A Model of Fickle Capital Flows and Retrenchment

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We develop a model of gross capital flows and analyze their role in global financial stability. In our model, consistent with the data, when a country experiences asset fire sales, foreign investments exit (fickleness), while domestic investments abroad return home (retrenchment). When countries have symmetric expected returns and financial development, the benefits of retrenchment dominate the costs of fickleness and gross flows increase fire-sale prices. Fickleness, however, creates a coordination problem since it encourages local policy makers to restrict capital inflows. When countries are asymmetric, capital flows are driven by additional mechanisms—reach for safety and reach for yield—that can destabilize the receiving country.

I. Introduction

Capital inflows are large, often exceeding 10% of a country's GDP per year. But they are also *fickle*—foreign investors tend to exit when a country is in financial distress. Fickleness can exacerbate *asset fire sales*, where

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assets are traded at a lower price than when investors with the highest valuation have sufficient liquidity.[1] Consistent with this mechanism, we show that the decline of capital inflows into a country is typically associated with higher future stock returns in that country (see sec. II). Concerns about fickle capital inflows exacerbating asset fire sales have spawned an academic and policy literature that emphasizes the need to regulate capital flows (see, e.g., IMF 2012).

Less studied than fickleness but as prevalent is *retrenchment*. Retrenchment occurs when local investors reduce their foreign investments and bring home their global liquidity during domestic distress. Empirically, capital outflows are highly correlated with inflows, meaning that local investors come home as foreign investors leave the country (see sec. II). Since retrenchment increases domestic liquidity during distress, it tends to offset the financial instability caused by fickleness and weakens the case for regulating capital flows. In this paper, we address this tension and its implications. We develop a stylized model of capital flows that assumes fickleness, and we ask whether capital flows can still be a useful source of liquidity.

Our model features a continuum of countries, each associated with a risky asset. The asset always pays a fixed amount, but the timing of the payoff is uncertain. Specifically, each country experiences a liquidity shock with some probability, in which case its asset's payoff is delayed to a future period. When this happens, the asset is traded at an endogenous price. In each country, there is one group of agents (distressed sellers) who sell their legacy risky assets to make new investments and another group of agents (banks) who can purchase risky assets. We make parametric assumptions so that the asset experiences a fire sale and its price is determined by banks' available liquidity. We analyze how cross-country investments impact the severity of asset price declines when there is a liquidity shock.

Specifically, in the ex ante period, banks have three choices: invest in the local risky asset, invest in foreign risky assets, or consume. These decisions are the source of ex ante capital flows in our model. If banks invest

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[1] By liquidity we mean financial resources that can be immediately deployed to purchase other financial or real assets. For early models of fire sales, see, e.g., Shleifer and Vishny (1992) and Kiyotaki and Moore (1997).

in the foreign risky asset, there are capital outflows from the sending country and capital inflows into the receiving country. Our key assumption is that, ex post, banks are home biased in that they are extremely fickle in foreign countries. If the foreign country experiences a liquidity shock, banks sell their risky asset in that country regardless of the price. This assumption captures a variety of factors that might handicap foreigners during domestic distress: asymmetric information or Knightian uncertainty, deteriorating property rights, asymmetric regulation, and so on. We are agnostic about the source of fickleness and view it as a modeling device to capture the asymmetric behavior of foreigners and locals during crises that we see in the data. In particular, while foreign banks in our model sell local assets, local banks retrench and use their global liquidity to purchase local assets at fire-sale prices.

In our baseline model, countries are identical except for their liquidity shocks. In this case, a natural question is whether banks invest in foreign countries at all, since fickleness (which occasionally forces banks to sell at fire-sale prices) reduces their expected return from foreign risky assets relative to the local risky asset. However, funds invested abroad can provide valuable liquidity during local fire sales. In our model, this liquidity effect is strong enough that there is always foreign investment and capital flows despite fickleness.

We then analyze how these fickle capital flows among similar countries affect global financial stability. Our main positive result is that capital flows increase fire-sale asset prices despite their fickleness. The intuition is that fickle foreign banks sell local assets at fire-sale prices, but local banks obtain liquidity from their diversified foreign assets at relatively high valuations. In a symmetric environment, every precrisis inflow is matched by a precrisis outflow of equal size. Thus, symmetric capital flows provide liquidity and increase fire-sale prices.

In this symmetric environment, we also assess policies that regulate capital flows. Our main normative result is that regulating capital flows is subject to a coordination problem. Even though capital flows increase fire-sale prices in global equilibrium, local policy makers trying to increase fire-sale prices in their home country might restrict capital inflows. This tension arises because there is a public goods aspect to the global liquidity generated via fickle capital flows. Every capital inflow into one country is an outflow from some other country. Local regulators restrict inflows to reduce the country's exposure to fickleness, but they do not recognize the retrenchment benefits that a stable source of foreign assets has for banks in other countries.

We also investigate the determinants of gross capital flows in our baseline model. First, we show that a greater scarcity of safe assets increases gross capital flows—a situation reminiscent of the period before the global financial crisis. Foreign assets (imperfectly) substitute for safe assets by creating liquidity during local liquidity shocks. Second, we show that an increase in the perceived correlation between liquidity shocks reduces gross capital flows—a situation reminiscent of the period after the financial crisis. When banks think liquidity shocks are more likely to be global, they perceive that foreign assets create less liquidity. The resulting decline in foreign investment reduces liquidity and fire-sale prices even if the global shock is not realized.

Our baseline symmetric model roughly captures gross capital flows among developed countries. However, when liquidity or investment returns are substantially asymmetric across regions, gross capital flows may not be stabilizing. We identify two potentially destabilizing mechanisms—reach for safety and reach for yield—that apply when developed markets with substantial liquidity but relatively low returns trade capital flows with emerging markets with less liquidity but relatively high returns.

The reach-for-safety mechanism is driven by cross-country differences in liquidity (captured by the supply of local safe assets in our model). Greater liquidity in a developed market country makes its assets relatively attractive to foreign banks. Other things equal, this induces the developed country to experience greater inflows relative to its outflows (or run current account deficits). Moreover, the inflows into the developed market country end up in stable, low-yield safe assets, whereas the outflows are directed to risky, high-yield assets. Banks in the developed market country effectively sell liquidity insurance to emerging markets. These types of reach-for-safety flows reduce fire-sale prices in the developed market while increasing them in emerging markets. (See Lane and Milesi-Ferretti [2007] for empirical evidence on the risk composition of cross-country assets and liabilities, and see Gourinchas and Rey [2007], Gourinchas, Rey, and Govillot [2010], and Gourinchas, Rey, and Truempler [2012] for evidence on the venture capitalist and insurer roles the United States plays in the global system.)

The reach-for-yield mechanism is driven by cross-country differences in investment returns. If the return in an emerging market country is greater than in other markets, foreign banks invest in this country not only to have a source of liquidity during their local liquidity shocks but also to chase higher returns. This process stops only when fickle inflows are large enough that, in the event of a local liquidity shock, the emerging market country has lower fire-sale prices compared with other countries (thereby reducing its appeal to foreign banks). Thus, we find that fickle flows driven by the pursuit of higher returns destabilize the emerging markets receiving these flows.

Related literature.—International diversification is at the core of our mechanism. An extensive literature studies capital flows in frictionless models of international risk sharing (see, e.g., Grubel 1968; Cole and Obstfeld 1991; Van Wincoop 1994; Lewis 2000; Coeurdacier and Rey 2013). The main reason for diversification in our paper is different from the reasons highlighted in this literature. In our model, investments abroad provide valuable liquidity to local banks during fire sales.

Our paper is part of a literature that focuses on gross positions held by sophisticated financial intermediaries and their role in allocating international liquidity where it is most valuable (see, e.g., Brunnermeier et al. 2012; Bruno and Shin 2013; Fostel, Geanakoplos, and Phelan 2015; Gabaix and Maggiori 2015; Miranda-Agrippino and Rey 2015). A related literature emphasizes the costs of capital flows: while flows improve capital allocation, their fickleness may exacerbate local fire-sale externalities and justify macroprudential regulation (see, e.g., Caballero and Krishnamurthy 2004; Jeanne and Korinek 2010; Ostry et al. 2010; Caballero and Lorenzoni 2014; Calvo 2016; Korinek and Sandri 2016). We explore the global equilibrium implications of fickleness and the policy coordination issues that arise in this global context.

We take fickleness as given. In this sense, we take a similar approach to Scott and Uhlig (1999), who take the fickleness of financial investors as given and study the impact of fickleness on economic growth. The all-or-nothing attitude of fickle foreign banks is extreme in our model, but it is intended to capture a variety of reasons that foreign investors exit during turmoil (see remark 3). One important reason is the attitude of Knightian agents facing an unfamiliar situation. As such, our model is related to Caballero and Krishnamurthy (2008) and Caballero and Simsek (2013). We develop this Knightian uncertainty interpretation in appendix A.1 (apps. A, B are available online).

One central reason for capital flows in our model is investors seeking safe assets. Because safe assets are scarce, investors diversify in foreign risky assets to secure liquidity during local fire sales. In this sense, our work is related to the literature on the limited availability of safe assets and its macroeconomic consequences (e.g., Caballero 2006; Caballero, Farhi, and Gourinchas 2008, 2016; Bernanke et al. 2011; Gorton, Lewellen, and Metrick 2012; Krishnamurthy and Vissing-Jorgensen 2012; Gorton 2017).

The endogenous liquidity creation aspect of our model is similar to Holmström and Tirole (1998), although our context and mechanism are different. The liquidity pricing of local assets is similar to the literature on limits to arbitrage and fire sales (e.g., Allen and Gale 1994; Shleifer and Vishny 1997; Holmström and Tirole 2001; Gabaix, Krishnamurthy, and Vigneron 2007; Lorenzoni 2008; Krishnamurthy 2010; Gromb and Vayanos 2016). In addition to these mechanisms, we highlight the benefit of gross flows as a stabilization channel.

The rest of the paper is organized as follows. Section II reviews and extends the empirical literature documenting the fickleness and retrenchment aspects of capital flows. Section III presents our baseline model with symmetric countries. Section IV illustrates how symmetric capital flows create liquidity and mitigate financial distress. Section V concerns the optimal regulation of capital flows in our environment. Section VI develops a special case of the baseline model to analyze the determinants of gross capital flows. Section VII considers a variant of the baseline model in which an (infinitesimal) country has different return and liquidity parameters from the remaining countries and uses it to analyze asymmetric flows driven by reach for safety and reach for yield. Section VIII concludes. Appendix A contains various extensions of the model as well as proofs of the propositions, and appendix B describes the data sources and the details of the empirical analysis.

II. Fickleness and Retrenchment: Some Facts

Our model is built on the observation that capital inflows are fickle (i.e., foreign investors exit when a country is in distress) and that capital outflows retrench (i.e., local investors reduce their foreign investments during domestic distress and bring home their global liquidity). In this section, we discuss the evidence for these phenomena and motivate our modeling ingredients.[2]

Systematic analysis of gross capital flows typically relies on the International Monetary Fund's balance of payments statistics. Using these data, Broner et al. (2013a, 2013b) document that fickleness and retrenchment are broad empirical regularities (see also Forbes and Warnock 2012; Bluedorn et al. 2013). They write that "during contractions foreigners reduce their investments in domestic assets and domestic agents reduce their investments abroad. This retrenchment toward home financial markets is particularly acute during crises." Figure 1, which extends their data set until 2017, illustrates this pattern for three developed economies from different regions: the United States, Spain, and Japan. For each country, we plot capital inflows by foreign agents (henceforth, capital inflows) and capital outflows by domestic agents (henceforth, capital outflows) together with a local stock market index to visualize the correlation of flows with each other and with domestic financial distress.

To quantify these correlations, we first regress capital outflows on capital inflows. We standardize the capital flow measures in figure 1 by the

[2] For a policy motivation, see Obstfeld (2012, 31), who documents the fickleness and retrenchment that occurred in the United States at the peak of the subprime financial crisis and argues that retrenchment mitigated the crisis. Specifically, he writes that "over the two quarters of intensive global deleveraging following the Lehman Brothers collapse in September 2008 . . . [United States] Gross capital inflows . . . went into reverse, as foreigners liquidated $198.5 billion in US assets. In addition, the US financed a current account shortfall of $231.1 billion. . . . Where did the total of nearly $430 billion in external finance come from? It came from US sales of $428.4 billion of assets held abroad."

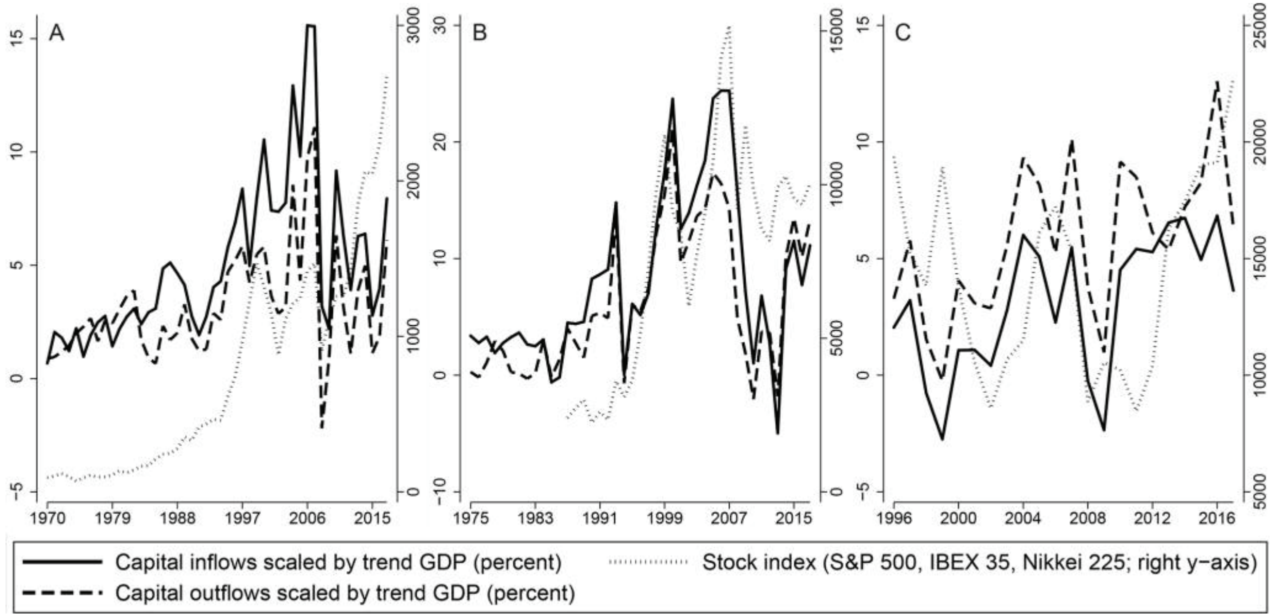

FIG. 1.—Gross capital flows and stock price index for three countries. Sources: IMF, World Bank, and Global Financial Data (see app. B for details). *A*, United States. *B*, Spain. *C*, Japan.

mean and standard deviation of each measure within each country. We focus on the period between 1970 and 2017 and consider two separate samples: a large sample of 170 countries for which we have data on capital flows and a smaller sample of 30 Organization for Economic Cooperation and Development (OECD) countries for which we have additional data on stock prices and returns (see app. B.1 for data sources and details). We include country-specific linear time trends in all regressions. Columns 1 and 2 of table 1 illustrate our results. Inflows and outflows are strongly correlated in both samples, and the magnitudes are especially large for the OECD sample. Columns 3 and 4 illustrate that the results remain largely unchanged when we include time fixed effects: that is, inflows and outflows in an individual country are highly correlated even after controlling for the average flows in sample countries (for similar evidence, see Alberola, Erce, and Serena 2016; Jeanne and Sandri 2017). As Broner et al. (2013a, 2013b) note, these patterns are difficult to reconcile with standard frictionless macroeconomic models because the shocks (e.g., to domestic productivity) in those models typically affect domestic agents' and foreigners' domestic investments in the same direction. Rather, the evidence is more easily reconciled with models where crises affect domestic agents and foreigners asymmetrically.

We model this asymmetry by assuming that foreign banks sell their assets in a distressed country regardless of the price, even if the expected return is high (fickleness). As foreign banks sell, local banks use their global liquidity to purchase local assets at a high expected return (retrenchment). To assess the plausibility of these ingredients, we investigate the relationship between capital flows and expected stock returns. Using our OECD sample, we regress future stock returns on current capital flows.

TABLE 1
Correlations between Capital Inflows and Outflows

	Outflows/Trend GDP			
	(1)	(2)	(3)	(4)
Inflows/trend GDP	.441**	.820**	.417**	.752**
	(.043)	(.034)	(.036)	(.047)
Time fixed effects	No	No	Yes	Yes
Country-specific linear trend	Yes	Yes	Yes	Yes
Sample	Full	OECD	Full	OECD
Observations	5,102	838	5,102	838
R^2 (adjusted)	.23	.74	.28	.76

Note.—The full (OECD) sample is an unbalanced panel of 170 (30) countries between 1970 and 2017 (see app. B for details). Inflows and outflows are scaled by trend GDP and standardized within each country. Estimation is via ordinary least squares. Standard errors are in parentheses and double-clustered by country and year.

* Significant at the 5% level.

** Significant at the 1% level.

Our baseline specification focuses on the annualized log return of the local stock market index (including dividends) measured in local currency over the subsequent 5 years (see app. B.2 for similar results with the return measured in US dollars or over different horizons). We control for country fixed effects and include country-specific linear time trends. Columns 1 and 2 of table 2 illustrate that a decline in capital inflows or outflows in a country is followed by high stock returns. The effects are statistically significant and economically large: a 1 standard deviation decline in the inflow (outflow) to GDP ratio is associated with a 3.3 (3.4) percentage point increase in the annualized log stock return over the subsequent 5 years. Consistent with our model, foreigners seem to exit when expected stock returns are high, whereas locals seem to return home.

One possibility is that these excess return findings are dominated by global shocks, where all investors retrench to their respective home countries, and the results reflect the excess return associated with global risk-off episodes. While we allow for global shocks, gross flows in our model create liquidity due to nonglobal shocks (where not all countries are hit symmetrically). To focus on nonglobal shocks, we consider a specification with time fixed effects, which absorbs global changes in flows and returns. Columns 3 and 4 of table 2 show that the results remain significant, although with a smaller magnitude. Consistent with our model, foreigners seem to exit a country when the expected stock return there is high, even after controlling for the average flows and stock returns in sample countries. Moreover, our model also predicts that local shocks

TABLE 2
Return Prediction Regressions Using Gross Capital Flows

	Log Stock Return in Next 5 Years (Annualized, Local Currency)			
	(1)	(2)	(3)	(4)
Inflows/trend GDP	−.033**		−.017**	
	(.005)		(.005)	
Outflows/trend GDP		−.034**		−.014**
		(.005)		(.006)
Time fixed effects	No	No	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Country-specific linear trend	Yes	Yes	Yes	Yes
Observations	716	716	716	716
R^2 (adjusted, within country)	.29	.29	.56	.55

Note.—The sample is an unbalanced panel of 30 OECD countries between 1970 and 2017 (see app. B for details). Inflows and outflows are scaled by trend GDP and standardized within each country. Estimation is via ordinary least squares. Standard errors are in parentheses and double-clustered by country and year.

* Significant at the 5% level.

** Significant at the 1% level.

should reduce local asset prices (and raise excess returns) less than global shocks, as in table 2. When shocks are mostly local, domestic investors obtain greater liquidity from their foreign assets (see sec. IV.B).

Remark 1 (Additional facts on the role of banks). In recent work, Avdjiev et al. (2017) further analyze international capital flows by the sectors that send or receive them (banks, corporates, or sovereigns) and find that global banks are largely responsible for the fickleness and retrenchment patterns in aggregate data. These banks seem to be especially important for understanding retrenchment in developed markets, whereas sovereigns (which increase their borrowing or draw down their reserves during crises) seem to account for some retrenchment in emerging markets. This motivates our emphasis on banks as the main empirical counterpart to the agents in our model, as well as our interpretation that our baseline symmetric model applies most naturally to developed markets. Moreover, retrenchment by emerging market sovereigns suggests that many of the mechanisms that we emphasize are also relevant in emerging markets, with central banks taking the functional role of banks in our model.

III. The Model

The baseline model features three periods, $t \in \{0, 1, 2\}$, and a single consumption good in each period. There is a continuum of mass 1 of countries denoted by superscript $j \in J$, which are symmetric except for their local shocks in period 1.

A. Shocks

In period 1, an aggregate state $s \in S = \{1, \dots, |S|\}$ is drawn with probability $\gamma_s > 0$, where $\Sigma_{s \in S}\gamma_s = 1$. The aggregate state determines the probability of a liquidity shock in a given country, which is the same across countries and denoted by $\pi_s \in [0, 1]$. Specifically, a random variable ω^j is drawn for each country j and independently and identically distributed (i.i.d.) across j, with $\pi_s = \Pr(\omega^j = b)$ and $1 - \pi_s = \Pr(\omega^j = g)$. We say that a country with $\omega^j = b$ experiences a liquidity shock (thus, b and g stand for bad and good states, respectively). The ex ante probability of a liquidity shock is positive but less than 1, $\Sigma_S \gamma_s \pi_s \in (0, 1)$. We also assume that π_s is strictly increasing in s so that aggregate states with greater s are associated with a greater likelihood of liquidity shocks.

B. Assets

There are three types of assets. First, each country j has a risky asset whose payoff depends on the realization of ω^j. If $\omega^j = g$, then each unit of the asset pays R units in period 1 and zero units in period 2. If instead $\omega^j = b$, so that the country experiences a liquidity shock, then each unit of the asset pays zero units in period 1 and R units in period 2. In this case, the asset has an endogenous price p_s^j in period 1. We focus on symmetric equilibria in which the price in period 1 is the same for all countries that experience a liquidity shock; that is, $p_s^j \equiv p_s$ for each country j with $\omega^j = b$. Initially, each country has e units of the risky asset, which we refer to as legacy assets (endowed to local distressed sellers that will be described below). In period 0, agents can produce more risky assets according to a linear technology. Specifically, they can convert one unit of the consumption good in period 0 into one unit of the risky asset in any country (therefore, the price of the risky asset in period 0 is equal to 1).

Second, there is a risk-free asset that pays one unit of the consumption good in period 1 (and zero units in period 2). The risk-free asset is in fixed supply: specifically, there are η units in each country (endowed to local banks that will be described below). In period 0, the risk-free asset is traded at an endogenous price q_f.

Third, there are Arrow-Debreu financial securities that facilitate aggregate risk sharing. Specifically, for each aggregate state $s \in S$, there is an Arrow-Debreu security that pays one unit of the consumption good in period 1 if state s is realized (and zero units in all other states or in period 2). The Arrow-Debreu securities are in zero net supply. In period 0, the Arrow-Debreu security for state s is traded at an endogenous price q_s.[3]

C. *Agents*

There are two types of agents. First, each country j has a mass 1 of agents that we refer to as distressed sellers. These agents are our modeling device to generate liquidity-driven asset sales while keeping the analysis tractable (see remark 5 for an interpretation in the context of a more conventional model). Therefore, we model them rather mechanically: they are born in period 1 endowed with e units of the local risky asset (all of the legacy assets). They maximize the utility function $E[\tilde{c}_{2,s}^j]$, where $\tilde{c}_{2,s}^j$ denotes their consumption in period 2 conditional on the aggregate state s. They have access to a linear technology that converts one unit of the consumption good in period 1 into λ units of the consumption good in period 2. The payoff from this technology cannot be pledged to other agents, so

[3] Note that agents cannot trade financial contracts whose payoffs are contingent on local liquidity shocks, $\{\omega^j\}_j$. In app. A.2, we first show that when markets are complete, fickleness is irrelevant for fire-sale prices. We then consider the case in which markets are partially complete; in particular, agents can sell contingent contracts subject to a collateral constraint. We show that as long as markets are not fully complete, fickleness affects fire-sale prices and our analysis generalizes. We adopt the incomplete-markets setting as our baseline model because it features the tension between fickleness and retrenchment while simplifying the exposition.

the distressed sellers can invest in their technology using only the liquidity from their legacy assets. Specifically, if $\omega^j = g$ is realized in their country, they receive Re units of the consumption good from their legacy assets. They invest these liquid resources in their technology and consume the output in period 2; that is, $\tilde{c}^j_{2,s}(\omega^j = g) = \lambda Re$. If instead $\omega^j = b$ is realized, then they decide whether to keep their legacy assets or to sell them. We let $\tilde{\chi}^j_s \in [0, e]$ denote their holdings of the legacy assets at the end of period 1 and note that their consumption in period 2 is

$$\tilde{c}^j_{2,s}(\omega^j = b) = \tilde{\chi}^j_s R + \lambda(e - \tilde{\chi}^j_s)p_s. \quad (1)$$

As long as $\lambda p_s > R$ for each s, distressed sellers optimally choose $\tilde{\chi}^j_s = 0$ and sell all of their legacy assets regardless of the aggregate state. We will make parametric assumptions so that this is the case along the equilibrium path for most of our analysis.

In each country j, there is also a second group of agents with mass 1, which we refer to as banks. These are the main agents in our model, and their preferences are

$$E\left[u\left(c^j_0\right) + c^j_{1,s} + c^j_{2,s}\right], \quad (2)$$

where the utility function, $u(\cdot)$, satisfies $u'(c) > 0$, $u''(c) < 0$ for each $c > 0$ as well as the Inada-type conditions, $\lim_{c\to 0} u'(c) = \infty$ and $u'(1) < R$. Note that these preferences also imply that if $\omega^j = b$ is realized, then (local) banks would be indifferent to holding the asset if and only if $p_s = R$. We will make parametric assumptions so that the equilibrium asset price will be below this level, $p_s < R$, which we refer to as a *fire sale*.[4]

D. Banks' Budget Constraints

Banks in each country j are endowed with one unit of the consumption good in period 0 as well as η units (all of the fixed supply) of the risk-free asset. In period 0, they choose an investment strategy in risky assets, $x^{j',j}$, across countries, j'. We impose that $x^{j,j}$ is a point mass, and $x^{j',j}$ for $j' \neq j$ is a density with respect to the Lebesgue measure. Banks also choose how many consumption units to invest in the risk-free asset, y^j, or in Arrow-Debreu securities, $(z^j_s)_s$. Their budget constraint in period 0 is

$$c^j_0 + x^{j,j} + x^{out,j} + y^j q_f + \sum_{s\in S} z^j_s q_s = 1 + \eta q_f, \quad (3)$$

[4] Recall that we assume that the assets in countries without a liquidity shock ($\omega^j = g$) pay early in period 1. This simplifies the exposition by ensuring that we do not need to worry about asset prices or fire sales in these countries (the ex dividend price would always be zero). Equivalently, we could assume that the risky asset always pays later (in period 2) but make parametric assumptions (e.g., on the legacy asset endowment of distressed sellers) such that the countries without liquidity shocks are not subject to fire sales ($p_s(\omega^j = g) = R$).

where $x^{out,j} = \int_{j' \neq j} x^{j',j} dj'$. Here, $x^{out,j}$ denotes the outflows: the aggregate amount banks in country j invest in other countries. Banks are not allowed to short sell risky assets, $x^{j',j} \geq 0$ for each j', but they are allowed to take unrestricted positions in the risk-free asset or the Arrow-Debreu securities subject to obtaining nonnegative consumption in all periods and states.

In period 1, if $\omega^{j'} = g$ and $j' \neq j$, then banks in country j receive R units of the consumption good from each unit of their risky asset investment in country j'. By an exact law of large numbers, these investments generate $x^{out,j}(1 - \pi_s)R$ units of the consumption good (see Uhlig 1996 for details).[5] If instead $\omega^{j'} = b$ and $j' \neq j$, then banks in country j sell their risky asset holdings in country j', which captures our main fickleness assumption (see remark 3 below for various interpretations). By the same law of large numbers, these sales generate $x^{out,j}\pi_s p_s$ units of the consumption good. Hence, the total resources that banks in country j receive from investments in other countries are given by $x^{out,j}\bar{R}_s$, where

$$\bar{R}_s = (1 - \pi_s)R + \pi_s p_s \tag{4}$$

denotes the expected one-period payoff from a unit of foreign investment conditional on the aggregate state s. In addition, banks receive $y^j + z_s^j$ units of the consumption good from their investments in the risk-free asset and the Arrow-Debreu securities.

Banks' total resources in period 1 and how they use these resources depend on the shock in their own country. If $\omega^j = g$, then banks' risky asset investments in their own country pay $Rx^{j,j}$ units in period 1. Moreover, banks have no more remaining investment opportunity, so they consume all of their available resources in period 1. Then, their budget constraint in state $\omega^j = g$ can be written as

$$\begin{aligned} c_{1,s}^j(\omega^j = g) &= x^{j,j}R + x^{out,j}\bar{R}_s + y^j + z_s^j, \\ c_{2,s}^j(\omega^j = g) &= 0. \end{aligned} \tag{5}$$

If instead $\omega^j = b$, then banks' risky investments in their own country pay zero units in period 1. However, banks are not required to sell their holdings in their own country. We let $\chi_s^j \geq 0$ denote banks' position in the local risky asset in period 1, with $\omega^j = b$ and aggregate state s. Then, banks' budget constraints in state $\omega^j = b$ can be written as

[5] More precisely, conditional on the aggregate state s, the return from these countries corresponds to an integral over random variables, $\int_{j' \in [0,1]} Rx^{j',j}\mathbf{1}[\omega^{j'} = g]dj'$ (where $\mathbf{1}[\omega^{j'} = g]$ denotes the indicator variable). We obtain the law of large numbers by interpreting this as a *Pettis integral*, which is a generalization of the Lebesgue integral to vector-valued functions. We then use a slight extension of theorem 3 from Uhlig (1996) to evaluate the integral as equal to $\int_{j' \in [0,1]} Rx^{j',j}(1 - \pi_s)dj' = R(1 - \pi_s)x^{out,j}$ with probability 1.

$$\begin{aligned} c^j_{1,s}(\omega^j = b) + \chi^j_s p_s &= x^{j,j} p_s + x^{out,j}\bar{R}_s + y^j + z^j_s, \\ c^j_{2,s}(\omega^j = b) &= \chi^j_s R. \end{aligned} \tag{6}$$

E. *Banks' Problem*

Putting everything together, banks in each country j make an investment plan, $\{[x^{j',j} \geq 0]_{j'}, y^j, (z^j_s, \chi^j_s \geq 0)_s\}$, to maximize their expected utility in equation (2), where c^j_0 is determined by equation (3), $c^j_{1,s}(\omega^j = g)$ and $c^j_{2,s}(\omega^j = g)$ are determined by equation (5), $c^j_{1,s}(\omega^j = b)$ and $c^j_{2,s}(\omega^j = b)$ are determined by equation (6), and consumption in all periods and states is nonnegative, $c^j_0 \geq 0$, $c^j_{1,s} \geq 0$, $c^j_{2,s} \geq 0$.

F. *Equilibrium*

The equilibrium with symmetric prices is a collection of optimal allocations for distressed sellers and banks together with prices, $(p_s)_s$, q_f, $(q_s)_s$, that ensure market clearing. The market-clearing condition for the risky asset in a country j with $\omega^j = b$ in period 1 is

$$e + x^{in,j} + x^{j,j} = \tilde{\chi}^j_s + \chi^j_s, \tag{7}$$

where $x^{in,j} = \int_{j' \neq j} x^{j,j'} dj'$. Here, $x^{in,j}$ denotes the inflows: the aggregate amount foreign banks invest in a country j. The left side of the equation captures the supply of risky assets, which comes from the distressed sellers' endowment of legacy assets, the ex ante inflows, and the ex ante local investments. The right side captures demand, which comes from only distressed sellers and local banks because foreign banks sell all their asset holdings in country j when $\omega^j = b$. The market-clearing condition for the risk-free asset in period 0 is given by

$$\int_j y^j dj = \int_j \eta dj = \eta. \tag{8}$$

Finally, the market-clearing condition for the Arrow-Debreu security for each state s is given by

$$\int_j z^j_s dj = 0. \tag{9}$$

REMARK 2 (Interpreting assets). We view the risky assets in our model as securities that are held by banks and that can be subject to fire sales. Some examples are equity, long-term debt (bank loans and portfolio debt), and unsecured short-term debt subject to default risk. In contrast, safe assets are not subject to fire sales and yield a relatively high payoff during distress events, for example, short-term debt that is highly collateralized or issued by entities with negligible default risk.

Remark 3 (Interpreting fickleness). Our fickleness assumption captures a variety of factors that, during a local distress event, reduce foreign banks' valuation of the local risky asset relative to locals' valuation. One interpretation is asymmetric information or uncertainty: foreign banks have an information disadvantage that worsens when the local market is distressed (see app. A.1 for a formalization based on Knightian uncertainty). This interpretation is broadly consistent with the large literature on portfolio home bias (see, e.g., Gehrig 1993; Brennan and Cao 1997; Van Nieuwerburgh and Veldkamp 2009). Another example is weaker property rights for foreign banks. In distressed markets, foreign banks are more likely to be expropriated or defaulted against than locals (see Broner et al. 2014 for a formalization in the context of the European sovereign debt crisis). A related interpretation is asymmetric regulation that increases foreign banks' cost of investment in distressed markets relative to their local counterparts (see Uhlig 2014 for a model along these lines in the context of the same European crisis). Finally, the asymmetry might also stem from distorted higher valuation by local banks, for example, because of moral suasion by local regulators and governments.

Remark 4 (Implementation with lending to local firms). In practice, banks often lend to firms (or other banks) as opposed to investing in production technologies, and their fickleness can take the form of not renewing these loans as opposed to selling loans. We could capture these realistic elements without changing anything substantive. In particular, our equilibrium has an equivalent implementation in which there are competitive local firms (with no funds) that invest in the domestic linear production technology in period 0 by borrowing from banks with a one-period, state-contingent debt contract. The contract promises R units for each unit borrowed if the country does not experience a liquidity shock and p_s units if there is a liquidity shock (while debt contracts in practice tend to be noncontingent, the promises in distress are often implicitly reduced, for example, via lenders' decision to recall loans). With this implementation, when there is a local liquidity shock, foreign banks withdraw their financing (fickleness) and local firms pay them by selling or pledging their risky assets to local banks.

Remark 5 (An alternative model with distressed banks). In appendix A.5, we build an alternative model in which there are no separate distressed sellers. Instead, we require banks to hold a minimum amount of the local risky asset (in view of their comparative advantage in lending in the local market), which corresponds to the legacy assets in the main model. We also model liquidity shocks as events in which local risky assets experience losses. These losses generate financial distress for banks because of their holdings of legacy assets. Banks are then forced to sell some of their legacy assets to another group of agents, secondary buyers (who reside in the same country). These buyers convert the assets to an alternative use that generates lower payoffs, following the standard fire-sale mechanism (as in, e.g., Kiyotaki and Moore 1997). Our main results hold in this setting. Hence, distressed sellers introduce the standard balance sheet channel into our model while substantially simplifying the analysis. By endowing these agents with legacy assets and a technology with high return (large λ), we mechanically generate liquidity-driven asset sales and the misallocation of capital (from high- to low-marginal-value agents) that results from these sales.

IV. Gross Flows and Global Liquidity Creation

In this section, we characterize the equilibrium. We show that, despite their fickleness, gross flows exist, contribute to global liquidity creation, and mitigate fire sales. We also show that foreign investment in period 0 is associated with a risk premium even though banks have linear utility in period 1 (thus risk aversion, the standard source of the risk premium, is absent). Throughout the rest of the paper, we focus on the following parametric condition.

Assumption 1. $eR/\lambda < \eta < eR$.

The right side of the inequality ensures that the equilibrium features fire sales, $p_s < R$. The left side ensures that $\lambda p_s > R$, so distressed sellers always sell their legacy assets, $\tilde{\chi}_s^j = 0$ (cf. eq. [1]).

A. *Equilibrium and Liquidity Creation*

Under assumption 1, we conjecture an equilibrium with symmetric prices that satisfy $p_s \in (R/\lambda, R)$ for each s. We also conjecture a symmetric equilibrium allocation in which each country invests the same amount in the risky asset of each other country, $x^{j',j} = x^{out,j}$ for each $j' \neq j$, and all countries choose identical allocations. We denote these symmetric allocations by dropping the superscript j; that is,

$$x^{out,j} \equiv x^{out}, y^j \equiv y, z_s^j \equiv z_s$$

for each j. Note that these assumptions imply that the inflows into a country are equal to its outflows, $x^{in,j} \equiv x^{in} = x^{out}$ (cf. eqq. [3], [7]). When it is clear from the context, we also drop the superscript "in" or "out" and denote these symmetric gross flows with x.

Since banks have linear utility between periods 1 and 2, the presence of fire sales ($p_s < R$) implies that banks in countries with state $\omega^j = b$ invest all of their resources in period 1 in the local risky asset, that is, $c_{1,s}^j(\omega^j = b) = 0$, and their position on the risky asset, χ_s^j, is determined by equation (6). In addition, since countries have symmetric allocations, the market-clearing conditions (8) and (9) imply that $y^j = y = \eta$ and $z_s^j = z_s = 0$. Combining these observations with the budget constraints (3), (5), and (6), we obtain

$$\begin{aligned} c_0^j + x^{j,j} + x^{out} &= 1, \\ c_{1,s}^j(\omega^j = g) &= x^{j,j}R + x^{out}\bar{R}_s + \eta, \\ c_{2,s}^j(\omega^j = b) &= (x^{j,j}p_s + x^{out}\bar{R}_s + \eta)\frac{R}{p_s}. \end{aligned}$$

Substituting these expressions into the objective function in equation (2) and rearranging terms, we find that the representative bank's problem can be written as

$$\max_{x^{j,j},x^{out}} u(1 - x^{j,j} - x^{out}) + x^{j,j}R + \sum_s \gamma_s(x^{out}\bar{R}_s + \eta)M_s, \tag{10}$$

$$\text{where } M_s \equiv 1 - \pi_s + \pi_s\frac{R}{p_s}. \tag{11}$$

Here, M_s denotes the expected period 1 marginal value of the consumption good conditional on the aggregate state s. When $\omega^j = g$, local banks do not have an investment opportunity in period 1 and consume their available resources. When $\omega^j = b$, local banks take advantage of local fire sales in period 1 to invest their available resources and obtain greater marginal value, $R/p_s > 1$. The expression for expected marginal value, M_s, combines these two cases.

To solve problem (10), first note that the ex ante marginal value from investing in the local risky asset is simply equal to its payoff, R. In contrast, the ex ante marginal value from investing in foreign risky assets is given by $\Sigma_s\gamma_s\mu_s(p_s)$, where

$$\mu_s(p_s) \equiv \bar{R}_sM_s = [(1 - \pi_s)R + \pi_sp_s]\left(1 - \pi_s + \pi_s\frac{R}{p_s}\right). \tag{12}$$

The function $\mu_s(p_s)$ captures the ex ante marginal value conditional on the aggregate state s and given the price level p_s. For banks, expected payoff from foreign investment is relatively low, $\bar{R}_s < R$, because they are fickle and sell their risky assets when there is a liquidity shock in the foreign country. On the other hand, expected period 1 marginal value is relatively high, $M_s > 1$, because they retrench and use the liquidity from foreign assets to buy underpriced, distressed assets during a local liquidity shock. The ex ante marginal value, $\mu_s(p_s) = \bar{R}_sM_s$, combines banks' costs and benefits from foreign investment. Our next result characterizes this expression and shows that it always exceeds the ex ante marginal value from local investment.

LEMMA 1. For each aggregate state s with $\pi_s \in (0, 1)$, the ex ante marginal value from foreign investment, $\mu_s(p_s)$, is strictly decreasing in p_s over the range $p_s \in (0, R]$, and it satisfies $\mu_s(R) = R$. In particular, when $p_s \in (0, R)$, we have $\mu_s(p_s) > R$, and investing in foreign risky assets dominates investing in local risky assets, so banks set $x^{j,j} = 0$.

The possibility of local fire sales induces banks to invest in a diversified portfolio of foreign risky assets as a form of liquidity insurance. Consistent with this intuition, a decline in the fire-sale price at home, p_s, increases the marginal value from foreign investment, $\mu_s(p_s)$.

Combining lemma 1 with problem (10), we characterize the equilibrium level of foreign investment as the solution to

$$u'(1 - x^{out}) = E[\bar{R}_s M_s] = \sum_s \gamma_s \mu_s(p_s). \tag{13}$$

Banks buy foreign risky assets until the ex ante marginal value from investment is equal to their current marginal utility from consumption. Note that a reduction in the fire-sale price p_s (in any aggregate state with $\pi_s > 0$) increases x^{out}: a lower price increases the value of liquidity insurance, and this insurance is obtained by increasing foreign investment.

Next, consider the determination of the fire-sale asset prices, p_s. Recall that $c^j_{1,s}(\omega^j = b) = 0$ and χ^j_s is determined by equation (6) after substituting $y^j = \eta$ and $z^j_s = 0$. Substituting this expression and $\tilde{\chi}^j_s = 0$ into the market-clearing condition (7), we obtain an expression for the fire-sale price:

$$p_s = \frac{\eta + x^{out}\bar{R}_s}{e + x^{in}}. \tag{14}$$

The denominator captures the total amount of sales, comprised of liquidity-driven sales (e) and past inflows, all of which are liquidated in a crisis. The numerator corresponds to local banks' available liquidity, which comes from their safe assets and their foreign asset positions, determined by past outflows. Equation (14) says that (when there are fire sales) the asset price is determined by the cash in the market per asset for sale. This expression illustrates the key tension captured by our model: while past inflows tend to reduce the fire-sale price, past outflows provide liquidity to retrenching local banks and help stabilize fire-sale prices.

Recall that in a symmetric equilibrium, inflows and outflows in period 0 are equal to each other, $x^{in} = x^{out} = x$. Using this observation and the expression $\bar{R}_s = (1 - \pi_s)R + \pi_s p_s$, we can solve equation (14) to obtain the following expression for fire-sale prices:

$$p_s = P^{mc}_s(x) \equiv \frac{\eta + x(1 - \pi_s)R}{e + x(1 - \pi_s)}. \tag{15}$$

The last equality defines the market-clearing relation, $p_s = P^{mc}_s(x)$, which describes the price level in state s as a function of gross flows. Increasing gross flows increases both the numerator and the denominator, which captures the competing effects of retrenchment and fickleness on fire-sale prices. The following lemma resolves this tension and shows that retrenchment dominates fickleness.

LEMMA 2. Under assumption 1, for each aggregate state s with $\pi_s < 1$, the market-clearing price level, $P_s^{mc}(x)$, is strictly increasing in symmetric gross flows, x.

Equation (14) provides the intuition for why retrenchment dominates fickleness. Note that past inflows (x in the denominator) are liquidated at the fire-sale return, p_s. However, past outflows (x in the numerator) provide liquidity to retrenching local banks at a higher return, $\bar{R}_s$. When $p_s < R$ and $\pi_s < 1$, the fire-sale return is lower than the return from foreign investment, $p_s < \bar{R}_s = (1 - \pi_s)R + \pi_s p_s$. It follows that symmetric flows increase liquidity in the bad state and raise fire-sale prices. Despite their fickleness, gross flows reallocate excess liquidity from foreign financial markets to the local market, which needs liquidity.

The equilibrium levels of gross flows and prices, x, $(p_s)_s$, are characterized by solving equation (13) together with equation (15) for each aggregate state s. We can now state our main result, which establishes the existence of a unique symmetric equilibrium that features $x \in (0, 1)$ and $p_s \in (R/\lambda, R)$. The result also compares the equilibrium prices with those that would obtain in an autarky allocation, where all foreign investment is banned. In autarky, banks solve the same portfolio problem as before, with the additional restriction that $x^{j',j} = 0$ for any $j' \neq j$. It is easy to check that banks hold some local risky assets, $x^{j,j} = \underline{x} > 0$, where $\underline{x}$ is the solution to $u'(1 - \underline{x}) = R$. However, these local investments do not generate any additional liquidity when there is a local liquidity shock in period 1. Therefore, the fire-sale price is still characterized by equation (15) after substituting zero capital flows. This yields a fire-sale price in autarky $p^{aut} = \eta/e$, which, by lemma 2, is lower than the equilibrium price p_s.

PROPOSITION 1 (Equilibrium capital flows and global liquidity creation). Consider the model with assumption 1. There exists a unique symmetric equilibrium allocation, $x^{j,j}$, $(x^{out} = x^{in} = x)$, y, $(z_s, \chi_s)_s$, with symmetric prices, $(p_s)_s$, q_f, $(q_s)_s$. The equilibrium allocation satisfies $x^{j,j} = 0$, $y = \eta$, $z_s = 0$. The tuple $(x, (p_s)_s)$ is characterized by equations (13) and (15) and satisfies $x \in (0, 1)$ and $p_s \in (R/\lambda, R)$ for each s. Capital flows create liquidity in the sense that the fire-sale price is greater than the price that would obtain in the autarky allocation; that is, $p_s \geq p^{aut} = \eta/e$ for each s, with strict inequality if $\pi_s < 1$.

Figure 2 illustrates this result for the special case with a single aggregate state. In this case, let $\pi \equiv \pi_s \in (0, 1)$ denote the probability of a liquidity shock, $p \equiv p_s$ denote the fire-sale price, and $\mu(p)$ and $P^{mc}(x)$ denote the functions characterized in lemmas 1 and 2. The declining curve in figure 2 corresponds to the optimality condition, $u'(1 - x) = \mu(p)$.

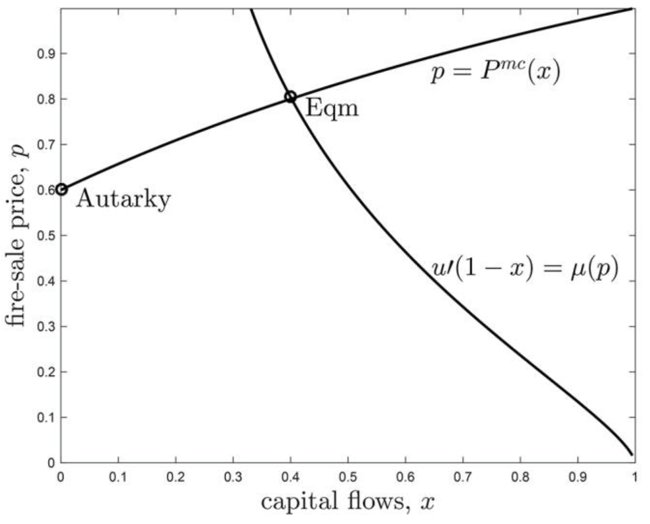

FIG. 2.—Equilibrium when there is a single aggregate state.

The increasing curve corresponds to the market-clearing relation, $p = P^{mc}(x)$. The equilibrium is the intersection. The equilibrium price is strictly greater than the autarky price, which illustrates that gross flows help create liquidity and mitigate fire sales despite their fickleness.

B. Asset Prices and Returns

Let us go back to the case with multiple aggregate states and characterize the equilibrium asset prices and returns. Recall our convention that π_s is strictly increasing in s so that states with a greater s are associated with a greater likelihood of liquidity shocks. Combining this with equation (15) illustrates that p_s is strictly decreasing in s: states with a greater likelihood of liquidity shocks are associated with strictly lower equilibrium prices. Intuitively, these states have less global liquidity since more countries are simultaneously hit by the liquidity shock. This also implies that the payoff from foreign investment, $\bar{R}_s = (1 - \pi_s)R + \pi_s p_s$, is strictly decreasing in s, whereas the marginal value in period 1, $M_s = 1 - \pi_s + \pi_s(R/p_s)$, is strictly increasing in s.

Next, consider the asset prices in period 0, q_f, $(q_s)_s$. Recall that the equilibrium features $y^j = \eta$ and $z_s^j = 0$ for each s. Suppose that banks in a country consider changing these allocations, y^j, z_s^j. Following similar steps as above (and using $x^{j,j} = 0$), we find that the optimal allocations solve

$$\max_{y^j,(z_s^j)_s} u(c_0^j) + \sum_s \gamma_s (x^{out}\bar{R}_s + y^j + z_s^j) M_s, \tag{16}$$

where $c_0^j = 1 - x^{out} - q_f(y^j - \eta) - \Sigma_s q_s z_s^j$. Using the optimality condition for z_s^j, we obtain an expression for Arrow-Debreu prices:

$$\frac{q_s}{\gamma_s} = \frac{M_s}{u'(1 - x)}. \tag{17}$$

As usual, the stochastic discount factor, q_s/γ_s, is determined by the expected marginal value in the corresponding state divided by marginal utility in period 0. Note also that q_s/γ_s is strictly increasing in s (because M_s is strictly increasing). As expected, states with a greater probability of liquidity shocks feature more expensive state prices. For future reference, note that substituting equation (17) into equation (13) implies $1 = \Sigma_s \bar{R}_s q_s$: the cost of foreign diversified investment is equal to the cost of the replicating portfolio of Arrow-Debreu securities.

Using the optimality condition for y^j, we solve for the risk-free asset price, $q_f = E[M_s]/u'(1 - x)$. We define the risk-free return as the inverse of this price, $R_f \equiv 1/q_f$. Using equation (13) to substitute for $u'(1 - x)$ in the expression for q_f, we obtain

$$R_f = \frac{E[\bar{R}_s M_s]}{E[M_s]} = E[\bar{R}_s] + \frac{\text{cov}(\bar{R}_s, M_s)}{E[M_s]}. \tag{18}$$

Observing that the covariance term is negative, since $\bar{R}_s$ is strictly decreasing in s and M_s is strictly increasing in s, we also find that the risk premium on foreign assets is positive:

$$E[\bar{R}_s] - R_f = -\frac{\text{cov}(\bar{R}_s, M_s)}{E[M_s]} \geq 0. \tag{19}$$

Here, the inequality is strict as long as there are multiple states. Intuitively, the risk-free asset provides valuable liquidity insurance in states (with higher s) in which aggregate liquidity is scarce, whereas risky foreign investment generates a relatively lower payoff in those states. In equilibrium, this reduces the risk-free rate and generates a risk premium on foreign investment.

Proposition 2 (Equilibrium asset prices and risk premia). Consider the symmetric equilibrium characterized in proposition 1. The fire-sale price, p_s, is strictly decreasing in s (which captures the likelihood of the liquidity shock). The state price, q_s/γ_s, is characterized by equation (17) and is strictly increasing in s. The return on the risk-free asset and the risk premium on foreign investment is characterized by equations (18) and (19). The risk premium is strictly positive as long as there are multiple aggregate states.

V. Regulating Gross Flows

In this section, we analyze policies that regulate capital flows. We first characterize the constrained optimal allocation and show that the competitive equilibrium is constrained inefficient because of pecuniary externalities. We then show that there is a public goods aspect to global liquidity creation that generates a need for coordinated policy.

Throughout, we focus on the special case with a single aggregate state, so we drop the subscript s from all variables. We also assume that the policy makers are utilitarian with identical welfare weights on all agents: the social welfare in each country j is the sum of (local) banks' and (local) distressed sellers' expected utilities, $W^j = u(c_0^j) + E[c_1^j + c_2^j] + E[\tilde{c}_2^j]$.

A. *Constrained Optimal Allocation and Externalities*

Consider a constrained social planner that can dictate (symmetric) period 0 local and foreign investment in each country but otherwise cannot interfere with the equilibrium allocations. We denote local investment by $x^{j,j}$, foreign investment by x, and the resulting equilibrium price by p. In view of assumption 1, we conjecture that the resulting price satisfies $p \in (R/\lambda, R)$ for any choice of $(x^{j,j}, x)$.

Following similar steps as in section III, the market-clearing condition (15) still applies. Moreover, the social welfare that results from this allocation is given by

$$W^j = u(1 - x - x^{j,j}) + (x^{j,j} + x + e)R + \eta + (\lambda - 1)e\bar{R}, \qquad (20)$$

where $\bar{R} = (1 - \pi)R + \pi p$. This expression is the sum of utility from investment activity by banks (first three terms) and net production by distressed sellers (last term). Conditional on risky investment $x + x^{j,j}$ in period 0, the risky assets produce a total of $(x + x^{j,j} + e)R$ units of the consumption good in either period 1 or period 2. Safe assets produce an additional η units of the consumption good in period 1. Finally, the investment activity by distressed sellers uses (in expectation) $e\bar{R}$ units of the consumption good in period 1 and delivers $\lambda e\bar{R}$ units in period 2 for an expected net production of $(\lambda - 1)e\bar{R}$. All of these resources are consumed by either banks or distressed sellers in periods 1 or 2. Since these agents have linear utility over these periods, the utilitarian social welfare is given by equation (20) (see app. A.6 for details).

The constrained social planner chooses $x, x^{j,j} \geq 0$ to maximize equation (20) subject to the market-clearing condition (15). Since p is strictly increasing in x (cf. lemma 1) but does not depend on $x^{j,j}$, the optimum features $x^{j,j} = 0$. That is, local investment is dominated both in equilibrium and in the constrained optimum.

However, the level of foreign investment in the constrained optimum can be different than in equilibrium. Specifically, the optimality condition for foreign investment implies that

$$u'(1-x) = R + (\lambda - 1)e\pi \frac{dp}{dx}, \quad \text{where } \frac{dp}{dx} = \frac{1-\pi}{e + x(1-\pi)}(R-p). \tag{21}$$

To find the constrained optimum, we solve this expression together with the market-clearing condition (15). Under assumption 1, there exists a unique intersection that satisfies $x \in (0, 1)$ and $p \in (R/\lambda, R)$. For comparison, recall that the equilibrium is characterized by solving a different optimality condition (13) together with the same market-clearing condition (15) (see fig. 2). Hence, the equilibrium is typically constrained inefficient. The following proposition characterizes the direction of the inefficiency.

Proposition 3 (Constrained optimal allocation). Consider the model with assumption 1 and a single aggregate state. The constrained optimal allocation, (x, p), is characterized as the unique solution to equations (21) and (15). Compared with the decentralized equilibrium allocation, denoted by (x^{eq}, p^{eq}), the constrained planner chooses greater x (which leads to greater p) if and only if

$$\frac{e\lambda + x^{eq}(1-\pi) + x^{eq}\pi(R/p^{eq})}{e + x^{eq}} > \frac{R}{p^{eq}}. \tag{22}$$

To understand this result, note that investing in foreign assets creates liquidity and increases the fire-sale price p (via eq. [15]). The increase in the fire-sale price increases the wealth of the sellers and reduces the wealth of the buyers. These effects represent pecuniary externalities that the banks ignore but the planner takes into account. Condition (22) says that foreign investment is associated with net positive pecuniary externalities if and only if it increases sellers' average marginal value more than it decreases buyers' marginal value. Note that in a liquidity shock, $e + x^{eq}$ units of the asset are sold (at the fire-sale price) from distressed sellers and fickle foreign banks to local banks. The right side of the expression describes the period 1 marginal value of the buyers (local banks), which is equal to R/p^{eq}. The left side describes the weighted average period 1 marginal value of the sellers, where the weights are proportional to the number of units that they sell. The distressed sellers have weight e and marginal value λ, foreign investors in countries without a liquidity shock have weight $x^{eq}(1-\pi)$ and marginal value 1, and foreign investors in countries with a liquidity shock have weight $x^{eq}\pi$ and marginal value R/p^{eq}.

In order to sharpen intuition, consider the extreme case where $\lambda \to \infty$. In this limit, condition (22) holds, and thus the constrained optimal allocation features greater x and p. In fact, foreign investment approaches 1 (its maximum feasible level) in the constrained optimum, whereas it is strictly below 1 in the competitive equilibrium. Intuitively, the sellers' average marginal value is dominated by distressed sellers' marginal value, which is large and exceeds buyers' marginal value. This leads to positive pecuniary externalities from foreign investment.

Now consider the case with lower λ. In this case, condition (22) can be violated because some of the sellers are fickle foreign banks that have lower marginal value than buyers (local banks). If the condition is violated, the constrained optimum features lower x and p than the equilibrium. Since raising fire-sale prices benefits both the distressed sellers and fickle foreigners with low marginal value, foreign investment generates negative pecuniary externalities when fickle foreigners benefit more than distressed sellers. The planner opts for lower foreign investment and lower fire-sale prices to transfer wealth from fickle foreign banks to local banks.

We view the distressed sellers in our setting as a modeling device to capture liquidity-driven sales that transfer risky assets from high- to low-marginal-value agents. In view of this interpretation, we take the case with high λ and positive pecuniary externalities from foreign investment as the most natural benchmark for welfare analysis.

B. *Public Goods Aspects of Liquidity Creation*

We next investigate whether local policy makers acting in isolation can achieve globally optimal outcomes without coordination. Specifically, suppose each country has a local policy maker that maximizes utilitarian social welfare in her own country. For the baseline scenario, we focus on the limit, $\lambda \to \infty$, while we relegate the discussion of the case with lower λ to the end of this section. As $\lambda \to \infty$, maximizing the utilitarian social welfare becomes equivalent to maximizing the fire-sale price in the local market, which we denote by p^j (see app. A.3). That is, similar to the social planner in section V.A, local policy makers want to increase the fire-sale price. The difference is that they exclusively care about the price in their own country.

To simplify the exposition, we equip local policy makers with a single binary policy instrument, $b^j \in \{0, 1\}$, encoding the decision to allow or ban capital inflows. The local policy maker chooses b^j at the beginning of period 0 before any other decision is made. If $b^j = 0$, then foreigners can invest in country j, as in our baseline model. If $b^j = 1$, then foreign investment is banned in country j. In period 0, banks choose their portfolio, $[x^{j',j} \geq 0]_{j'}$, subject to the additional constraint that $x^{j',j} = 0$ for each $j' \neq j$ such that $b^{j'} = 1$. The remaining ingredients are the same as in section III.

If all policy makers choose $b^j = 0$, then we recover the equilibrium allocation with free flows. If instead all policy makers choose $b^j = 1$, all foreign investment is banned, and we recover the autarky allocation. Recall that the price with free flows is strictly greater than in autarky (see fig. 2). Thus, a global policy maker that prescribes symmetric policies (with the objective of maximizing the symmetric fire-sale prices, p) would allow capital flows in all countries. Note that this is consistent with our analysis in section V.A: the global policy maker creates as much global liquidity as possible, given the instruments to which she has access.

We next characterize the Nash equilibrium outcome and contrast it with the coordinated solution. First, consider the equilibrium for a given configuration of policy choices. Suppose that the sets of countries with $b^j = 1$ (banned countries) and $b^j = 0$ (free countries) are Lebesgue measurable with measures $B \in [0, 1)$ and $1 - B$, respectively. As before, we focus on a symmetric equilibrium in which each banned country chooses identical and fully diversified foreign investment in each free country, denoted by $x^{ban} \geq 0$, and experiences identical fire-sale prices, $p^{ban} \in (0, R)$. Likewise, each free country chooses identical and fully diversified foreign investment in each free country, denoted by $x^{free} \geq 0$, and experiences identical fire-sale prices, $p^{free} \in (0, R)$. Following similar steps as above, the fire-sale price levels satisfy

$$p^{ban} = \frac{\eta + (1 - B)x^{ban}\bar{R}^{free}}{e},$$

$$p^{free} = \frac{\eta + (1 - B)x^{free}\bar{R}^{free}}{e + Bx^{ban} + (1 - B)x^{free}},$$

where $\bar{R}^{free} = (1 - \pi)R + \pi p^{free}$. The equilibrium tuple, $(p^{ban}, p^{free}, x^{ban}, x^{free})$, is characterized by solving these equations jointly with the optimality conditions (see app. A.3). The expressions for fire-sale prices show that for banned countries, inflows (zero) are smaller than outflows $((1 - B)x^{ban})$. In contrast, for free countries, inflows $(Bx^{ban} + (1 - B)x^{free})$ are greater than outflows $((1 - B)x^{free})$. These net imbalances raise the fire-sale price in banned countries while lowering the price in free countries. In equilibrium, the optimal levels of outflows also react to these changes, but these induced effects do not overturn the initial effect: that is, $p^{ban} > p^{free}$ in any symmetric equilibrium with $B \in [0, 1)$.

Now consider the Nash equilibrium among the policy makers. Since $p^{ban} > p^{free}$ for $B < 1$, the only candidate for equilibrium is the autarky allocation, in which all policy makers ban capital inflows. In appendix A.3, we verify that this is an equilibrium and establish the following result.

Proposition 4 (Nash equilibrium with restrictions on capital inflows). Consider the model with assumption 1 in which local policy makers choose whether to ban capital inflows, $b^j \in \{0, 1\}$. Suppose that $\lambda \to \infty$ so that each policy maker's objective is to maximize the asset price in her own country, p^j. Then, the unique Nash equilibrium features bans on capital inflows, $b^j = 1$ for each j, whereas the symmetric constrained optimum features free capital flows, $b^j = 0$ for each j.

In particular, the Nash equilibrium generates strictly lower fire-sale prices and lower welfare in every country compared with a coordinated equilibrium (see fig. 2). This discrepancy arises because global liquidity is a public good: policy makers that make locally optimal policy choices ignore their impact on global liquidity. Every inflow into a country corresponds to an outflow that provides liquidity and raises fire-sale asset prices in the sending country. In the limit $\lambda \to \infty$, greater asset prices improve welfare by mitigating fire-sale externalities. Local planners ignore the beneficial effects of inflows for sending countries while fully internalizing the fickleness costs, as these costs are felt at the local level, which leads to smaller capital flows and liquidity.

Finally, consider the alternative scenario where λ is lower. As our analysis in section V.A suggests, the global policy maker might prefer to reduce foreign investment and fire-sale prices. Nonetheless, coordination improves welfare in this less standard case too. Consider the extreme version where the policy makers have the objective function $-p^j$; that is, they would like to minimize the local fire-sale price. We can check that a coordinated solution would ban capital flows, whereas the Nash equilibrium would feature free capital flows. In this scenario, liquidity is a public bad, which leads to a coordination problem in the opposite direction.

The general point is that when liquidity has a first-order effect on welfare, capital flows must be coordinated because they contribute to global liquidity. Fickleness exacerbates the coordination problem because it lowers local liquidity during distress and induces local policy makers to take different actions than a global policy maker would prescribe.

VI. Determinants of Gross Flows

In this section, we analyze the determinants of gross flows in our setting.

A. The Beta Model

We conduct our analysis using a special case of the model (the beta model) that leads to closed-form solutions. In this model, liquidity shocks are either completely uncorrelated or fully correlated across countries. Specifically, there are three aggregate states, $s \in \{1, 2, 3\}$, with

$$\begin{aligned} \pi_1 &= 0, \\ \pi_2 &= \pi, \\ \pi_3 &= 1, \end{aligned} \tag{23}$$

for some $\pi \in (0, 1)$. In particular, state $s = 2$ corresponds to the case in which the liquidity shocks are i.i.d. across countries. States $\{1, 3\}$ together can be thought of as a correlated shock state in which the liquidity shocks are perfectly correlated across countries. Specifically, either all countries are hit (state 3) or no country is hit (state 1). We also assume that the state probabilities are given by

$$\gamma_1 = \beta(1 - \pi),$$
$$\gamma_2 = 1 - \beta, \tag{24}$$
$$\gamma_3 = \beta\pi.$$

Here, the parameter $\beta \in (0, 1)$ captures the probability that shocks are correlated.

Note that the expected returns and marginal values conditional on each aggregate state are

$$\bar{R}_1 = R,$$
$$\bar{R}_2 = (1 - \pi)R + \pi p_2, \tag{25}$$
$$\bar{R}_3 = p_3,$$

$$M_1 = 1,$$
$$M_2 = 1 - \pi + \frac{\pi R}{p_2}, \tag{26}$$
$$M_3 = \frac{R}{p_3}.$$

Next, note that the ex ante marginal value from foreign investment satisfies $\mu_1(p_1) = \bar{R}_1 M_1 = R$ and $\mu_3(p_3) = \bar{R}_3 M_3 = R$. Thus, equation (13) becomes

$$u'(1 - x) = E[\bar{R}_s M_s] = \beta R + (1 - \beta)\mu_2(p_2), \tag{27}$$

where $\mu_2(p_2) = \bar{R}_2 M_2$. The market-clearing condition (15) implies

$$p_2 = P_2^{mc}(x) = \frac{\eta + x(1 - \pi)R}{e + x(1 - \pi)}. \tag{28}$$

Equations (27) and (28) determine the pair (x, p_2). Figure 3, which is a generalized version of figure 2, provides a pictorial illustration of the equilibrium pair, (x, p_2).

Using the market-clearing condition (15), we calculate the price in state 3 (with $\pi_3 = 1$) as

$$p_3 = \frac{\eta}{e}. \tag{29}$$

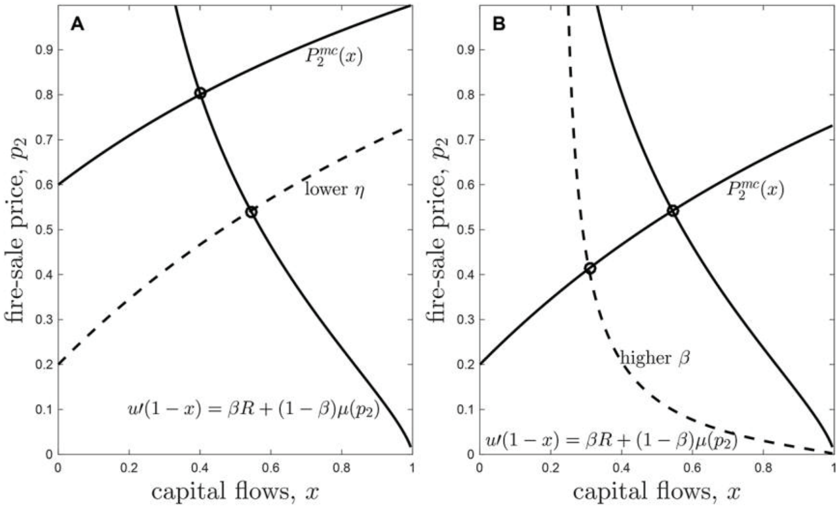

Fig. 3.—Comparative statics of equilibrium. *A*, Change in the supply of safe assets. *B*, Change in the probability of correlated liquidity shocks.

We omit the derivation of p_1, which plays no role since there are no liquidity shocks in state 1 ($\pi_1 = 0$). This also implies that the average fire-sale price conditional on a correlated shock (states {1, 3}) is equal to p_3. Note that we have $p_3 < p_2$; that is, the correlated shock state features lower fire-sale prices on average than the state with uncorrelated shocks.

Next, consider the prices and returns for financial assets. Using equation (25), we find that the expected return on foreign assets depends on the expected fire-sale price; that is,

$$E[\bar{R}_s] = (1-\pi)R + \pi[\beta p_3 + (1-\beta)p_2]. \quad (30)$$

State prices are given by $q_s/\gamma_s = M_s/u'(1-x)$, where M_s are characterized in equation (26).

Finally, combining equation (18) with equations (26) and (27), we find that the risk-free rate can be calculated as

$$R_f = \frac{E[\bar{R}_s M_s]}{E[M_s]} = \frac{\beta R + (1-\beta)\mu(p_2)}{\beta(1-\pi+\pi R/p_3) + (1-\beta)(1-\pi+\pi R/p_2)}. \quad (31)$$

The risk premium can be obtained from equations (30) and (31). Thus, equations (25)–(31) provide a closed-form characterization of the equilibrium in the beta model. We use this model to establish a number of comparative statics results.

B. *Safe Asset Scarcity*

Consider a reduction in the supply of safe assets, η. By equation (29), this reduces the fire-sale price in the correlated shock state, p_3. To see the effect on the rest of the equilibrium, recall that the pair (x, p_2) is characterized by the optimality condition (27) and the market-clearing relation (28). Figure 3*A* shows that a decline in η shifts the market-clearing equation downward without affecting the optimality condition. This increases capital flows, x, while also reducing the fire-sale price in the uncorrelated state, p_2. Intuitively, the fire-sale price declines because banks have less liquidity to arbitrage asset fire sales (cf. eq. [28]). Anticipation of these more severe fire sales induces greater ex ante investment in foreign risky assets to obtain liquidity insurance (cf. eq. [27]). When safe assets are scarcer, there is greater demand for global liquidity, and gross capital flows increase to meet this need.

Next, consider the impact on expected asset returns in period 0. By equation (30), the expected return on risky foreign assets declines because of lower fire-sale prices. In appendix A.6, we show that the risk-free return characterized by equation (31) also declines. Finally, consider the risk premium on foreign assets, $E[\bar{R}_s] - R_f$. We can check that the risk premium becomes zero as $\eta \to eR$ (as this limit features $p_s \to R$ and $M_s \to 1$ for each s), whereas it is strictly positive for any $\eta < eR$ (see eq. [19]). Thus, in the neighborhood of abundant safe assets, $\eta = eR$, the decline in η also increases the risk premium. The following result summarizes this discussion.

Proposition 5. Consider the beta model described in this section. A reduction in η (which exacerbates safe-asset scarcity) increases gross flows, x, reduces fire-sale prices, p_2 and p_3, and reduces the expected risky and safe asset returns, $E[\bar{R}_s]$ and R_f. In the lower neighborhood of $\eta = eR$, the reduction in η also increases the risk premium, $E[\bar{R}_s] - R_f$.

This result provides one explanation for the worldwide increase in gross capital flows in the run-up to the global financial crisis (see Bluedorn et al. 2013). Through the lens of our model, gross flows increased at least partly as a response to the global safe asset scarcity that developed in the early 2000s (see, e.g., Caballero 2006).

C. *Global Shocks and the Global Financial Cycle*

Now consider an increase in the probability of the correlated shock state, β. Figure 3*B* illustrates that this increase shifts the optimality curve downward without affecting the market-clearing equation. Hence, it lowers gross flows, x, and the fire-sale price in the uncorrelated state, p_2. Correlated shocks reduce the liquidity insurance value of capital flows, which translates into lower ex ante foreign investment, x, and lower ex post liquidity. Lower ex post liquidity reduces the price even in the uncorrelated state. That is, the possibility of correlated shocks, by reducing capital flows, affects asset prices even if those shocks are ultimately unrealized. The impact on expected asset returns in period 0 is analogous to the impact of the decline in η described in section VI.B, which leads to the following result.

PROPOSITION 6. Consider the beta model described in this section (with assumption 1). An increase in β (which increases the correlation of the liquidity shocks) reduces capital flows, x, reduces the fire-sale asset price in the uncorrelated state, p_2, and reduces the expected risky and safe asset returns, $E[\bar{R}_s]$ and R_f. In the neighborhood of $\beta = 0$, an increase in β also increases the risk premium, $E[\bar{R}_s] - R_f$.

An increase in β in this model can be thought of as capturing a risk-off environment in which the banks become more concerned about investing abroad. This reduces capital flows and liquidity creation while also reducing the risk-free rate and increasing the risk premium. This result is consistent with the large and persistent decline in gross capital flows in the aftermath of the global financial crisis illustrated in figure 1 (see also Milesi-Ferretti and Tille 2011; Lane and Milesi-Ferretti 2012; Bluedorn et al. 2013). Through the lens of our model, the global crisis increased the (real or perceived) correlation of financial crises, which in turn reduced the usefulness of gross capital flows as liquidity insurance.[6]

VII. Reach for Safety and Yield

In our baseline model, countries are symmetric and gross capital flows are entirely driven by the liquidity insurance motive. In this section, we deviate from the baseline model by introducing asymmetries in liquidity supply and risky asset return across countries. We illustrate two additional mechanisms that might drive capital flows—reach for safety and reach for yield—and we investigate how they affect fire sales.

A. *The Model with a Special Country*

Suppose that all but one of the countries are regular and have the parameters described in section IV. The remaining country is special and can have different parameters, (η^*, R^*): its supply of safe assets is given by η^*, and the return on its risky assets is given by R^*. As before, banks in the

[6] In app. B.3, we corroborate that the correlations of stock price changes in OECD countries increased after the crisis and remained elevated for several years (see fig. A1). However, note that other factors, such as the implementation of the Basel III accord that restricted banks' risk-taking, also contributed to depressing gross capital flows. Conversely, the increase in bank capital and leverage before the crisis arguably contributed to the growth of gross capital flows at that time.

special country are endowed with all this country's safe assets as well as one unit of the consumption good in period 0. The rest of the model is unchanged. To simplify the exposition, we assume that $\pi_1 > 0$, so liquidity shocks happen with strictly positive probability in all aggregate states (see app. A.4 for cases with $\pi_1 = 0$).

Since the special country has Lebesgue measure zero, the equilibrium allocations and prices in the regular countries are the same as the symmetric equilibrium characterized in the previous sections, denoted by x, $(p_s)_s$, q_f, $(q_s)_e$. Our goal is to characterize the equilibrium allocations and prices in the special country, which we denote by $x^{*,*}$, $x^{in,*}$, $x^{out,*}$, y^*, $(z_s^*)_s$, $(\tilde{\chi}_s^*)_s$, $(p_s^*)_s$. Throughout, we assume that the parameters in the special country satisfy the following assumption.

Assumption 2.

$$R^* - R \in \left[0, \frac{\eta}{e} \frac{\sum_s q_s \pi_s}{\sum_s q_s (1 - \pi_s)}\right], \eta^* - \eta \geq - \frac{\sum_s q_s p_s x}{q_f}.$$

In particular, the special country features weakly greater return, $R^* \geq R$, which suffices to cover the cases of interest, and its parameters are not too different from those in regular countries, which yields an interior solution.

First, consider the investments regular countries' banks make in the special country, $x^{in,*}$. In view of assumption 2, we conjecture an equilibrium with strictly positive inflows, $x^{in,*} > 0$. We assume that foreign banks are indifferent between investing in the special country and regular countries at the margin. We can state this using a no-arbitrage condition between investments into the special country and other countries:

$$1 = \sum_s \bar{R}_s^* q_s = \sum_s \bar{R}_s q_s, \tag{32}$$

where $\bar{R}_s^* = (1 - \pi_s) R^* + \pi_s p_s^*$. This condition says that (when there is positive investment into the special country) the cost of investment (one unit) must be equal to the value of a replicating portfolio of Arrow-Debreu securities.[7] The second equality (which we established in sec. IV.B) says that the same condition holds for investment into regular countries.

Next, consider investments by the special country's banks, $x^{out,*}$, y^* $(z_s^*)_s$. These values are not uniquely determined because there are multiple equivalent ways of obtaining the same payoff vector. We therefore define the country's liquidity purchase (or sale) in each aggregate state as

$$l_s^* = x^{out,*} \bar{R}_s + y^* + z_s^* - \eta^*.$$

[7] We technically state this as an assumption because banks in regular countries are actually indifferent to taking any nonnegative position in the special country, as this country has measure zero. In a version of the model in which the special countries have strictly positive but small mass $\Delta > 0$, condition (32) always holds in equilibrium. Hence, the equilibrium we analyze can be viewed as the limit of these equilibria as $\Delta \to 0$.

Note that l_s^* captures the additions to the country's liquidity starting from its endowment, η^*. We conjecture that the equilibrium also features fire sales in the special country, $p_s^* < R^*$ for each s. Then, banks in the special country solve the following analog of problem (10):

$$\max_{x^{*,*}\geq 0,(l_s^*\geq -n^*)_s} u(c_0^*) + x^{*,*}R^* + \sum_s \gamma_s(n^* + l_s^*)M_s^*, \quad \text{where } c_0^* + x^{*,*} + \sum_s q_s l_s^* = 1. \tag{33}$$

In appendix A.6, we show that $x^{*,*} = 0$; foreign investment dominates local investment for the special country. The remaining optimality conditions (for an interior solution) are

$$\frac{q_s}{\gamma_s} = \frac{M_s^*}{u'\left(c_0^*\right)} = \frac{M_s}{u'(c_0)}, \tag{34}$$

where $M_s^* = 1 - \pi_s + \pi_s(R^*/p_s^*)$. Hence, the relative stochastic discount factor is equal to the relative marginal value of banks in the special country and the regular countries (as we established in sec. IV.B).

Finally, consider the equilibrium value of fire-sale prices in the special country, $(p_s^*)_s$. Using similar steps as before, these prices are determined by the following analog of equation (14):

$$p_s^* = \frac{\eta^* + l_s^*}{e - \tilde{\chi}_s^* + x^{in,*}}, \tag{35}$$

$$\text{where } \tilde{\chi}_s^* = 0 \text{ if } \lambda p_s^* \geq R^* \text{ and } \tilde{\chi}_s^* = e \text{ if } \lambda p_s^* < R^*. \tag{36}$$

Here, $\tilde{\chi}_s^*$ denotes the optimal amount of legacy assets the distressed sellers in the special country retain (cf. eq. [1]), which is not necessarily zero unless we strengthen assumption 1 (specifically, we could ensure $\tilde{\chi}_s^* = 0$ by considering the limit $\lambda \to \infty$). The following result establishes the existence of an equilibrium.

Proposition 7. Consider the model with assumption 1 and $\pi_1 > 0$, together with a special country that satisfies assumption 2. There exists an equilibrium in which the allocations and prices for regular countries are characterized by propositions 1 and 2. In the special country, there is no local investment, $x^{*,*} = 0$. The remaining allocations—$x^{in,*}$, c_0^*, $(l_s^*)_s$, $(p_s^*)_s$, $(\tilde{\chi}_s^*)_s$—are characterized as the unique solution to the system of equations (32)–(36).

We next use this model to illustrate capital flows driven by reach for safety and reach for yield. Unlike regular countries, the special country trades safe and contingent assets in equilibrium, which modifies the balance of payments accounting. We adopt the convention that total inflows are equal to foreign investment in local risky assets, $\bar{x}^{in,*} \equiv x^{in,*}$, whereas total outflows account for the local investment in foreign risky assets and the net trade of safe and contingent assets:[8]

$$\begin{aligned}\bar{x}^{out,*} &\equiv x^{out,*} + q_f(y^* - \eta^*) + \sum_s q_s z_s^* \\ &= \sum_s q_s l_s^* = 1 - c_0^*.\end{aligned} \tag{37}$$

Here, the second line uses the definition of l_s^* (together with the no-arbitrage condition, $\Sigma_s \bar{R}_s q_s = 1$) as well as the budget constraint (33). Hence, total outflows are equal to the value of banks' liquidity purchases in period 0. Since there is no local investment in period 0, these purchases are also equal to the banks' endowment in period 0 net of their consumption.

B. *Reach for Safety and Global Imbalances*

We first abstract away from return differences (i.e., $R^* = R$) and focus on the effect of asymmetries in the liquidity supply (i.e., $\eta^* \neq \eta$). We can think of a developed country with deep financial markets and a large supply of safe assets—such as the United States—featuring $\eta^* > \eta$. Conversely, an emerging market country can be thought of as having $\eta^* < \eta$.

As a benchmark, consider the autarky allocation in which the special country does not exchange capital flows with regular countries. It is easy to check that the special country's autarky price is characterized by $p_s^* = \min(R, \eta^*/e)$ for each s (see proposition 1 for a similar result for regular countries). In particular, a special developed country with sufficiently high liquidity, $\eta^* > eR$, would completely avoid fire sales, whereas regular countries would experience fire sales; that is, $p_s^* = R > p_s$ for each s. In contrast, a special emerging market country with $\eta^* < \eta$ would experience more severe fire sales than regular countries, $p_s^* = \eta^*/e < p_s$ for each s.

Next, we analyze the equilibrium with free capital flows. Using proposition 7, we can verify that the equilibrium in the special country obtains when $c_0^* = c_0$, $\tilde{\chi}_s^* = 0$, and

$$\begin{aligned} p_s^* &= p_s < R, \\ x^{in,*} &= x + (e + x)(\Lambda - 1), \\ \bar{x}^{out,*} &= x, \\ l_s^* &= \Lambda x \bar{R}_s - (\eta^* - \Lambda\eta), \end{aligned} \tag{38}$$

[8] With trade in safe and contingent assets, gross flows are indeterminate since the special country can always sell a financial asset to regular countries and purchase exactly the same asset from those countries. This would increase inflows and outflows without any additional effects. Our definition excludes these types of spurious flows and focuses on the lowest level of gross flows that can emerge in our setting.

where we refer to Λ as the *leverage ratio of outflows* and define it as

$$\Lambda = \frac{x + q_f \eta^*}{x + q_f \eta}. \tag{39}$$

The first line of equation (38) says that the asset prices in the special country are the same as asset prices in regular countries. In particular, even though a developed country with $\eta^* > eR$ would avoid fire sales in autarky, it cannot escape fire sales in equilibrium with free capital flows. Conversely, an emerging market country with $\eta^* < \eta$ obtains higher fire-sale prices with free capital flows than it would obtain in autarky.

To understand these results, consider the case of a developed country with $\eta^* > \eta$ (the case with $\eta^* < \eta$ is symmetric). All else equal, greater liquidity in this special country increases its fire-sale prices, which increases the expected return, $\Sigma_s \bar{R}_s^* q_s$, above the level obtained in regular countries, $\Sigma_s \bar{R}_s q_s$. This temporarily violates the indifference condition (32) and makes the special country's assets attractive to foreign banks. The special country's increased appeal translates into greater inflows, $x^{in,*}$, and lower fire-sale prices, as illustrated by equation (35). This process stops only when the special country also experiences severe fire sales that equate its expected return with the expected returns in regular countries. In fact, the second and the third lines of equation (38) illustrate that the developed country receives more inflows than outflows (it has a current account deficit). These net inflows neutralize the country's initial liquidity advantage and induce a fire sale in equilibrium.

While this intuition explains why fire sales in the developed country are as severe as in the regular countries on average, it does not explain why asset prices are equated state by state. In fact, from the earlier market-clearing condition (15), one could expect a developed country to have relatively high prices in states with high π_s, where global liquidity is low, because its greater local liquidity supply can provide some cushion. This does not happen in our model because banks in the developed country do not necessarily retain their initial endowments of liquidity. Rather, as captured by equations (34) and (35), they trade financial assets to move their liquidity across aggregate states.

The last line in equation (38) characterizes the equilibrium outcome from these trades. Banks in the developed country sell some of their safe asset endowments, $\eta^* - \Lambda\eta$ (which is positive when $\eta^* > \eta$), to increase their investment in a diversified foreign portfolio. We refer to Λ as the leverage ratio of outflows because it captures the value of foreign risky asset investments divided by the value of outflows (note that $(\Sigma_s \Lambda x \bar{R}_s q_s)/x = \Lambda$ in view of eq. [32]). For regular countries (that feature $\eta^* = \eta$), the leverage ratio is normalized to 1. For a developed country, the leverage ratio is greater than 1, $\Lambda > 1$, meaning that the country's outflows are riskier than outflows in other countries. Intuitively, banks in the developed country are selling some of their excess liquidity to take advantage of the positive risk premium on foreign assets (cf. eq. [19]). In our model, this effect is strong and ensures that the special country has the same (fire-sale) asset price as the regular countries in every state.

Conversely, an emerging market country with $\eta^* < \eta$ has more outflows relative to its inflows ($\bar{x}^{out,*} = x > x^{in,*}$), and its outflows are also safer than those in regular countries, $\Lambda < 1$. Intuitively, the scarcity of liquidity in the special country reduces its inflows while also inducing its banks to purchase safe assets from abroad to obtain additional liquidity (by paying the risk premium). These forces improve fire-sale prices relative to what the country would obtain in autarky. The following result summarizes this discussion.

Proposition 8. Consider the setup in proposition 7 with $R^* = R$ and $\eta^* \neq \eta$. With free financial flows, the equilibrium allocations in the special country are given by equation (38). Regardless of its liquidity supply, the special country experiences fire sales with prices that are equal to those in regular countries, $p_s^* = p_s < R$ for each s. When $\eta^* > \eta$, the country receives more inflows than outflows, $x^{in,*} > \bar{x}^{out,*} = x$, and has riskier (more leveraged) outflows than regular countries, $\Lambda > 1$. When $\eta^* < \eta$, the country has more outflows than inflows, $\bar{x}^{out,*} = x > x^{in,*}$, and safer (less leveraged) outflows than regular countries, $\Lambda < 1$.

These results suggest that reach-for-safety flows have potentially destabilizing effects for developed markets with $\eta^* > \eta$ but stabilizing effects for emerging markets with $\eta^* < \eta$.

Our results are consistent with the empirical work of Gourinchas and Rey (2007) and Gourinchas, Rey, and Govillot (2010), who document that outflows from the United States are riskier than its inflows. They show that the United States earns a risk premium on capital flows in normal times, but it transferred resources and provided insurance to the rest of the world during the global financial crisis. Our model suggests that these transfers exacerbated the severity of the crisis in the United States while mitigating its impact in the countries that held (relatively) safe US assets.

In appendix A.4, we extend this analysis to the beta model from section VI to investigate how the global risk conditions affect the reach for safety. We show that an increase in the correlation parameter, β, increases the absolute value of the country's imbalances as a fraction of outflows, $|x^{in,*} - x|/x$, as well as the absolute value of its relative leverage ratio, $|\Lambda - 1|$. These results suggest that the risk off induced by the increase in β strengthens the flows driven by reach for safety.

C. Reach for Yield

We next abstract away from differences in liquidity supply (i.e., $\eta^* = \eta$) and investigate the effect of asymmetries in return ($R^* \neq R$). We focus on the more interesting case with $R^* > R$ so that the special country can be thought of as a rapidly growing or high-yielding emerging market country.

Note that equations (32) and (34) can be combined to obtain

$$\sum_{s \in S} q_s \left[(1 - \pi_s)R^* + \pi_s p_s^*\right] = \sum_{s \in S} q_s[(1 - \pi_s)R + \pi_s p_s], \tag{40}$$

$$\frac{1 - \pi_s + \pi_s\left(R^*/p_s^*\right)}{1 - \pi_s + \pi_s(R/p_s)} = \frac{u'\left(c_0^*\right)}{u'(c_0)}, \text{ for each } s \in S. \tag{41}$$

This represents a system of $|S| + 1$ equations in $|S| + 1$ unknowns, $(p_s^*)_s$, c_0^*. In appendix A.6, we show that there is a unique solution to this system (see lemma 4). We characterize the remaining equilibrium allocations by solving the rest of the equations listed in proposition 7.

We also show that when $R^* > R$, the solution satisfies $p_s^* < p_s$ for each s; that is, the fire-sale prices in the special country are lower than in regular countries. To understand this result, suppose that the countries had identical fire-sale prices, $p_s^* = p_s$. This would violate the indifference condition (40) because foreign banks would strictly prefer to invest in the special country. Foreign investment would increase the inflows into the special country $x^{in,*}$ and lower the fire-sale prices according to equation (35). This process stops only when the special country's fire-sale prices are lower and the indifference condition is reestablished. Using more subtle arguments, we show that the special country obtains a lower fire-sale price in every aggregate state s.

Furthermore, we show that p_s^*/p_s is strictly increasing in s; that is, relative fire-sale prices in the special country are higher in aggregate states with a greater likelihood of liquidity shocks. Equation (41) illustrates that local banks in the special country distribute their liquidity across states to equate their expected marginal value. Since (by assumption) crises are more frequent in states with higher s, they purchase more liquidity insurance for these states. This mitigates the fire sales caused by the reach-for-yield inflows in states with higher s (e.g., the global financial crisis) at the expense of deepening the fire sales in states with lower s (more localized crises).

The solution satisfies $c_0^* < c_0$, which implies that $\bar{x}^{out,*} > x$ (cf. eq. [37]). Thus, the special country has greater outflows than the regular countries. Put differently, banks in the special country take precautions not only by purchasing more insurance (as in the previous result) but also by holding more foreign assets. Nonetheless, with free capital flows, these attempts to obtain greater insurance make the country attractive to foreigners and ultimately translate into greater inflows. Formally, we show that $x^{in,*} > \bar{x}^{out,*} > x$: the reach for yield increases the special country's inflows more than its outflows. The following result summarizes this discussion.

Proposition 9. Consider the setup in proposition 7 with $\eta^* = \eta$ and $R^* > R$. With free financial flows, the special country experiences larger price drops than the regular countries in all states. However, this difference is smaller in more distressed states: $p_s^*/p_s < 1$ for each s, and p_s^*/p_s is strictly increasing in s. The special country's inflows exceed its outflows, $x^{in,*} > \bar{x}^{out,*}$, which in turn exceed the gross flows in (otherwise comparable) regular countries, $\bar{x}^{out,*} > x$.

In appendix A.4, we extend this analysis to the beta model from section VI to investigate how global return and risk conditions affect the reach for yield. All else equal, a decline in investment returns in regular countries, R, reduces fire-sale prices (on average) in the special country relative to their counterpart in regular countries. Intuitively, lower returns in other countries make investing in high-yielding countries more attractive, but this is countered by lower fire-sale prices, as in proposition 9. These results are consistent with recent findings that depressed interest rates in developed markets cause a surge of capital inflows to emerging markets (see, e.g., Shin 2014; Tillmann 2016).

We also show in appendix A.4 that a drop in the correlation parameter, β, reduces fire-sale prices in the special country relative to their counterpart in regular countries. We can understand this result by considering the timing of losses on investments made in high-yielding countries. These losses will be less costly for foreign banks if the shocks in the high-yielding country have a lower correlation with aggregate distress states (when β is lower). Thus, a reduction in β makes investing in high-yielding countries more attractive, which increases their ex ante inflows and lowers their ex post fire-sale prices because of fickleness. This result is consistent with the view that reach-for-yield flows rise during risk-on environments.

VIII. Final Remarks

We develop a global equilibrium model of capital flows that addresses the tension between destabilizing fickleness and stabilizing retrenchment during liquidity crises. We show that in a global symmetric equilibrium, gross capital flows create liquidity and stabilize fire sales despite their fickleness. Fickleness, however, creates a coordination problem since it encourages local policy makers to restrict capital inflows. Thus, global policy coordination is important for the regulation of international capital flows.

Asymmetries in returns or liquidity qualify our baseline findings, generating potentially destabilizing reach-for-safety and reach-for-yield scenarios. This instability arises not from gross flows but rather from imbalances that lead to net flows. Therefore, our model features a clear distinction: symmetric flows are stabilizing while net flows are destabilizing for the (net) receiving country. This highlights net flows as a potential source of instability, although in general other features, such as the risk composition of gross flows, can also affect stability.

We focus on policies that concern restrictions on capital flows. In doing so, our goal is to highlight and isolate the public goods aspect of capital flows that local policy makers likely miss, not to argue against macroprudential policies in general. In fact, if we interpret the distressed sellers in our model as banks (see app. A.5 for a formalization), then macroprudential policies that reduce banks' risks would also be useful in our environment as they would further mitigate fire sales. Moreover, our model illustrates how foreign investment can make banks more stable, although unmodeled features (such as speculation driven by mistaken beliefs) might turn foreign investment into a destabilizing force.

In our model, the main rationale behind capital flows is liquidity insurance. However, capital flows in practice are also driven by other motives, such as comparative advantage. Many of the mechanisms we highlight are robust to broadening the rationale behind flows. To see this, consider an alternative scenario in which banks have specialized expertise (e.g., in making certain types of loans). They start in their home market, where their expertise is strongest, and expand into foreign markets as they build sufficient capital. To match the capital flow correlations in the data, suppose also that banks' investments in foreign countries are fickle. Then, reversing these investments during local distress would provide some liquidity insurance, as in our model. Moreover, local policy makers would still dislike the fickle nature of capital inflows, although they might be more receptive to inflows than in our model because of the foreign banks' expertise.

One of our core assumptions is that fickleness stems from a reaction by foreign investors to local conditions. However, capital inflows can also reverse when there is a local shock in the foreigners' home location: that is, foreigners' own retrenchment might feel like fickleness in the receiving country.[9] This raises the question of whether one can explain the capital flow correlations in the data purely from retrenchment shocks without

[9] This happens in our model, but the resulting fickleness does not hurt receiving countries that do not experience a liquidity shock, because we assume that assets in those countries pay early. We can relax this assumption and generate some contagion in our environment. Nonetheless, retrenchment is still likely to be a stabilizing force, because retrenching (but nonfickle) investors would sell foreign assets at relatively low prices only when they could purchase distressed home assets at even lower prices.

assuming fickleness. While this mechanism is likely to contribute to gross flows patterns during global crises, it has difficulty explaining the decline in capital flows (and the rise in expected returns) when countries experience nonglobal shocks (see sec. II).

Finally, an important dimension of crises that we leave for future work is the behavior of exchange rates. The current model already sheds light on which exchange rate implications might arise. For example, proposition 9 implies that high-yielding countries, $R^* > R$, experience greater net outflows during crises (driven by their relatively large ex ante inflows that are fickle), which is likely to put downward pressure on the exchange rate. Conversely, low-yielding countries, such as Japan, can experience net inflows and a currency appreciation during financial distress (driven by their relatively large ex ante outflows that retrench).

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