take is that SME loans do not have the power to shock banks' balance sheets to a significant extent, because SME loans are a small fraction of US banks' balance sheets (see table 3), and also because nonbanks have taken over this market since the financial crisis (Gopal and Schnabl 2020).

SUBSIDIZING VOLUNTARY RESTRUCTURING Another related policy option is to subsidize voluntary restructuring. Greenwood and Thesmar (2020) propose a one-size-fits-all approach for small businesses, subsidized by the government to reduce haggling between different counterparties and thereby to reduce the deadweight costs of bankruptcy and business failure.

Greenwood and Thesmar (2020) focus their discussion on unpaid rents, because these are often the largest class of financial claim facing the smallest businesses, after salaries and wages. Using Statistics of Income data, figure B.4 in the online appendix shows the aggregate rent-to-asset ratio by firm size. Canceling rents altogether can offer a significant relief: in the smallest category of firms, canceling one year of rent can reduce the debt-to-asset ratio by just over 8 percentage points.

To illustrate their proposal, consider a restaurant owner with a viable business post-pandemic, with a landlord to whom she owes \$1,000. The landlord voluntarily gives up her \$1,000 claim against the restaurant in exchange for a tax credit of \$300. If, for instance, rents are taxed at say 40 percent, giving up \$1,000 worth of claims has a net cost of only \$300 to the landlord. This proposal is designed to make renegotiation of debt simple and fast, and because the agreement is standardized, it eliminates the need of the landlord or creditor to investigate the financial resources of the small business. It is focused on small firms and valid for a prespecified grace period.

Government-subsidized restructuring shares the costs of restructuring between taxpayers (in the form of lower tax receipts in the future) and lenders or landlords. In this way, subsidized out-of-court restructuring lies somewhere between straight-out grants, which pass costs fully to taxpayers, and moratoria, which keep restructuring costs fully with investors. The Greenwood-Thesmar proposal recognizes the unique position of the government in implementing a form of debt-for-equity swap: the government “buys” the forgiven debt in exchange for a slice of the value created from restructuring the debt. The government can do this because it can give both tax credits and cash via corporate income taxes.

III.B. Bankruptcy-Specific Policies

BOLSTERING THE BANKRUPTCY JUDICIAL SYSTEM If bankruptcies increase as much as we forecast, they will strain the legal system. Crowded courts may lead to either excess liquidation or excess continuation and lower recovery rates overall.

There are 347 bankruptcy judges in the United States. According to Iverson, Ellias, and Roe (2020), between 50 and 246 temporary judges could be needed to ensure that the workload per judge does not increase more than it did in 2010. Congress could authorize additional judgeships or retired bankruptcy judges could be temporarily recalled. Bankruptcy case-loads are expected to vary substantially across districts, with the largest needs in Delaware, Texas, Illinois, and Florida (Iverson, Ellias, and Roe 2020), suggesting the need to transfer judges across jurisdictions.

Since February 2020, small businesses have had their own simplified version of Chapter 11, put forth by the Small Business Reorganization Act (SBRA). All businesses with less than \$7.5 million of liabilities can file under the new Subchapter V, whose goal it is to protect the owners' equity. The economic rationale is that, for many small businesses, wiping out the owner's equity destroys the enterprise value, as the entrepreneur is critical to the going concern of the firm.

There are two key differences between the Subchapter V procedure and Chapter 11. First, unsecured debt loses priority to equity. Second, the court has the power to confirm a plan without a formal vote of creditors. This has the effect of making creditors weaker than in Chapter 11 and leaves a pivotal role for the judge and trustee. It is, in short, untested. The efficiency of the process depends heavily on the ability of the legal system to filter viable from nonviable firms. As this form of bankruptcy became available just as the pandemic was taking root, its take-up has so far been limited. We suspect it will have little impact on the very smallest businesses that will

close without filing for bankruptcy, but it still has the potential to alleviate pressures on businesses with assets between \$1 million and \$10 million. To the extent that Subchapter V becomes more widely used, even more judges and trustees will be needed to be able to carefully consider these small business cases.

PREPACKAGED BANKRUPTCIES FOR SMALL FIRMS So-called prepackaged bankruptcies can save time and resources but are still used almost exclusively by large firms, where the firm files for Chapter 11 with a plan that is already preapproved by all classes of creditors. This shortens the procedure considerably, avoiding uncertainty, court fees, and a need for DIP financing. Skeel (2020) suggests generalizing this insight to help the bankruptcy system absorb the coming wave of financial distress.

An example of such prepackaged bankruptcy is the “Super Chapter 11” proposed by Miller and Stiglitz (1999). This proposal creates a new chapter of the bankruptcy code which resembles Chapter 11. The main difference is that the government injects fresh funds and becomes an equity holder, while creditors get a haircut. Management stays in place, allowing the firm to continue operations without firing employees. An economic rationale for such a policy is that firms are to some extent interdependent, so the government is best placed to internalize these externalities against taking a slice of the upside. The other rationale is that such a restructuring is simple and reduces costs of financial distress.

This proposal comes with many caveats. First, the government cannot rescue all firms that file, and if it did so it would rescue far too many nonviable entities. It has to make a choice, and it would need to set up a large-scale administrative process with little expertise and no time. This would be battlefield medicine with no experienced surgeon. As we discussed earlier, to this point it appears that private DIP financing is sufficient for the larger firms that typically rely on it. Second, some firms may have such large claims that the government would become the primary equity holder. Third, political economy considerations would likely pollute the process, with local politicians lobbying for federal funds to save small businesses.

GOVERNMENT SUBSIDIZING SUCCESSFUL RESTRUCTURING In the same spirit as Greenwood and Thesmar (2020), Blanchard, Philippon, and Pisani-Ferry (2020) suggest that the government could subsidize court-assisted debt restructuring by taking an extra haircut on its debt. This extra haircut would be a transfer to existing creditors but only conditional on the firm emerging from bankruptcy. If the firm were to liquidate, the government would not make any concession. In theory, the difference between the haircut

facing private investors and the haircut taken by the government should reflect the wedge between the private and social value of business continuity. This wedge would need to be estimated in order to calibrate the policy parameters.

DIP FINANCING SUBSIDY DeMarzo, Krishnamurthy, and Rauh (2020) suggested that there is an undersupply of DIP funding. They suggest that the government set up a special purpose funding vehicle, itself funded by equity from the Treasury and with Federal Reserve backing, to issue senior credit at very low discount rates. As our earlier discussion suggests an abundant supply of private capital, this will not be necessary.

EXTENDING CHAPTER 11 COURT DEADLINES Finally, there are policy options to modify the bankruptcy code without requiring any government funding. In May 2020, the Bankruptcy and COVID-19 Working Group sent a letter to Congress with recommendations designed to give small businesses more breathing room once they enter Chapter 11. In particular, their proposal is to temporarily extend all major deadlines by six months for small business bankruptcies. This would allow the business to continue to operate with protection from creditors but give the owner, judge, and trustee more time to evaluate the long-term viability of the business before needing to come up with a reorganization plan.

IV. CONCLUSION

Every year, firms become financially distressed. Some of these firms are affected by transitory shocks: to get back on their feet, they need new funding and a reduction of legacy leverage. Other firms are facing more existential threats: their products or markets are disappearing, their technology is obsolete. Usually, a financial and legal infrastructure helps route firms to the correct outcome. But this process is expensive; most distressed smaller firms simply shut down.

This paper addresses the question of whether this system is going to work as it should when, in the coming year, we encounter a potentially unprecedented surge of distress. Much depends on the length of the pandemic and what structural shifts in the economy it engenders. The longer the crisis and the greater the amount of reallocation needed, the more that some form of restructuring and liquidation will be inevitable. Viewed from this perspective, interventions that can reduce the costs of financial distress and ease the burden on the court system are low-hanging fruit. Especially promising are interventions that encourage out-of-court restructuring. Meanwhile, our analysis suggests that the financial system generally has

enough liquidity to support restructuring, but this should be monitored closely as the pandemic lengthens.

Our focus has been on firm-specific inefficiencies related to restructuring. But there may be additional spillovers as well, which combine to have long-lasting economic effects, ranging from aggregate demand externalities from failing businesses to the deadweight losses from firm-worker separations. For example, Bernstein and others (2019) show that forced liquidation has a strong negative effect on employment at other firms located in the same block as the liquidated business, and this effect lasts for at least five years. Moreira (2016) shows that firms born during recessions begin smaller and remain smaller throughout their life cycles. All of these forms of economic scarring reinforce our conclusion that policy should focus on smaller firms.

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Comment and Discussion

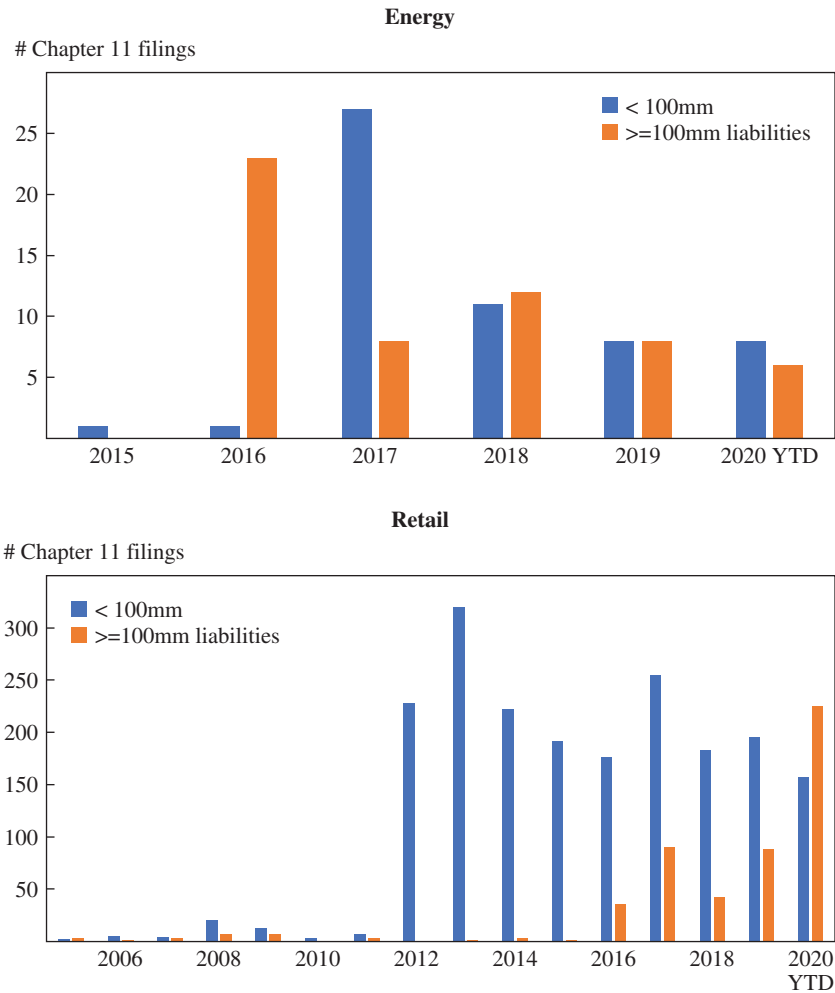
COMMENT BY

EDITH HOTCHKISS In order to evaluate economic policy proposals in the wake of the unexpected shock to businesses in the COVID-19 pandemic, one needs a broad understanding of the typical path for resolving financial distress of US companies. This paper by Greenwood, Iverson, and Thesmar undertakes such analysis, reviewing existing evidence and providing new estimates of the current and expected extent of financial distress among both small and large firms. It further provides discussion of the likely impact of government intervention on the incidence and outcomes of financial distress under the current crisis and a potentially prolonged recession.

HOW WIDESPREAD IS FINANCIAL DISTRESS DUE TO THE COVID-19 SHOCK? Unsurprisingly, the shock to business operations in the current global pandemic is of unprecedented magnitude. The paper provides two key analyses demonstrating the immediate impact on firms' financial condition based on (1) the decline in revenues and earnings of public companies, based both on analyst forecast revisions and on financials reported for the second quarter of 2020, and (2) evidence, including that from the Census Bureau Small Business Pulse Survey (as of July 2020), showing an even stronger shock to small firms who report that the pandemic has had a large negative effect on their business.

How should one interpret the sharp increase in distressed firms demonstrated in the paper? One complication is that many firms that are the most severely distressed are in industries already in decline pre-COVID-19—namely, energy and brick and mortar retail. In fact, as shown in figure 1, for both energy and retail firms a significant increase in large corporate bankruptcy filings under Chapter 11 of the US Bankruptcy Code had begun pre-COVID-19. Arguably, COVID-19 has accelerated a decline already under way. Thus, assistance to such firms runs the risk of

Figure 1. Chapter 11 Filings for Energy and Retail Sector Firms as of September 2020



Source: New Generation Research.

postponing needed restructuring of viable but insolvent firms and of extending the life of so-called zombie firms—both of which are costly outcomes.

Perhaps the most striking aspect of results throughout the paper is the large divide between large and small firms. For most academic research, “large” means studies of public companies whose equity is typically listed on an exchange. Data limitations present a challenge to researchers trying to understand outcomes for firms below this threshold. This is particularly

problematic in understanding the impact of financial distress, because many small firms do not use a formal bankruptcy process, making it even more difficult to track outcomes. Small firms often do not use debt or may simply shut down, as they cannot withstand the large fixed costs of a financial restructuring (including the cost of hiring legal and financial advisers with expertise specific to the restructuring process). Thus, the US Census surveys provide the clearest evidence of the extent of financial distress for small firms during the pandemic. The most negatively impacted industries for larger public firms are also among those reported to have the most severe negative impact for smaller firms.

Forecasts for corporate bond default rates are in the neighborhood of 5 percent based on studies cited in the paper (Ma 2020; Altman 2020). Default rates in the current recession may be exacerbated by the historically high levels of leverage of firms entering the crisis (Altman 2020). These forecasts, however, miss the market segment likely of most concern—that of smaller firms. The paper therefore provides analysis predicting a large increase in business bankruptcy filings based on expected unemployment (Iverson, Elias, and Roe 2020). The basis for this estimation is that there is a close historical relationship between the unemployment rate and the frequency of business bankruptcies (as shown in figure 3 in the paper). These results show a particularly clear divide between small and large firms. The authors forecast a 140 percent increase in total bankruptcies relative to the 2019 level, but the number is driven by smaller firms. Bankruptcies have not in fact reached these levels thus far, likely because small firms have been most directly targeted by the CARES Act and other interventions early in the pandemic.¹ Filings that have been delayed by these interventions may still occur but may be very dependent on when and if there is continued support.

There are additional reasons to question whether these forecasts will bear out in the current crisis, at least for large corporations. For example, following the 2008 failure of Lehman Brothers, Moody's forecast in February 2009 called for a 16.4 percent default rate among high yield bond issuers (Emery and Ou 2009), yet realized defaults were less than 12 percent, though still historically large (Levine 2010). The ability of some firms to avoid an expected default in this earlier episode is generally attributed to liquidity in credit markets, enabling firms to reduce their immediate cash flow burden by refinancing. The current situation is arguably similar to or even more extreme in terms of the supply of funds from US capital

1. US Courts, "Statistics and Reports," <https://www.uscourts.gov/statistics-reports>.

markets. Credit markets have further seen a significant impact as a result of the March 2020 actions of the Federal Reserve (see, for example, O'Hara and Zhou 2020). This has so far enabled a large number of firms to refinance, extending maturities and enabling firms to avoid default, as well as to raise record levels of additional capital to fund expected shortfalls in cash flows needed to fund operations (Hotchkiss, Nini, and Smith 2020). This is subject, of course, to the same caveat that these observations are based on the supply of capital to larger firms.

TRIAGING OF DISTRESSED FIRMS The authors provide an overview of the path and ultimate outcome of firms that become financially distressed, based on evidence from numerous prior academic studies. Most notably, a large proportion of firms that cease operating simply close and never enter a court-supervised restructuring process (91.7 percent of all firm closures).² This group of firms is vastly dominated by smaller companies, outside the realm of much prior academic research. In-court business bankruptcies represent a much smaller portion of firm failures and are also dominated by liquidations under Chapter 7 of the bankruptcy code; a substantially greater share of firms filing for Chapter 11 bankruptcy (over two-thirds) successfully reorganize, at least in the sense of emerging from the bankruptcy process (Altman, Hotchkiss, and Wang 2019).

The central question for researchers examining outcomes from any system for resolving firm failures is whether that system strikes an efficient balance between enabling viable firms to reorganize, yet not enabling excessive continuation of firms with low going concern relative to liquidation value. The information problem is that both reorganization and liquidation values are unobservable. Specific provisions of the bankruptcy code as well as costs to the firm of using these procedures can tilt the system toward either excessive dismemberment of viable firms or excessive continuation.

Researchers examining larger public firms have been somewhat divided on this question of whether our current system enables excessive continuation of weak firms. In fact, the occurrence of liquidations for larger firms is often overstated because of the significant trend toward sales of entire businesses as going concerns in Chapter 11 via Section 363 of the bankruptcy code (Gilson and others 2021). Researchers further cite the high incidence of failure after emergence from bankruptcy, the so-called Chapter 22 filings of public corporations (Altman, Hotchkiss, and Wang 2019). But the stark

2. US Census Bureau, "Business Dynamics Statistics," <https://www.census.gov/programs-surveys/bds.html>.

contrast shown by the evidence reviewed in this paper makes it clear that the primary concern for smaller business is that of excessive liquidation.

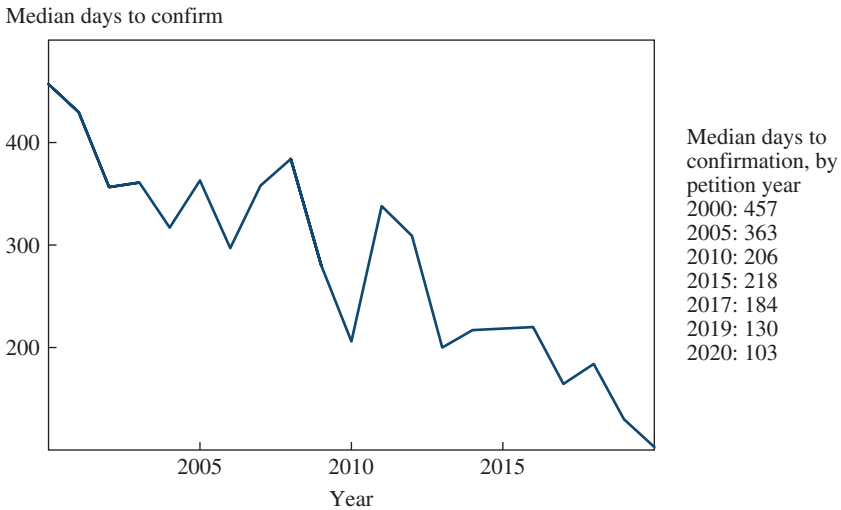
THE UPCOMING SURGE IN FAILURES AND EXPECTED COURT CONGESTION As the authors discuss, the ultimate length of the economic crisis (as of September 2020) is still highly uncertain. Whether there will eventually be a surge in defaults, bankruptcies, or inefficient liquidations will depend on whether or not there is continued government support and on the time it takes the COVID-19 pandemic to subside. If the current system proves inadequate to handle a sudden increase in bankruptcy filings, that will impose additional costs on distressed firms and likely lead to an even greater extent of inefficient liquidations.

There are several factors that currently suggest the supply of capital to firms experiencing negative shocks due to COVID-19 will be sufficient to ease cash flow constraints for many companies, including those already in bankruptcy (via debtor-in-possession financing). But the currently observed availability of financing may be limited to larger firms, which have access to public capital markets. In addition, private capital—what the authors call “dry powder”—that is available to inject equity or lend to private equity-backed firms, as well as interest from private equity funds in purchasing claims or entire companies in distress, also may enable larger firms to delay or avoid default. For smaller firms, insufficient bank capital is not a significant factor impairing the availability of credit at this point. However, increases in evictions and foreclosures or a prolonged recession would eventually have a negative impact on bank loan portfolios and ongoing lending.

Inefficient resolution of distress can also result from overcrowded bankruptcy courts. Offsetting a rise in cases filed, there has been a strong trend in recent years toward shorter stays in bankruptcy. The decrease in the time spent under court supervision can be attributed to increases in the use of prepackaged or pre-negotiated bankruptcies, in the use of restructuring support agreements (Casey, Tung, and Waldock 2020), and in the use of bankruptcy to facilitate sales of going concerns. Figure 2 demonstrates the steep decline in the time spent in bankruptcy for larger firms, with some recent cases even completed within twenty-four hours. These factors, combined with the length of time needed to appoint additional bankruptcy judges, suggest that market factors can adjust to compensate for court congestion.

POLICY OPTIONS AND CONCLUSIONS An important contribution of the paper is to provide a framework that can be used to compare potential policy responses to the pandemic. Specifically, one can evaluate proposals

Figure 2. Median Days to Plan Confirmation for Large Chapter 11 Bankruptcy Cases



Source: New Generation Research.

based on the particular source of inefficiency that a given policy might address and can consider whether the specific market friction is likely exacerbated by the crisis. The key frictions of concern are (1) large fixed costs of restructuring; (2) inability to renegotiate with claimants, given holdouts and complexities in capital structure, or to bring in new capital given debt overhang problems; and (3) search costs and financing frictions in asset redeployment.

The most apparent source of inefficiency based on the authors' analysis is that the large fixed costs and need for expertise of specialized advisers and lenders are beyond the capacity of most small firms to sustain. As a result, we observe high liquidation rates for smaller firms. In the current crisis, given smaller firms' more limited access to capital markets, limitations on their ability to restructure are likely to be even greater.

In response to the pandemic, the CARES Act increased the eligibility limit for small businesses to utilize Subchapter V of the Small Business Reorganization Act (SBRA) of 2019 from \$2,725,625 to \$7,500,000.³ The SBRA was enacted to provide a more streamlined path for smaller firms restructuring their debt in bankruptcy, recognizing the low rate of successful

3. Small Business Reorganization Act of 2019, Pub. L. 116–54, 133 Stat. 1079 (August 23, 2019), <https://www.congress.gov/116/plaws/publ54/PLAW-116publ54.pdf>.

reorganizations of smaller firms. Unfortunately, at this time there is little publicly available information to show whether firms have successfully made use of these relatively new procedures or whether there have been difficulties that suggest the need for further reform of these procedures. At the same time, because smaller firms have benefited more directly from funds provided under the Paycheck Protection Program (PPP), researchers have proposed that the ability to receive such funds be extended to firms operating under Chapter 11 protection (Bankruptcy and COVID-19 Working Group 2020).

To conclude, there is extensive literature that guides our understanding of the mechanism for resolution of financial distress. Adding to this work, the authors of this paper highlight the potential inefficiencies in this process, pointing toward those likely to be exacerbated in the pandemic. Given the large number of policy proposals in response, the paper provides a framework that can be used to better understand the likely impact of such proposals on economic outcomes. The evidence provided further demonstrates the importance of policies targeted at avoiding excessive liquidation of small firms in financial distress.

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GENERAL DISCUSSION Janice Eberly asked about the difference between small firms and young firms. She observed that although most firms tend to start off small, some grow quickly. It turns out, she continued, that these fast-growing firms are much more important for both employment and economic growth; while firms that start small and stay small are important to neighborhoods. She wondered whether the policy interventions—especially during COVID-19—were different for these two groups of firms.

Wendy Edelberg attempted to construct a coherent narrative linking all the papers presented at the conference. She commented that an underlying presumption in the discussion of this paper is that a wave of bankruptcies of small firms is coming. Edelberg wondered, however, whether it is also possible that instead there has been a massive structural shock that is both destroying many firms but also creating firms that are keeping employment elevated. She specified that these firm creations—which might be a reason behind why the unemployment rate has decreased quickly since its peak—show that the government response has been quite nimble. After the pandemic ends, however, these newly created firms might not be needed and another massive restructuring might take place, she concluded.

James Stock responded to Edelberg's comment and remarked that one coherent narrative could be the importance of both wearing masks and increasing testing. These two measures would allow those who are temporarily unemployed to get back to work and as a result many firms wouldn't go into bankruptcy, which, in turn, would have led to the Paycheck Protection Program (PPP) being a moderate success.

Elaine Buckberg mentioned the 2019 Small Business Reorganization Act, which makes it easier and less costly for small businesses to file for Chapter 11 bankruptcy by allowing small businesses to reorganize rather than liquidate. She asked whether this act changes the authors' outlook on business bankruptcies during the pandemic.

Ben Iverson responded to Buckberg, saying that the presentation's mention of Subchapter V of Chapter 11 is the same thing as the 2019 Small Business Reorganization Act. Iverson pointed out that the act had only been used by about 1,000 firms. Although he wasn't sure why this act hadn't been used very much, Iverson agreed with Buckberg that this act could prove to be very useful in keeping small businesses alive.

Referring to Edelberg's comment on whether the government response has been quite nimble, Iverson concluded that it is difficult to know. He observed, however, that if the government response has been nimble in response to the pandemic, it can also be nimble when the pandemic ends.

Replying to Eberly's comment on small firms versus young firms, Iverson said that in the data that he has looked at, variables listed typically include size of the firm but not age of the firm, which makes differentiating between these two types of firms when they are both small difficult but not impossible. The firms that are high-growth, Iverson argued, could be supported by markets.

Robin Greenwood brought up the figure in the paper that showed the percent of firms that have negative earnings per share. The level in regular times, Greenwood remarked, is about 40 percent. Young, fast-growing firms—like those in biotechnology—will continue to get financing, at least in the current market, Greenwood noted. It is the small, slower-growing firms, however, that tend to fail, which is costly to the economy, he concluded.

