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RESEARCH ARTICLE

Grads on the go: Measuring college-specific labor markets for graduates

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Abstract
This paper introduces a new measure of the labor markets served by colleges and universities across the United States. About 50% of recent college graduates are living and working in the metro area nearest the institution they attended, with this figure climbing to 67% in-state. The geographic dispersion of alumni is more than twice as great for highly selective 4-year institutions as for 2-year institutions. However, more than one quarter of 2-year institutions disperse alumni more diversely than the average public 4-year institution. In one application of these data, we find that the average strength of the labor market to which a college sends its graduates predicts college-specific intergenerational economic mobility. In a second application, we quantify the extent of "brain drain" across areas and illustrate the importance of considering migration patterns of college graduates when estimating the social return on public investment in higher education.

INTRODUCTION

A principal aim of colleges is to equip students with knowledge, skills, and connections that will lead to labor market success and future well-being. A clear understanding of the labor markets in which a college operates stands to inform institution-level decision-making as well as broader questions about links between college-going and economic development, mobility, and inequality (e.g., Chetty et al., 2020).[1] However, most work in this area focuses on characterizing markets that colleges face

[1] We are focused on the labor markets for the graduates of colleges, specifically undergraduates. Institutions also face labor markets for staff and faculty, each of which vary in scope according to the research intensity of the institution.

for incoming students (e.g., Hoxby & Turner, 2019; Monarrez & Washington, 2020; Sá et al., 2004) rather than the markets where students ultimately live and work. Even when the latter is the focus, due to data limitations, the surrounding state or nearest metropolitan statistical area (MSA) is often a crude proxy. Given the wide range of institutions that speckle the United States, such simplifications may mismeasure the relevant labor markets for many colleges.

The ability to characterize relevant labor markets for an institution's graduates has implications for our understanding of the supply of college-educated workers, gaps in skill demand, institutional planning, and public finance concerns about the loss of homegrown graduates to other labor markets (e.g., Kelchen & Webber, 2018; Winters, 2020). To facilitate the study of these topics, we develop a new measure of such markets using data on alumni from publicly accessible institutional webpages on LinkedIn (LI). These data provide aggregate information on the geographic locations of former students for nearly all public and private nonprofit colleges and universities in the United States. We have made these data available for research use via the Open ICPSR Archive (Conzelmann et al., 2022).[2] Various validation exercises demonstrate a strong correspondence between LI and government data sources in the number and location of graduates, lending support to our measure. However, the LI data cover a more extensive range of institutions and are available at finer levels of geography than any current source of such information.

We operationalize college labor markets for 2,600 public and private nonprofit institutions that offer at least an associate degree and participate in the Title IV federal financial aid programs. For each institution, we construct a set of weights from the LI data that represent the share of the institution's alumni living in geographic units that map to one or more Core-Based Statistical Areas (CBSAs).

Borrowing from the literature on market concentration, we calculate a Herfindahl-Hirschman Index (HHI) to quantify each institution's geographic clustering of graduates across the United States. We also compute the average distance traveled by alumni of each institution. Taken together, these statistics permit us to characterize colleges' labor markets in a more detailed fashion and for a wider group of institutions relative to existing data sources. In general, we confirm that graduates of more selective institutions appear in more distant and geographically diverse locations. However, there is appreciable variation in the HHI and distance metrics across groups of institutions defined by level (2-year/4-year) and selectivity. Indeed, we find that 28% of 2-year institutions boast a diversity of graduates' locations that surpasses the average among public 4-year institutions, even though the typical 2-year graduate tends not to venture far from the institution they attended.

We demonstrate the utility of our labor market measure through two empirical applications. Our first application examines the relationship between college markets and rates of intergenerational economic mobility. Chetty et al. (2020) found that the colleges with the highest mobility rates "do not differ substantially from other colleges on institutional characteristics like public-versus-private status, instructional expenditures, or endowments" (p. 1570), which points to the need for further exploration of such differences based on measures of student outcomes. We posit that one way a college generates upward mobility for its students is through the labor market connections it provides (Chetty et al., 2022a, 2022b). Institutions with well-established networks to robust labor markets across the country may more easily facilitate such mobility for their graduates from low-income backgrounds.

Using data from the American Community Survey (ACS), we calculate the wage for bachelor's degree recipients averaged across a college's labor markets, weighted by our college-specific labor market shares. We find that this measure of the strength of the labor markets to which a college sends its graduates meaningfully predicts variation in the bottom-to-top quintile economic mobility rates across colleges, even after conditioning on a range of institutional and student-body characteristics, as well as geography fixed effects that capture access to a common local labor market. A 10% increase in the average bachelor's degree wage of the relevant labor market for an institution is associated with a 14.2% increase in the likelihood that a student from a household in the bottom income quintile reaches the top income quintile.

[2] The Open ICPSR Archive is available at http://doi.org/10.3886/E170381.

In our second application, we explore the role of migration in understanding the social return to public investment in higher education. Understanding and quantifying the migration of college graduates has implications for the financing of higher education. Bound et al. (2019) suggested that greater mobility of college graduates has contributed to the decline in state appropriations over the past 40 years, and Hurst et al. (2023) provided additional evidence that taxpayers' support for public spending on higher education depends on the return on investment. We show that the social benefits of public investment in postsecondary education disproportionately accrue to high-wage and urban/suburban areas due to graduate mobility, which we now can quantify at sub-state and institution-specific levels. We also find that regional public universities tend to produce the greatest number of 4-year college graduates who remain and work in-state per dollar of state funding.

More broadly, in research that aims to study the migration of college-educated workers and its determinants (e.g., Molloy et al., 2011) or estimate the responsiveness of human capital investments to demand shocks (e.g., Acton, 2020; Blom et al., 2020; Weinstein, 2022), our measure of college labor markets serves as a key ingredient for properly characterizing labor and skill demand. Our data should also be useful for studying spatial policies—for example, computing the marginal value of public funds of education policies (Hendren & Sprung-Keyser, 2020) in a federal system (Agrawal et al., 2022), which involves measuring changes in the tax base from new college graduates across space. These examples highlight the wide and policy-relevant potential uses of our new measure of college-specific labor markets.

The paper unfolds as follows. The next section, "Measuring College Markets," describes the construction of our new measure of college-specific labor markets and discusses results from a series of validation checks. The section "Describing College Labor Markets" uses these new data in a range of descriptive analyses that characterize the labor markets for college graduates. The section "Application 1: Understanding Economic Mobility of College Graduates" presents findings from our application on colleges and intergenerational economic mobility. The following section, "Application 2: Brain Drain and the Value of Public Investment in Higher Education," discusses results from our application on brain drain and the social return to public investment in higher education. The last section concludes.

MEASURING COLLEGE MARKETS

Current data sources for characterizing destinations of college graduates

Few existing data sources contain the requisite information to tie an individual's current area of residence to the college they attended; moreover, such sources are not typically representative of entire institutions or cover only a small subset of them. For instance, longitudinal datasets from the National Center for Education Statistics (NCES) include detailed geographic information on sample members up to 10 years after the completion of a bachelor's degree—however, institution-level estimates are not feasible and even state-level estimates are unreliable because of limited sample sizes.[3]

A new resource from the Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) program, the Post-Secondary Employment Outcomes (PSEO) project, contains data (as of 2023) on employment outcomes for graduates of a few hundred public 4-year institutions in 27 states.[4] The data include counts of graduates employed in each Census Division, as well as in the institution's own state. At the time of this writing, PSEO covers less than one third of public 4-year institutions, and its coverage of private institutions is especially sparse, with (incomplete) data for just seven states.

[3] The same issues arise with datasets from the National Science Foundation, such as the National Survey of College Graduates. Moreover, information on the specific institution a worker attended for their bachelor's degree is often either unavailable or is a restricted-use variable.

[4] Many, but not all, of these states also provide information for 2-year colleges. The program periodically adds more institutions. The latest coverage of states and colleges is listed here: https://lehd.ces.census.gov/data/pseo_experimental.html.

Further, the relatively coarse geographic information available is not sufficiently specific for measuring college labor markets, especially to the extent that former students congregate in specific metropolitan areas or nearby states due to the nature of local job opportunities.[5]

A new measure of college labor markets

We introduce a comprehensive measure of the geographic dispersion of college graduates from nearly all public and private nonprofit institutions in the United States. Using the Integrated Postsecondary Education Data System (IPEDS), we define a population of 2,832 public and private nonprofit colleges that are located in the 50 U.S. states or DC, offer at least an associate degree, and participated in the Title IV federal financial aid program every year from 2010 to 2018.

For each institution we obtain publicly available information on college alumni webpages from LI, the popular professional social networking platform.[6] Nearly every college and university in the U.S. has claimed an official page—which houses aggregate, college-level counts of users who self-report having attended the school, counts from the 15 most common geographies where alumni reside,[7] and counts of other top-15 pieces of information, including employers, industry, skills, and college majors. These pages can be further filtered by years of college attendance and by individual geographies outside the top-15 list.

Of the 2,832 institutions in our population, we located and obtained LI geographic data for 2,600 (approximately 92%). These institutions account for 99% of the associate and bachelor's degrees awarded from 2010 through 2018, per IPEDS counts. For each of the 2,600 schools with a valid page, we obtain alumni counts using year (of attendance) filters for 2010 through 2015. Our target population is bachelor's and associate degree recipients from each college in our sample between 2010 and 2018. We collect data based on attendance through 2015 to minimize the number of current students in the counts. Because we are using aggregate data from institutional pages, we cannot explicitly limit our LI search to (bachelor's or associate) graduates, and thus the year filters capture all individuals who report attendance that overlapped with the specified date range (in our case 2010 to 2015) for any degree program.

For each institution in our sample, we first collect the number of alumni in each of the non-country-wide LI geographies within its top-15 locations. Across institutions, this accounts for about 82% of alumni in the U.S., a known figure since the top geography on each institution's page in our sample is the whole United States. We supplement these data in two ways. First, for each institution, we search and incorporate counts of alumni residing in all remaining in-state geographies (i.e., in-state geographies outside the top-15 locations). Second, we incorporate additional locations associated with each institutions' peers; we match institutions to groups of three peers using a Mahalanobis distance algorithm.[8] We compare the top-15 list of locations for the focal institution to the top-15 lists of its three peers to identify locations that are missing from the focal institution's list but present for at least one peer. For these locations, we obtain counts of graduates from the focal institution who are living and working in each location. Together across these two supplementary steps, we add information on 5 or 6 geographies per institution (average = 5.7 locations), which boosts overall coverage by 2.2

[5] Research outside the United States has used administrative data that link students to labor market outcomes (e.g., Joensen & Nielsen, 2009; Zimmerman, 2019), but those papers do not tend to focus on location in their analyses.

[6] Appendix Figure B1 provides an example of the layout of these data for an example institution. The aggregate college-level information is viewable to any user with an LI account, which is free to obtain. All appendices are available at the end of this article as it appears in JPAM online. Go to the publisher's website and use the search engine to locate the article at http://onlinelibrary.wiley.com.

[7] The entire United States is the top geography reported for each institution; thus, we observe 14 sub-state locations for each institution. Sub-state areas (e.g., Greater New York City Area) roughly correspond to one or more CBSAs from the U.S. Census Bureau.

[8] Variables include each institution's state, control (public/private), level (2-year/4-year), percentage of first-year students attending from in-state, basic Carnegie classification, and Barron's selectivity rating.

percentage points, to about 84%. Because we always capture all graduates residing in an institution's own state, the remaining 16% of graduates reside outside the state.

We work with this analytic sample of 2,600 institutions and 278 U.S.-specific LI geographies throughout the rest of the paper. The final dataset contains observations uniquely identified by institution-geography pairs, and each pair is accompanied by both a count and a share of graduates residing in that location.[9] Within institution, the shares sum to 1 and the raw graduate counts sum to the institution's total U.S. alumni for whom a location was identified.[10] Because LI geographies map closely to one or more CBSAs,[11] one can supplement the dataset of shares with characteristics of the geographies where graduates of an institution reside. For example, in our first empirical application, we use this crosswalk to develop a proxy for the "average strength" of the labor markets to which an institution's graduates flow based on data at the CBSA level from various government agencies (e.g., Census and Bureau of Labor Statistics). Appendix B provides more details about the data collection process and analytic steps necessary to arrive at our final dataset.

Validation of LinkedIn coverage

We assess the validity of the LI data for measuring college markets through several validation analyses. Participation in LI is voluntary, and we can only speculate on how students decide to create a profile and the information they publicize.[12] The goal of this paper, to measure college-specific labor markets for graduates, is attainable even without complete alumni coverage in LI. However, we need to verify that data from LI cover most institutions, are reasonably reflective of the alumni of those institutions, and that any gaps do not systematically influence the measures we aim to produce (e.g., share of graduates in a given area). We validate the LI data against several official government data sources to bolster this claim.

To assess the overall coverage of the LI data, we first compare the total number of bachelor's and associate degrees awarded by each institution (between 2010 and 2018, according to IPEDS) to counts of alumni from the same institution who appear in LI and reside in the United States. Figure 1a plots these two measures overlaid with a simple linear regression line, where each observation is an institution weighted by its completion count. We see a strong positive relationship between IPEDS and LI, with an *R*-squared of 0.94 and a slope of 0.66. This suggests the LI data cover about 66% of graduates found in the true counts, on average, while the *R*-squared suggests this coverage is rather homogenous across institutions.

Private nonprofit institutions exhibit slightly lower coverage compared to public institutions. The slope of a regression line including only private institutions is smaller, at 0.58.[13] However, the *R*-squared from a regression on this subsample is comparable to the full sample, at 0.93. Appendix Table B1 documents LI institutional page discovery rates. Columns 1 and 2 of Appendix Table B2 explore institution-level correlates of coverage rates of the LI data, benchmarked to the IPEDS counts.[14] We see that coverage is strongest among 4-year institutions, non-rural colleges, and institutions outside the most selective (Barron's) category.

[9] For all 2,600 institutions, we take the alumni counts from each of the 278 available U.S.-specific geographies in LI and divide them by the institution's total number of alumni residing in the United States. These shares sum to 1 within institution after we add an observation with the count and share of "unlocated" U.S. graduates.

[10] This requires that we renormalize the shares after ignoring unlocated graduates. See Appendix B for details.

[11] Appendix B explains the construction of the CBSA-LI crosswalk. Appendix Figure B2 illustrates the process of mapping LI geographies to CBSAs.

[12] Users are unlikely to misrepresent easily verifiable information such as educational and employment histories (Guillory & Hancock, 2012).

[13] Among publics, coverage is higher at 4-year institutions (slope = 0.68) than at 2-year institutions (slope = 0.58).

[14] Columns 3 and 4 of Appendix Table B2 examine institution-level correlates of the "unlocated" share of alumni based on LI data. Because we collected information for each institution on all in-state locations of its alumni (see dataset construction details in Appendix B), the share "unlocated" retains some meaning—namely, it represents a group of alumni who are living and working in a state other than the home state of

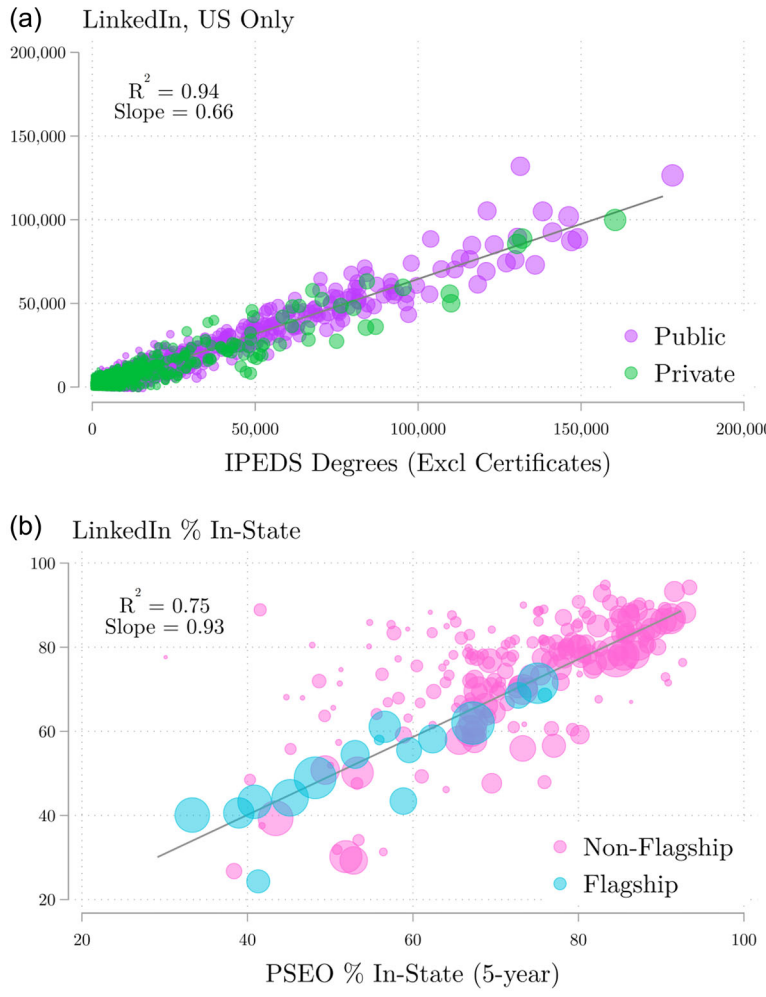

FIGURE 1 LinkedIn validation exercises: Comparisons to IPEDS completion counts (2010 to 2018) and PSEO percentage of students residing within institution's state.
[Color figure can be viewed at wileyonlinelibrary.com]
Notes: Panel A compares the total number of degrees (excluding certificates) awarded between 2010 and 2018 according to IPEDS to counts of alumni found at the same institution in LinkedIn targeting the same time frame. The *R*-squared and slope are from a linear regression of the LinkedIn count on the IPEDS count, weighted by institutional enrollment. Panel B compares data from PSEO institutions on the percentage of their graduates residing in-state 5 years after graduation to the percentage of LinkedIn alumni residing in-state. The R-squared and slope are from a regression analogous to that in Panel A.

Beyond aggregate coverage, geographical selection into LI would also undermine the validity of our measure. For example, the use of LI may be more common in certain parts of the country than others—and thus students with an LI profile might systematically differ from those without in terms of geography. We address this concern using data from the PSEO on 209 public 4-year institutions spread across 17 states[15] that are also in our analytic sample (U.S. Census Bureau, 2022).[16]

the institution they attended. We see that the share of unlocated alumni is higher among 4-year universities, private institutions, the most selective colleges, and institutions outside the northeastern United States.

[15] These states are Alabama, Arizona, Colorado, Connecticut, Indiana, Iowa, Louisiana, Maine, Michigan, Missouri, New York, Ohio, Pennsylvania, Texas, Utah, Virginia, and Wisconsin; these were the states with coverage when we conducted our analysis.

[16] We note that PSEO covers only employed graduates, based on state unemployment insurance wage records. Since we are interested in labor markets for graduates, this restriction is not a problem for our purposes. Indeed, our data, as well as PSEO, should not be thought in terms of

In Figure 1(b), we compare PSEO data on the percentage of bachelor's degree graduates employed, 5 years after graduating, in the same state as the institution they attended to the percentage of alumni residing in their institution's state as reported in our LI data. We observe a strong positive relationship between the government data source and LI, with an *R*-squared of 0.75 and a slope of 0.93. Shares are about 2 percentage points lower, on average, in LI than in PSEO.[17] Encouragingly, we see little variation between flagship institutions and non-flagship public institutions.[18]

While overall coverage of LI is quite high and we find little evidence of bias in coverage of in- versus out-of-state students, non-random selection into LI based on major or field of study could still be a concern. As a check on the representativeness of the LI data along this dimension, we compare the aggregate distribution of majors in the LI data among the 4-year institutions in our sample to IPEDS degree completions between 2010 and 2018 by two-digit Classification of Instructional Programs (CIP) codes. Across institutions, some fields like Business are clearly overrepresented in LI, with 32% of graduates versus 18% of bachelor's degrees awarded in IPEDS. Others, like Health and Education, are underrepresented (6% vs. 10% and 2% vs. 5%, respectively).[19] The full distributions of reported majors from both sources, along with their differences, appear in Appendix Table A1.

In Figure 2, we explore the degree to which the under- and over-representation of different fields in the LI data alters basic conclusions about the labor markets of institutions' graduates. In Figure 2(a), we compare institution-level PSEO estimates of the share of graduates employed in-state, built from a weighted-average across programs of study (y-axis), to the estimates we would get if we altered the weights to reflect the distribution of majors observed in our LI data for each institution (x-axis). We see that the share of graduates employed in-state changes very little when we allow for over- and under-representation of majors based on the LI data. The linear regression coefficient is 0.95 with an *R*-squared of 0.99.

Figure 2(b) suggests that, when calculating institution-level labor market shares, the overrepresentation of certain fields in the LI data is offset by underrepresentation of other fields. Indeed, after reweighting the PSEO data to reflect the composition of majors in the LI data, the overall percentage of graduates employed in-state falls by about 1 percentage point, from 68.9% to 67.9%.[20] Although we cannot rule out bias that may arise at finer levels of geography, such as sorting of students across different metro areas, our validation results imply that this bias, if it exists, is likely to be small when estimating college-specific labor market shares. All told, when benchmarked against reliable governmental data sources, the LI data stand up well to assessments of coverage and validity.

destinations for *all* graduates but as destinations for *employed* graduates. However, our measure—unlike PSEO—will also capture self-employed workers and other forms of employment outside the unemployment insurance system.

[17] Because we cannot restrict the LI data to undergraduate students, we also used the PSEO data to examine the association between the shares of undergraduate completers and graduate completers working in-state 5 years after graduation. The correlation coefficient weighted by the total number of employed graduates (across both degree levels) is 0.83, suggesting that any inclusion of graduate students in the LI data does not create much bias for capturing the mobility of undergraduates. It is also important to note that several professional schools (e.g., law) have their own LI pages, where graduate students may affiliate on the platform. Doing so would effectively remove them from the undergraduate counts on the overall institution's page.

[18] Several of the exceptions occur in one state—Pennsylvania—which has many regional colleges near state borders. As the PSEO data are based on employer location, not residence, it is possible that interstate commuters help explain the discrepancy.

[19] Aggregate information on majors is listed separately from information on alumni geographic locations in the LI data. The average share of total graduates from an institution for which we can observe major is 58%. This is due to the observation of only the top-15 most listed majors and likely also to students who do not list major on their profiles. Together, this suggests caution when interpreting magnitudes of these field-specific estimates.

[20] We find an extremely similar pattern when using aggregate employment data by program for graduates from North Carolina's public 4-year universities. For example, Appendix Figure A3b shows that, once again, after reweighting the North Carolina data to reflect the composition of majors in the LI data, the overall percentage of graduates employed in the state of North Carolina falls by about 1 percentage point. In addition, reweighted program-specific means of in-state employment are very similar to the means based on the program-level data in NC Tower (from the NC Department of Commerce), available here: https://tower.nc.gov/data-sets.

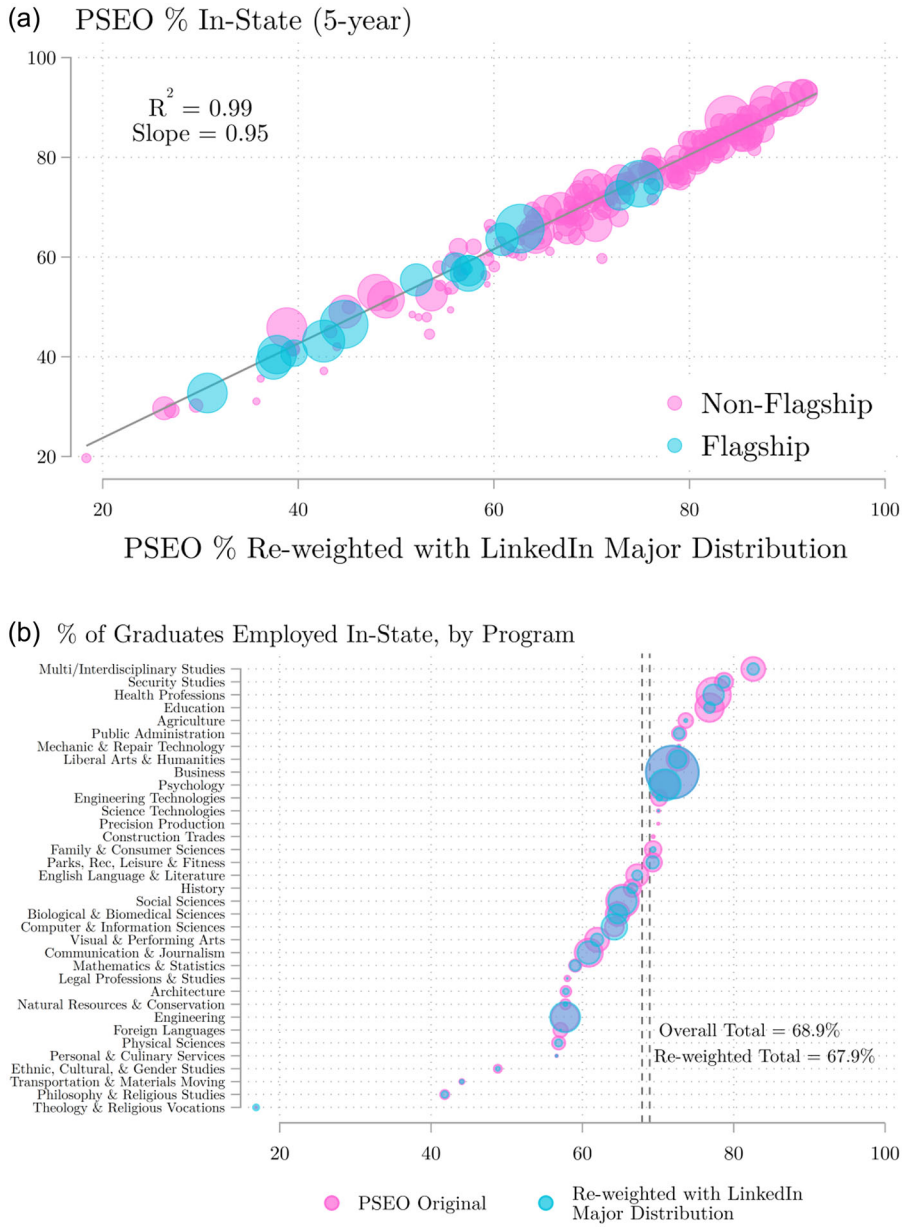

FIGURE 2 Limited influence of compositional differences in distribution of majors in LinkedIn and PSEO on measures of college-specific labor markets.

[Color figure can be viewed at wileyonlinelibrary.com]

Notes: Institutions represented in this figure are 4-year public colleges in states with PSEO data (see main text for list) that also appear in our main analytic sample. Dots in Panel A are weighted by the total number of graduates across programs at a given institution found in PSEO data. Dots in Panel B are weighted by the total number of degrees awarded in the corresponding 2-digit CIP code in PSEO, overlaid with the re-weighted number that reflects the major distribution reported in LinkedIn at the same set of institutions.

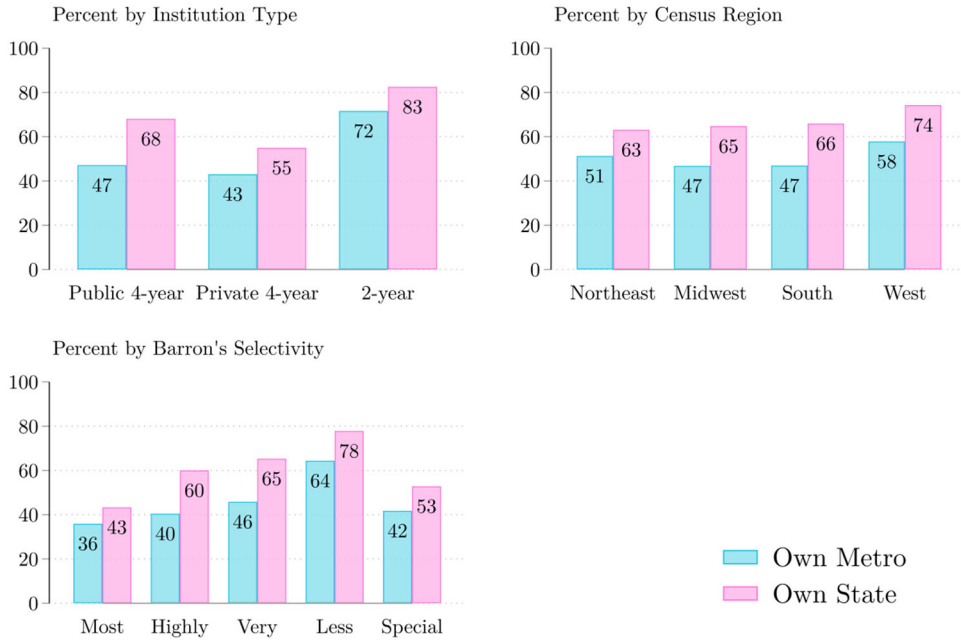

FIGURE 3 Percentage of institution's graduates residing in same or nearest metro area and same state, by institution type, census region, and Barron's Selectivity Index.
[Color figure can be viewed at wileyonlinelibrary.com]
Notes: The Barron's Selectivity panel reflects 4-year institution counts only (i.e., excluding 2-year counts). The top panels include the full sample of institutions. "Less" includes all categories below "Very" except for "Special." Institutions not located in a metro area are assigned the nearest one based on driving distance to the metro area's geographic center. Average proportions are implicitly weighted by the number of graduates.

DESCRIBING COLLEGE LABOR MARKETS

Binary definitions of college graduates' locations

Our college labor market data can be used to address simple questions related to where recent college graduates live and work. For instance, economic developers and state and local officials often want to know how well an institution's own state or closest metropolitan area retains its graduates. State policymakers in particular often have concerns about loss of homegrown, college-educated talent to other states (i.e., brain drain), which motivates policy interest in these measures (Bound et al., 2004). Indeed, many state merit aid programs are explicitly aimed at retaining talented college graduates (Fitzpatrick & Jones, 2016; Nguyen et al., 2019).

We find that the nearest metro area (i.e., LI geography) and own state capture 50% and 67% of all graduates, respectively. Figure 3 disaggregates these results by various institutional characteristics, showing the percentage of graduates living in their institution's nearest metro area with blue bars and the percentage living within the institution's home state in pink bars.[21] Even among 2-year institutions, where we expect graduates to cluster locally, nearly 30% of graduates live and work outside the local metro area. There is also substantial variation in these two measures across both Census region and Barron's selectivity level. Institutions in the Northeast appear to retain about half of their graduates in the nearest metro area, and 63% remain within the home state. In contrast,

[21] Because some metro areas cross state lines, our calculations assign graduates who reside in an institution's own or nearest metro area to the institution's "in-state" count. We explored several alternative approaches, including apportioning graduates based on population sizes of the states that share a given metro area. However, none of our alternative approaches produced statistics that performed better than the current approach in our validation analyses.

the percentage of graduates remaining in-state in the West is significantly higher, at 74%. In terms of selectivity, we see a near-linear negative relationship with the percentage of students residing in-metro-area or in-state. The more selective an institution, the less likely its graduates live and work nearby. The most selective 4-year institutions retain only about 36% and 43% of graduates within metro area and state, respectively, while institutions in the least selective category have 64% of their graduates living within the nearest metro area and 78% living within the same state.

Concentration and distance of graduates' destinations

While informative, the percentage of graduates living and working in-state (or in-metro-area) is a blunt measure that does not capture the full range of a college's labor market. We thus use our data to compute a Herfindahl-Hirschman Index (HHI) to quantify the degree of geographic concentration of an institution's graduates across the United States.

In our context, the HHI equals the sum of the squared percentages of an institution's graduates residing in each of the 278 possible LI geographies. A maximum value of 10,000 implies that 100% of an institution's graduates live in one single LI geography. Lower numbers imply that graduates are more dispersed across place. The weighted average of the HHI for the full sample of 2,600 institutions is 4,796.[22] The largest contribution to the HHI comes from graduates living and working in an institution's own or nearest LI geography. However, these graduates account for just half of all graduates in our sample. This suggests that recent college graduates migrate substantially.

Since HHI captures dispersion of alumni locations regardless of distance from the institution, equal shares of graduates across metro areas within a short drive can yield the same value as equal shares of graduates spread throughout the country. Therefore, we also compute the average distance traveled by employed graduates of each institution, weighted by labor market shares. The weighted average is 198 miles, with the typical graduate of the most selective 4-year institutions traveling about 5.5 times as far as the average community college graduate.[23]

The granularity of the HHI and distance measures permit rich characterization of an institution's geographic labor market. Figure 4a shows a clear negative relationship between HHI and selectivity, while Figure 4b shows a clear positive relationship between average distance traveled and selectivity. The gap in the average HHI between the most selective 4-year institutions and 2-year institutions is 3,746 (or 1.6 standard deviations) and the analogous gap in average miles traveled by alumni is 405 (or 2.5 standard deviations). Less-selective schools tend to have higher concentrations of graduates in fewer areas that are physically nearby, whereas the most-selective schools send their graduates farther and to a greater diversity of locations.

Figure 4c and Figure 4d show density plots of the HHI and distance measures, respectively, for three groups of institutions: public 4-year, private 4-year, and 2-year.[24] In Figure 4b, the HHI distributions for public and private 4-year institutions look quite similar, with the mean for 4-year privates falling a bit below that for 4-year publics. However, in testament to the appreciable variation in colleges' labor markets, we find that 28% of community colleges exhibit a geographic dispersion of graduates that surpasses the average public 4-year institution.[25] Yet, only a bit more than 8% of community colleges send their typical graduate farther than the average 4-year public institution.

[22] We weight by each institution's number of graduates. The unweighted average (median) HHI equals 4,470 (4,486).

[23] For comparison, Sprung-Keyser et al. (2022), using tax data, found that, for cohorts only slightly older than those we analyze, 80% of all young adults live within 100 miles of where they attended high school, with average distance rising with parental income.

[24] Nearly all of the 2-year institutions are public.

[25] The estimates in Figure 4 are weighted by the number of alumni and thus reflect the experiences of the average student (within a given group of institutions). Unweighted results show the same punchlines.

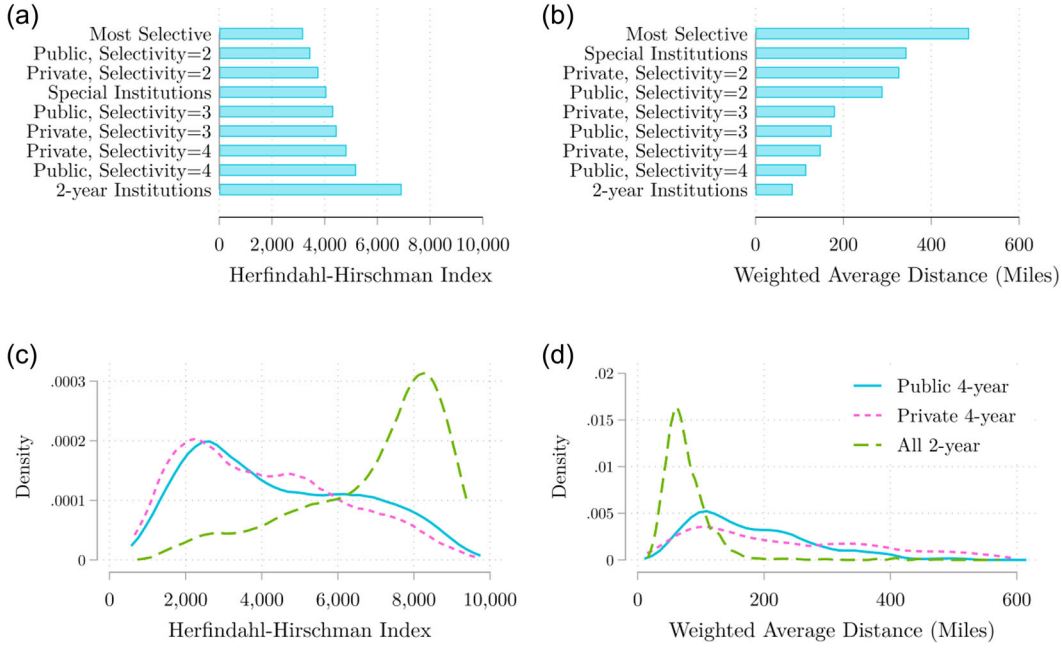

FIGURE 4 Herfindahl-Hirschman Index and weighted average distance traveled of alumni, by institution type. [Color figure can be viewed at wileyonlinelibrary.com]

Notes: Selectivity categories are based on Barron's Selectivity Index; 1 = *Most Competitive*, 2 = *Highly Competitive*, 3 = *Very Competitive and Competitive*, 4 = *Less and Non-competitive*. Special institutions typically focus on specific programs, such as art, music, or religious training. The Herfindahl-Hirschman Index (HHI) is calculated for each institution by summing the squared shares of graduates (multiplied by 100) living in each LinkedIn (LI) geography. A maximum of 10,000 implies 100% of the institution's graduates reside in one area, whereas lower numbers imply greater dispersion across the country. The average distance for each institution is calculated by taking the crow-flies distance from each institution to the geographic center of each main LI geography multiplied by the share of graduates residing in that geography, then summed within institution. The HHI and average distance measure for each group is a weighted average, where each institution's value is weighted by the number of alumni.

Contrasting institutions in terms of these measures can shed light on the nature of their labor markets.[26] For example, the University of Southern California (USC) and Shasta College (a 2-year institution in California) both have near-median HHI values of 4,400, suggesting that their graduates live and work in a similarly diverse set of locations. However, the average distance traveled by USC alumni is nearly 3.5 times as far as alumni of Shasta College (i.e., 345 miles and 99 miles, respectively), implying that these institutions realize comparable levels of alumni geographic dispersion within markedly different geographic reaches. Another pair of institutions, SUNY Buffalo State and SUNY Cortland, both send their graduates an average of 140 miles from campus. However, the HHI for SUNY Buffalo (4,520) is more than 50% larger than the HHI for SUNY Cortland (2,891). Thus, although their graduates travel similar distances, SUNY Buffalo alumni tend to be more concentrated in fewer geographic areas, compared to SUNY Cortland graduates.

While we do not explore mechanisms for these patterns in this paper, we note that the underlying data provide the groundwork for future study of candidate explanations. For instance, it is an open question how closely linked the destinations of recent graduates are to the original areas from which they entered college. The data presented here could be used with other data sources that capture geographic information on incoming students to assess the strength of this relationship and heterogeneity across institutions.[27]

[26] We also note that the labor markets served by colleges differ substantially from the markets of their self-identified peer institutions. Appendix C explores the degree of overlap between the peers identified by institutions and the peers measured by the geographic locations of graduates.

[27] To illustrate this potential, we plot for each institution a measure of the percentage of first-time, degree-seeking freshmen from in-state (taken from IPEDS) against our institution-level measure of graduates living in-state after college. We present results at both the institution level

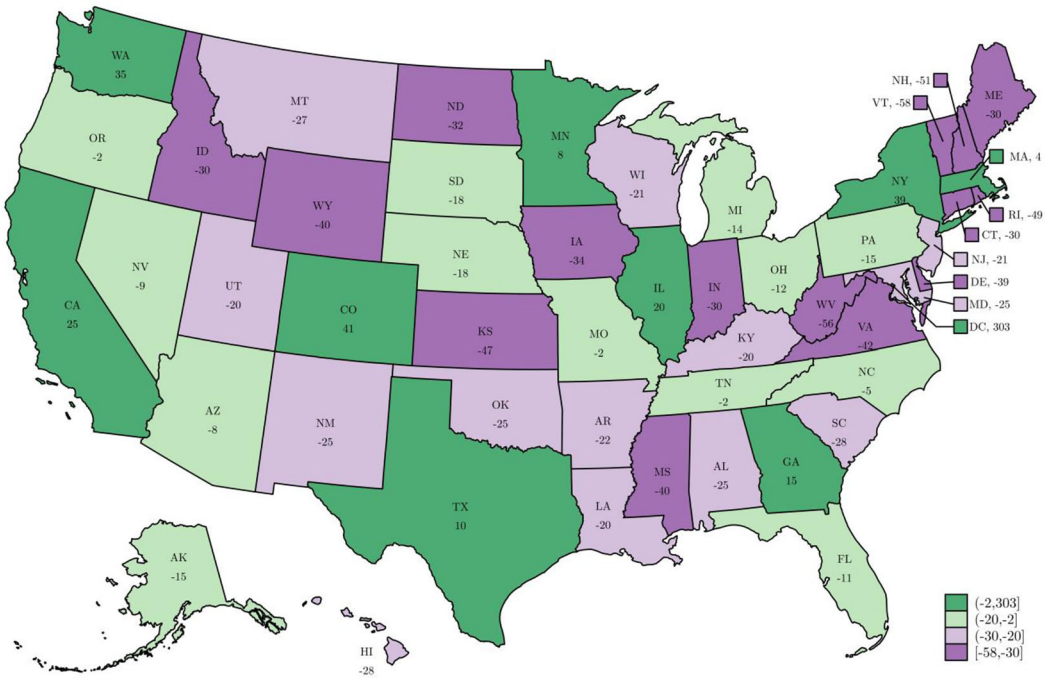

FIGURE 5 Net import and export of 4-year college graduates across states.
[Color figure can be viewed at wileyonlinelibrary.com]
Notes: Underlying data are restricted to 4-year institution counts. Numbers are rounded to the nearest percentage point, calculated with the following formula, $\frac{Living_s - Graduated_s}{Graduated_s} \times 100$, where *Graduated* refers to the total number of graduates observed in LI from institutions in state *s*, and *Living* refers to the total number of graduates from any institution who were living within state *s* in 2021 per LI. Green shades imply higher levels of importing (or retainment of own-state graduates) and purple shades imply higher levels of exporting.

Macro movements of college graduates

Beyond quantifying how graduates of individual institutions migrate after college, we can use our data to explore the distribution of graduates across geographic boundaries at a more macro level. Such an exercise is relevant to studies that examine how state-level financial aid policy, like broad-based merit aid, influences the retention of skilled workers within a state (e.g., Fitzpatrick & Jones, 2016; Sjoquist & Winters, 2014). We approximate the extent to which areas experience net in- or out-flows of graduates by aggregating initial counts of graduates by institution to some higher level of geography, and then compare this figure to the total number of students found residing in that geography after college from *any* institution.

In Figure 5, we depict the net flow of 4-year graduates at the state level, calculated for each state *s* as follows:

$$\frac{Living_s - Graduated_s}{Graduated_s} \cdot 100 \tag{1}$$

In the spirit of Bound et al. (2004), we define $Graduated_s$ as the sum of LI users who graduated from institutions in state *s*, and $Living_s$ as the sum of graduates from any institution whose LI location

(Appendix Figure A1) and state level (Appendix Figure A2). Appendix Figure A1 suggests that public institutions, as a group, tend to attract relatively high shares of in-state first-year students but retain less than proportional shares of graduates within their states. We observe the opposite phenomenon for private institutions in our sample, suggesting they may have greater "stickiness," but also prompting a need for further investigation.

places them in state *s* in 2021 (i.e., when the data were obtained). Positive numbers indicate that more students now reside in that state than initially graduated there, suggesting more graduates were drawn to (i.e., "imported") or retained in that state than were "exported" to other states. A negative number suggests the opposite—more students left the state compared to the number of students who were drawn there or retained.

In terms of broad patterns, many western states like California and Washington seem to import many students on net (green colors), most likely due to larger cities with ample job opportunities for college graduates, such as Seattle, the Bay Area, and Los Angeles. On the other side of the country, in the northeast, large metropolitan areas like New York City and Washington, DC are also prominent importers of graduates, likely in part from neighboring states, as suggested by the large net outflow (dark purple) for the adjacent states of Delaware, Virginia, and Connecticut.

As a complement to these net migration patterns, Appendix Figure A4 presents in-state retention rates for graduates of the 4-year public institutions within a state (Panel A) separately from the in-state retention rates of graduates from the 4-year private nonprofit institutions located in the state (Panel B). From the perspective of a state policy leader, the estimates in Appendix Figure A4(a) may be of particular interest.[28] These results suggest that several of the "net positive" importer states in Figure 5 may achieve this status, in part, by retaining large shares of graduates from their public 4-year universities (e.g., CA, GA, NY, and TX).

APPLICATION 1: UNDERSTANDING ECONOMIC MOBILITY OF COLLEGE GRADUATES

In our first illustrative research application, we use our measure of colleges' labor markets to examine the variation in institution-specific economic mobility rates, a relatively new marker of college success introduced by Chetty et al. (2020). The authors use comprehensive federal income tax data on children and their parents to construct intergenerational bottom-to-top income quintile mobility rates for colleges and universities in the United States. These mobility rates constitute a novel, accessible measure of the degree to which colleges promote economic opportunity for low-income students.

Aside from the measure's substantive value, the authors find that basic institutional characteristics—such as control (public/private) and measures of instructional and endowment spending—have limited capacity to predict bottom-to-top quintile mobility rates (Chetty et al., 2020, pp. 1570). This finding highlights the promise of using data on student outcomes to explore other avenues through which colleges might promote intergenerational economic mobility. We use our data to explore a reasonable hypothesis that builds on this finding: one way a college may generate upward mobility for its students is through the labor market connections it provides. Institutions with connections to robust labor markets may facilitate greater mobility for their graduates.

We test whether the relative strength of the labor markets where an institution sends its college graduates can explain the variation in economic mobility rates across institutions. We measure the "strength" of the labor market of each college by calculating average hourly wages earned by bachelor's degree recipients within LI geographic areas, and then aggregating across areas using the institution-specific labor market shares as weights. More specifically, we calculate this wage measure by aggregating data from yearly waves (2010 to 2018) of the American Community Survey (ACS) public-use datasets (Ruggles et al., 2023) on individuals with a bachelor's degree, not currently enrolled in school, and ages 24 to 35, to capture a population likely to reflect the alumni in our LI data. We aggregate wages to the LI-geography level using the CBSA designations of ACS respondents and

[28] Because we manually obtain counts of graduates living and working in all in-state locations for every institution, the "unlocated" share of graduates (i.e., those we can place out of state but not in a specific out-of-state location) does not complicate the interpretation of such in-state retention estimates.

TABLE 1 Economic mobility and college labor markets.

	Outcome = Log(P(Child in Q5|Parent in Q1))			
Independent variable	**(1)**	**(2)**	**(3)**	**(4)**
Log BA degree wages	2.5566***	1.5876***	1.0535***	1.4213***
	(0.2271)	(0.1510)	(0.1519)	(0.3445)
School characteristics	N	Y	Y	Y
Student characteristics	N	N	Y	Y
LI geography fixed effects	N	N	N	Y
Adjusted *R*-squared	0.289	0.696	0.793	0.830
Observations	1,913	1,913	1,913	1,913

Notes: Observations are weighted by the number of students in a cohort with parents in the bottom income quintile, from Chetty et al. (2020). Wages for each institution's individualized labor market were calculated using the average hourly wages for bachelor's degree recipients in each CBSA from pooled 2010 to 2018 ACS estimates and aggregated to the LI-geography level. These averages were then multiplied by the share of an institution's graduates residing in each area and then summed within institution. School characteristics include control, level, Barron's selectivity, urbanicity, HBCU designation, log of net price, and log instructional expenditures per FTE. Student body characteristics include share of students who are White, Black, Hispanic, Asian, female, above age 25, and log median parents' income. Full regression results are available in Appendix Table A2. Standard errors in parentheses are clustered at the institution's LI-geography level. LI = LinkedIn. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

our CBSA-LI crosswalk.[29] We then multiply each LI geography's wage rate by the share of graduates living in that area for each institution and sum these values within institution. Since the shares sum to 1, the new wage value is a weighted average unique to each institution and a function of the areas to which its graduates flow.

Our primary measure of intergenerational economic mobility is the proportion of students in low-income families who reach the top quintile of income as adults (P(Child in Q5|Parent in Q1)), or what Chetty et al. (2020) defined as the "success rate," obtained from the Opportunity Insights website.[30] Among the 1,913 institutions for which we have both labor market and mobility rate data, the weighted average bottom-to-top quintile success rate is 0.18, meaning that 18% of students who came from families in the bottom quintile of the income distribution made it to the top quintile by age 30.[31]

Table 1 presents results from a series of regressions of the log of the success rate on the log BA wages, with progressively richer sets of controls. The baseline specification, with no controls, shows a strong, statistically significant positive relationship between the average wages of an institution's labor market and economic mobility. The addition of basic institutional characteristics in column 2 reduces the focal coefficient, although it remains highly statistically significant. Chetty et al. (2020) found that sociodemographic characteristics of colleges' student bodies explained some of the variation in mobility rates across colleges. Thus, in column 3, we add a vector of student characteristics, including shares of undergraduates of different races/ethnicities, the share female, the share over age 25, and median parental income. The estimated elasticity drops a bit further to 1.05 but remains statistically significant ($p < 0.01$). This suggests that the strength of the average labor market to which a college sends its graduates meaningfully predicts rates of intergenerational economic mobility across institutions, over and above key observable characteristics of colleges and the students they educate.

[29] We map ACS observations to CBSAs (2013 vintage) using the county field in the ACS microdata and a county-to-CBSA crosswalk available from the U.S. Census Bureau (https://www.census.gov/geographies/reference-files/time-series/demo/metro-micro/delineation-files.html). For the approximately 30% of observations where county is missing, we assign observations to county using a PUMA-to-county crosswalk from the Missouri Census Data Center's Geocorr 2018 (https://mcdc.missouri.edu/applications/geocorr2018.html).

[30] Source: https://opportunityinsights.org/data/. This task required creation of a crosswalk from IPEDS *unitid* to the 6-digit *OPEID*. The Chetty et al. (2020) data further grouped some institutions into "super-OPEIDs" based on tax data and institutional reporting. They provide a crosswalk for this purpose. Our findings are robust to excluding institutions that are linked to a "super-OPEID" from the analytic sample.

[31] Weights equal the number of students in a cohort with parents in the bottom income quintile, from Chetty et al. (2020). The unweighted average is 0.21. We drop three institutions with a success rate of zero from the analysis.

In the fourth and final column of Table 1, we add fixed effects for the institution's (nearest) LI geography, constraining comparisons to institutions located within or near the same metropolitan areas. The elasticity remains statistically significant and positively related to mobility rates ($p < 0.01$). In this most stringent specification, a 10% increase in the average bachelor's degree wage of the relevant markets for an institution is associated with a 14.2% increase in the success rate, or roughly a 2.6 percentage point increase relative to the sample mean of 0.18. The magnitude of this relationship is about 3 times as a large as a 10% increase in median parental income of the student body, which has an elasticity of 0.46.[32] Hence, our results suggest that institutions are likely to create more economic mobility when they have stronger links to robust labor market networks than other nearby institutions with similar access to the local market.[33]

These results are an important first step toward better understanding links between geographic and economic mobility of low-income students in American higher education. While some institutions may do well by their low-income students by fostering close ties to their local labor markets, it appears students also gain from institutional networks outside the most proximate labor market. Of course, disentangling student preferences for different locations, demand for individual majors and skills in different areas, and the institution's contribution to ultimate student outcomes requires micro-level data. Our analyses highlight the potential merit of such explorations by establishing a relationship between economic mobility and a novel measure of the strength of the labor markets in which graduates of institutions live and work.

APPLICATION 2: BRAIN DRAIN AND THE VALUE OF PUBLIC INVESTMENT IN HIGHER EDUCATION

In our second application, we use our data to show how migration affects the geographic incidence of public investment in higher education. In 2019, state governments collected more than $87 billion in tax revenue to fund public colleges and produce a college-educated workforce (Laderman & Heckert, 2021). Private colleges receive government funding as well, through programs like the federal Pell Grant, although on a smaller scale. Such revenue generally supports instructional expenditures by offsetting tuition costs (Webber, 2017), providing a transfer to college students. Increases in these transfers boost degree attainment (Bound et al., 2010; Bound & Turner, 2007; Deming & Walters, 2017), benefiting both graduates and society by creating a social return in excess of the private benefits through salutary effects on crime, health, voting, and the labor market (Moretti, 2004).

However, the social rate of return on investment for a state depends on the spatial distribution of graduates across the country. States and other smaller localities may not receive the full value of their investment due to brain drain. For instance, Bound et al. (2004) found that the number of bachelor's degrees produced within state boundaries has little relationship to the stock of college-educated labor living and working in a state. High mobility rates decrease the value of public investment by states, potentially leading to an under-provision of the services as other states "free ride." While federal investment is more agnostic to these issues, the mobility of graduates has equity implications for the geographic distribution of funds. In both state and federal investment, mobility determines which taxpayers subsidize and benefit from government-financed human capital production.

We use the number of 4-year college graduates working in an area divided by the total amount of public (state, local, and federal) funding transferred to 4-year colleges in that area as a proxy for the

[32] Appendix Table A2 presents results for the full models. Unweighted regressions produce qualitatively similar conclusions.

[33] Indeed, the use of fixed effects for LI geographies rules out an alternative interpretation of this descriptive result—namely that universities with high value-added cluster in high-paying areas, and that students attend these colleges for that reason.

local rate of return of public investment.[34] This return varies by the level of tax revenue spent per student, the rate at which students graduate, and net migration. For instance, the return may be low because of tax revenue spent on students who do not graduate or because an area has high levels of outmigration. Similarly, the return may be high because an area retains a high number of graduates or because it imports a large number from other areas.[35] We also compare this measure to the number of 4-year college graduates produced per dollar of government funding in each area to understand how migration after college affects the spatial distribution of benefits.[36]

We calculate total government expenditure using information on both the amount each college spends per student from government sources each year as well as the number of years students enroll. Using first-time full-time bachelor's degree seeking cohorts who began school in 2009 or 2010 from IPEDS, we estimate the total government dollars spent on the cohort in each year through 2018 as a function of the number of students who enroll initially along with retention, graduation, and dropout rates.[37] Finally, we sum the dollar values across institutions located in each LI geography to produce our measure of graduates per total government expenditure for each area.

The maps in Figure 6 depict two measures of graduates per total government expenditure at the local level. Figure 6(a) shows the number of graduates produced by institutions in each area per $100,000 of total government spending at those institutions, which is akin to what the return on taxpayer expenditures would look like without post-graduation migration. Figure 6(b) shows the number of 4-year graduates retained or received from other geographies per increment of government spending at colleges in each area. The measures in Figure 6(a) and 6(b) have the same denominator but differ in how they handle graduates in the numerator. In Figure 6(a), graduates are assigned to the location of their college; in Figure 6(b), they move to the labor market where they work after graduating based on the LI data.[38] Comparing the two panels, mobility more than doubles the variance—and inequality—across areas in college-educated labor per dollar spent, from 0.08 to 0.17.

Although both approaches result in considerable variability across areas, the specific areas identified as high versus low return differ across panels. To characterize these patterns, we estimate the extent to which labor market and institutional characteristics predict our two measures of the local rate of return. Panel A of Table 2 presents coefficients from a regression of graduates produced per $100,000 in government funding on local area college graduates' earnings, urbanicity, institutional control and selectivity. Including Census Division fixed effects nets out potential regional differences that may be due to geographic factors, although this has a minimal effect on our estimates.[39]

There is no difference between high- versus low-wage areas or urban/suburban versus rural areas in the number of graduates produced per dollar. Since this outcome captures transfers to students while they are still in college, it is perhaps unsurprising that labor market features—such as wages and urbanicity—do not predict that outcome. Also unsurprising, areas with larger shares of private, and especially selective, institutions have a greater number of graduates produced per dollar of government

[34] Recall that the analytic sample underlying this analysis ignores the unlocated shares of graduates for each institution (as we know that this share represents out-of-state graduates, but we cannot apportion them to specific out-of-state locations); see Appendix B for additional details on the dataset.

[35] This measure reflects a state's average return given its current policies, but changes in state expenditure—which affect the behavior of both students and colleges, for example which types of students are admitted and enroll—may alter its return.

[36] Previous work on the incidence of public investment in higher education has implicitly ignored the social returns, and instead focused on private benefits, or subsidy, to those who enroll (e.g., Johnson, 2006). Bound and Simon (2021) also considered the effects on aggregate human capital, but not across different labor markets, as we do here.

[37] We pool the 2009 and 2010 full-time, first-time (FTFT) first-year cohorts from IPEDS for approximately 1,490 4-year institutions, then estimate the number of cohort members enrolled in a given year between 2010 and 2018 using 1-year retention rates and 4-, 6-, and 8-year graduation rates. We then multiply the total federal, state, and local appropriations and grants per FTE (of all students) by the number of FTFT cohort members still enrolled each year and sum across years to get the total state spending for the cohort.

[38] Appendix Figure A5 presents the net number of 4-year college graduates retained or received per $100,000 of total government spending (i.e., Figure 6b minus Figure 6a).

[39] For example, the distance between major cities in New England is much smaller than in the Pacific Census Division, which likely influences migration patterns.

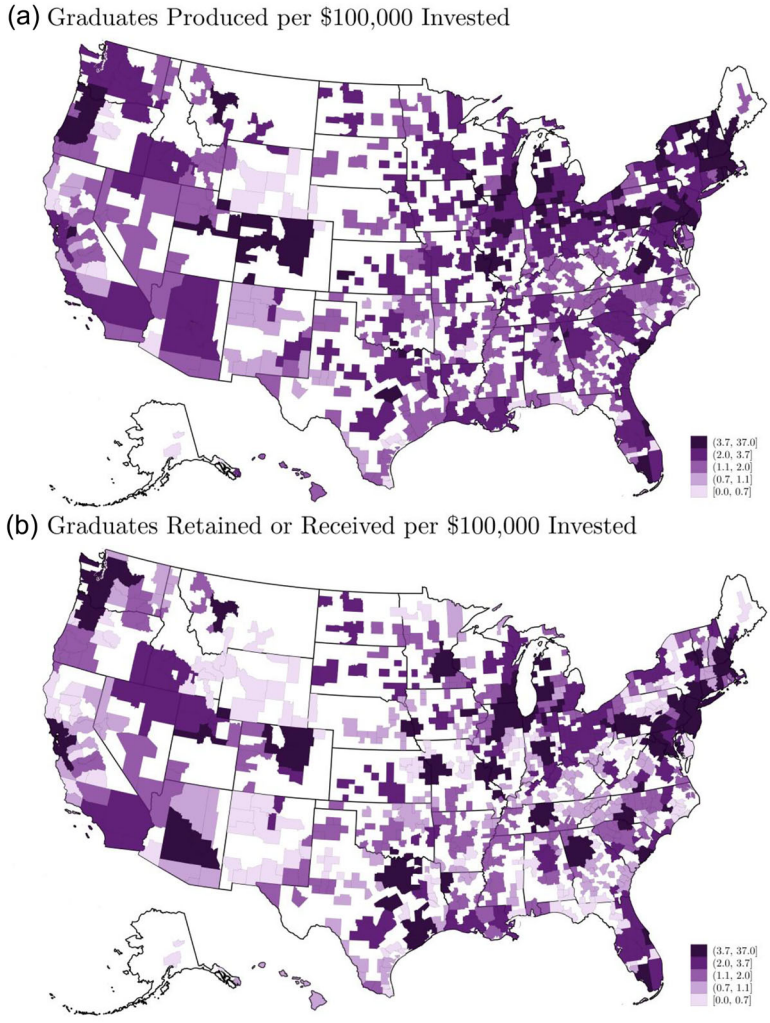

FIGURE 6 The mobility of 4-year college graduates and public investment in higher education. [Color figure can be viewed at wileyonlinelibrary.com]

Notes: Panel A presents the number of 4-year college graduates produced by all colleges in a given LI geography divided by the total amount of state, local, and federal government spending (i.e., appropriations and grants) by those colleges. Panel B contains a similar measure, but the numerator is the total number of 4-year college graduates that move to or stay in a given LI geography after graduation, estimated with our college-specific labor market shares. Spending and college graduation data are from IPEDS and migration rates are based on the LI data. Student counts from IPEDS are based on pooled 2009 and 2010 first-time full-time bachelor's degree seeking cohorts.

funding (Panel A). Such institutions tend to have higher graduation rates on average, driving up the numerator, and rely more on tuition, rather than public funding, lowering the denominator.

Panel B of Table 2 examines the social return inclusive of migration (as captured in Figure 6b). Now the labor market features matter substantially. That is, areas with high wages for college-educated workers and urban areas have high local returns because they attract more graduates regardless of where the students completed college. Finally, the dependent variable in Table 2, Panel C is the difference between graduates produced and graduates retained or received (Figure 6b minus Figure 6a, respectively). The implication is that the social benefits of public investment in postsecondary education disproportionately accrue to high-wage and urban/suburban areas due to graduate mobility, which we now can quantify precisely.

TABLE 2 Variation in the social return to public investment in higher education.

	Panel A: Graduates produced per $100K		Panel B: Graduates retained or received per $100K		Panel C: Net graduates retained or received per $100K	
Independent variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Log hourly BA degree wage	−0.0059	0.0208	2.3883***	2.6520***	2.3942***	2.6312***
	(0.2696)	(0.2792)	(0.4870)	(0.5122)	(0.4023)	(0.4530)
Share enrollment in towns or rural areas	0.0242	−0.0353	−0.5300***	−0.5603***	−0.5541***	−0.5251***
	(0.1020)	(0.0953)	(0.1646)	(0.1549)	(0.1330)	(0.1333)
Share enrollment in private institutions	1.1789***	1.0172***	1.9773***	1.8894***	0.7984***	0.8722***
	(0.1475)	(0.1330)	(0.2127)	(0.2261)	(0.1875)	(0.2124)
Share enrollment in selective institutions	0.1952*	0.1355	−0.1781	−0.2213	−0.3733***	−0.3568***
	(0.1059)	(0.1016)	(0.1551)	(0.1554)	(0.1397)	(0.1363)
(Share enrollment in private institutions)*(Share enrollment in selective institutions)	0.6550**	0.6409**	0.0519	0.1185	−0.6032*	−0.5224
	(0.2675)	(0.2568)	(0.4234)	(0.4132)	(0.3531)	(0.3594)
Log FTE enrollment	0.0242	−0.0353	−0.5300***	−0.5603***	−0.5541***	−0.5251***
	(0.1020)	(0.0953)	(0.1646)	(0.1549)	(0.1330)	(0.1333)
Constant	0.5244	0.5866	−6.6956***	−7.4007***	−7.2200***	−7.9874***
	(0.8021)	(0.8266)	(1.4144)	(1.4815)	(1.1691)	(1.2993)
Adjusted *R*-squared	0.473	0.537	0.479	0.505	0.328	0.351
Census division fixed effects	No	Yes	No	Yes	No	Yes
Observations	263	263	263	263	263	263

Notes: The outcome for Panel A is the number of 4-year college graduates produced at institutions in a given LI geography divided by the total amount of state, local, and federal government spending by those colleges. The outcome for Panel B contains a similar measure but the numerator instead estimates the total number of 4-year college graduates in a given LI geography's labor force after graduation based on the number of graduates produced and our college-specific labor market shares.

LI geographies without any 4-year college enrollment are excluded from these regressions, since our measures are not defined for those areas. Average wages are from pooled ACS 2009 to 2018 data and estimated using employed bachelor's degree recipients ages 23-32. Selectivity is defined as the share of the LI geography's enrollment from institutions in categories 1 through 3 of Barron's Selectivity Index. Student counts from IPEDS are based on pooled 2009 and 2010 first-time full-time bachelor's degree seeking cohorts. All regressions additionally control for the log of FTE enrollment in each area. Robust standard errors appear in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Next, we separate state and local from federal funding and examine correlates of the local rate of return of each form of public investment. Since these sources target different types of institutions and students, the returns across labor markets may differ as well. In particular, the funding sources may have differential effects on the types of students who enroll in a given institution (i.e., resident vs. nonresident, low- vs. high-income enrollments), and therefore on the dispersion of graduates as well as graduation rates. To explore these potential differences, we estimate a regression of our three measures of the local rate of return of public investment separately for federal funding, and for state and local funding, on local area college graduates' earnings, urbanicity, institutional control and selectivity. We find minimal differences between federal versus state and local funding in the extent to which labor market and institutional characteristics predict net graduates per dollar (Appendix Table A3, columns 5 and 6).

A related question is how many graduates a state retains in-state for each public dollar spent at different types of institutions. This might be the relevant question of concern to a state higher education

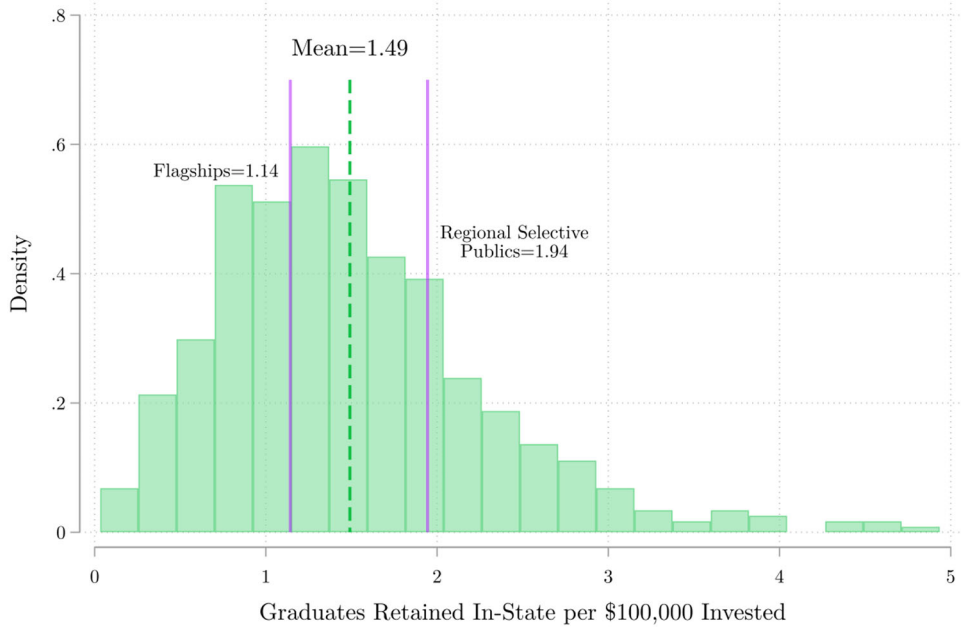

FIGURE 7 Public 4-year graduates retained in-state per $100,000 state expenditures.
[Color figure can be viewed at wileyonlinelibrary.com]
Notes: The analytic sample includes public 4-year institutions in the U.S. that appear in our broader sample of institutions. Flagship public institutions are the most selective, research-intensive institutions in each state. Regional selective publics are doctoral and master's institutions within the top three selectivity bins of Barron's data that fall outside the "very high research activity" (R1) Carnegie classification. State expenditures include state appropriations and state grants from IPEDS.

agency allocating funding across different institutions.[40] State flagships, despite having much higher graduation rates, have greater out-of-state migration and higher spending, lowering the number of graduates retained in-state per state dollar spent.

Figure 7 presents the distribution of graduates retained per $100,000 in state funding for public 4-year institutions across the United States, including separate (unweighted) statistics for two subgroups of institutions.[41] There is substantial variation. Institutions with modest spending, high graduation rates, and low migration—such as selective regional public universities—rank highest. Flagships rank among the lowest. An important caveat is that this metric does not reflect benefits accruing from institutions' ability to attract graduates from out-of-state nor other local economic spillovers (e.g., Andrews, 2023; Valero & Van Reenen, 2019).

CONCLUSION

Research on the role of colleges in economic growth and mobility, workforce and skill evolution, and the social return to public investment in education—to name a few—has been hampered by an absence of data on where students from individual institutions go after graduating. Prior work has typically assumed—explicitly or implicitly—that graduates remain nearby or has relied on small samples of students or institutions. This paper introduces new data on the metro-level labor markets served by

[40] Indeed, one potential use of the data underlying our article is to produce state-specific analyses of college-specific labor markets. For example, Conzelmann and Hemelt (2022) conducted such an exercise for North Carolina.

[41] This analysis does not suffer from the limitations related to the unlocated share of graduates from a given institution because we manually obtain information for all in-state locations for every institution.

individual institutions drawn from alumni data contained on LinkedIn institutional pages. These data, validated with several official government sources, are available for almost every nonprofit college and university in the United States.

We use these data to reveal several new descriptive facts about the mobility of college graduates. Recent college graduates tend to be quite mobile, traveling an average of nearly 200 miles, though there is wide variation across and within institutions' level, selectivity, and control. For instance, 28% of 2-year institutions have a geographic spread of alumni that surpasses that of the typical public 4-year institution. Clearly, assuming that graduates remain in-state or that in-state retention rates are similar across colleges is erroneous. Relatedly, flows of graduates across state or metro-area boundaries are far from uniform, as some areas tend to be strong net-importers of recent college graduates, where others are net-exporters of college-educated workers. These patterns are likely related to state and federal policies and could be explored in more depth in future work.

Two empirical applications showcase the research potential of our novel dataset, though many other uses are possible. First, we use these data to examine the relationship between the strength of the labor markets to which an institution's graduates flow and the economic mobility of low-income students at that institution. We find that college-specific, bottom-to-top quintile income mobility rates, a benchmark of institutional success, are statistically linked to the geographic destinations of colleges' graduates. This suggests that one of the key ways institutions propel upward economic mobility for their low-income students is through connections to robust labor markets across the country.

Our second application characterizes the spatial distribution of both graduates and public spending to illustrate the importance of accounting for migration when measuring the return on public investment in higher education. Federal and state transfers to college students create both direct benefits in a college's own area as well as spillovers from migration. Focusing only on where the money starts, rather than how it follows students after graduation, misrepresents who benefits from public investment. Specifically, higher-wage and urban or suburban areas tend to have more college graduates per public dollar spent due to inequitable migration of graduates. From the lens of a state policymaker, we show that regional public institutions tend to produce the greatest number of graduates who stay and work in-state per dollar of state funding, suggesting investments in these institutions could have particularly high local returns (Sprung-Keyser et al., 2022).

These are a few of many uses of new data on the destinations of graduates from individual colleges in the United States. Postsecondary institutions play an important role in labor markets, constitute a target of substantial public investment, and are crucial cultural and political institutions. Simply knowing where an institution's graduates end up living after graduation is a hurdle many analysts struggle to surmount. Our novel measure helps to fill this analytic gap.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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