

The Local Economic Impact of International Students: Evidence from US Commuting Zones

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Abstract

This paper examines the impact of international students on local labor markets and establishments in the United States. Identification rests on a shift-share instrument strategy that exploits supply-driven changes in foreign enrollments in non-US destinations. One additional student per thousand residents increases the employment-to-population ratio by 0.19 percentage points and average hourly wages by 0.48 percent. Local demand shocks induced by an increase in enrollment also lead to substantial labor reallocations toward potentially more productive establishments, particularly within non-tradable industries. These findings highlight important economic benefits from international students through increased local income and aggregate productivity.

JEL Codes: F22, I23, J23, J61

Keywords: International students, Local labor markets, Labor demand, Job flows.

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1 Introduction

Despite rising attendance costs, international students' enrollment in US higher education has increased substantially over the past few decades. Rapid economic growth, particularly in China and many other emerging markets, has led to a remarkable surge in the number of students who can afford an education overseas ([Bound et al. 2020](#); [Bound et al. 2021](#); [Khanna et al. 2023](#)). Indeed, as figure 1 demonstrates, the rise in the number of self-funded students accounted for almost all of the growth in foreign enrollment in US higher education in recent years. Besides generating more tuition and fee revenue for the higher education sector, such changes in the number and composition of students from abroad have the potential to fuel demand for local goods and services and result in substantial economic impacts on local economies ([Peri 2016](#)).¹

In this paper, I examine the short-run effects of international students on local labor markets and establishments. My empirical analysis aims to quantify the overall impact of an increase in foreign enrollment on local employment and wages, as well as document the distributional consequences of potential labor reallocations across establishments. These distributional effects are theoretically predicted by a class of general equilibrium models with heterogeneous firms, whereby local demand shocks lead to not only a net increase in labor demand but also within-industry reallocations of resources toward high-productivity establishments (e.g., [Melitz 2003](#); [Bernard, Redding, and Schott 2007](#); [Melitz and Ottaviano 2008](#)).² Specifically, increases in local demand and profitability will likely stimulate establishment entry and expansion, thereby heightening the competition for workers and market shares. However, as the vast majority of international students do not engage in off-campus employment due to student visa restrictions (figure 2), the surge in local labor demand might not be met with a commensurate increase in labor supply, leading to higher wages.³ Higher labor costs and reduced markups force the least productive establishments

¹Foreign students generated \$47.3 billion in education revenue alone in 2018, almost equivalent to US export of passenger cars in the same period ([Bureau of Economic Analysis 2022](#)).

²See [Redding \(2011\)](#) for a review of these models in the context of international trade, and [Syverson \(2011\)](#) for a broader discussion of the empirical literature on the productivity-enhancing effects of market competition.

³It is worth noting that my analysis focuses on the immediate impact of international students upon enrollment. Under an F-1 visa, international students cannot undertake off-campus employment during the first year of study. After

to contract or exit altogether. Consequently, the presence of international students could improve local aggregate productivity by freeing up labor and market shares for establishments that are more capable of taking advantage of the induced local demand shocks.

To test these hypotheses, I use several sources of data and the concept of commuting zones to approximate local labor markets. At the heart of my analysis is a large set of administrative data covering all international students enrolled in US higher education under F-1 student visa status between 2003 and 2015. These data allow me to precisely measure enrollment at the commuting zone level and utilize spatial variation in the distribution of international students to study their local economic impact. More importantly, available information on each student's country of origin enables a shift-share instrumental variable estimation approach, which I use to address key identification challenges. As with many studies in the immigration literature, a major concern with the spatial correlation approach in this setting is the existence of potentially unobserved pull factors that may influence both the inflows of international students and local labor market conditions. For instance, [Bound et al. \(2020\)](#) show that declines in state appropriations for higher education, particularly after an economic recession, led public research universities to respond to budget shocks by enrolling increasing numbers of students from overseas who could readily afford out-of-state tuition. In such cases, as worsened local economic conditions aggravate US universities and colleges' reliance on international students for tuition revenue, OLS estimates of the effects of an increase in foreign enrollment on local labor markets and firms could be biased downward.

My identification strategy circumvents potential biases caused by unobserved local pull factors by exploiting changes in the outflows of international students across countries of origin into other top English-speaking destinations. These shocks help isolate plausibly exogenous, supply-push components of the variation in foreign enrollment, which I combine with the tendency of students to apply to US programs where previous cohorts from the same countries of origin have attended to construct my instrument. Through a series of falsification tests, I show that the varia-

the first academic year, students may engage in certain forms of training related to their studies, though as figure 2 and my regression results later show, the short-run local labor supply contribution of international students is very small compared to their impact on labor demand.

tion in foreign enrollment predicted by the instrument is uncorrelated with pre-determined changes in local economic conditions.

To examine the net impact of international students on local labor demand, I combine administrative data on international students with employment, wage, and demographic data from the American Community Survey. My results suggest that an increase in foreign enrollment leads to significant increases in local employment and earnings. At the commuting zone level, an increase in enrollment by one student per thousand residents raises the employment-to-population ratio by 0.19 percentage points and average hourly wages by 0.48%. These effects are economically substantial and indicate that the overall growth in foreign enrollment in US higher education between 2005 and 2015 has led to the creation of over 1.2 million jobs, an impact equivalent in magnitude to 49-59% of the displacement effect caused by rising import competition from China (Acemoglu et al. 2016).⁴ In line with expectations, increases in local labor demand are concentrated in the non-tradable sector, particularly in construction and services. These effects are much more pronounced in commuting zones that experienced larger-than-median changes in students' resources and potential spending. Importantly, I demonstrate that these effects reflect an increase in the capacity of US higher education to tap into the supply of international students, as increased foreign enrollment does not displace domestic students at the local labor market level.⁵

Next, I use Business Dynamics Statistics data as well as establishment microdata from the Your-Economy Time Series database to study the effects of international students on local job flows. The latter tracks establishments across the US and contains key information on employment, industry affiliation, and sales, allowing me to examine how an increase in foreign enrollment affects labor reallocation across different establishments. I show that the observed net impact of international students on local employment conceals substantial positive effects on job creation as

⁴While sizable, these effects are not implausible as they capture both the direct effects of students' expenditures on employment and indirect effects from increased natives' earnings and housing prices on local demand. Assuming a multiplier of 1.9 for university spending (Kantor and Whalley 2014), my results imply a cost of \$36,000 to create one additional job, which is consistent with recent findings (Serrato and Wingender 2016).

⁵I document some negative effect on first-time, first-year domestic enrollment at two-year programs, most likely due to improvements in local labor market conditions and, therefore, increases in the opportunity cost of attending community colleges.

well as job destruction along both the intensive and extensive margins. While there was a small reallocation of labor away from agriculture, mining, and manufacturing during the study period, much of the observed effects of an increase in foreign enrollment on labor reallocation occurred within retail and services. Using average annual sales growth as a measure of establishment performance, I demonstrate that the positive effects on job creation are driven by the entry and expansion of the potentially most productive establishments. On the other hand, international students also lead to substantial job destruction through the exit and contraction of the least productive establishments. These results suggest that, beyond the immediate impact on local employment and earnings, the overall growth in foreign enrollment in the past few decades may have catalyzed more long-term improvements in local economic efficiency in the non-tradable sector through increased business dynamism and intra-market competition.

My findings contribute to three separate strands of literature. First, existing studies on the impact of international students have typically focused on the higher education sector, where previously examined outcomes include school finance ([Bound et al. 2020](#)), domestic enrollment ([Shih 2017](#); [Zhu 2024](#)), and academic innovation ([Chellaraj, Maskus, and Mattoo 2008](#); [Stuen, Mobarak, and Maskus 2012](#)). The recent slowdown in foreign enrollment, particularly during the COVID-19 pandemic and also as a result of trade wars with China ([Khanna et al. 2023](#)), has raised concerns over potential negative consequences to the US economy in both the short and long run, though little systematic analysis has been conducted to date. This paper addresses this gap by taking a first step toward assessing the broader effects of international students on local labor markets and business dynamics.

Second, this paper contributes to the broader debate on the economic consequences of immigration by providing direct evidence of the positive effects of immigrant consumption on natives' labor market outcomes. Much of the discussion in this area has focused exclusively on the potentially negative impact of an immigration-induced labor supply shock and neglected the fact that immigrants could also stimulate local labor demand through their spending on non-tradable goods

and services.⁶ I document these demand-side effects by studying a large and growing group of foreign-born individuals in the US that cannot participate in the labor market in the short term due to visa restrictions. To the extent that these effects can compensate for an increase in local labor supply, the results presented in this paper provide a short-run explanation as to why many empirical studies have found relatively small overall effects of immigrants on natives' employment and wages.⁷

Finally, this paper also relates to a body of literature that assesses how competition can spur efficiency. In particular, a Darwinian selection process through which resources are reshuffled toward more productive producers has been linked to heightened intra-market competition ([Disney, Haskel, and Heden 2003](#); [Syverson 2004](#); [Foster, Haltiwanger, and Krizan 2006](#)) and trade liberalization ([Pavcnik 2002](#); [Trefler 2004](#); [Bernard, Jensen, and Schott 2006](#); [McCaig and Pavcnik 2018](#)). My findings reinforce the notion that competition can have productivity-enhancing effects and point to immigration-induced local demand shocks as a potential determinant of market competitiveness in the non-tradable sector.

The rest of the paper proceeds as follows. Section 2 describes data sources. Section 3 outlines the spatial correlation approach and, in particular, an instrumental variable estimation strategy that seeks to address identification challenges. Section 3 presents empirical results on the net impact of international students on local employment and wages. This section also looks at heterogeneity in effects by industry and types of workers, as well as various robustness checks. Section 4 examines the effects of international students on local job flows and their distributional implications. Section 5 concludes.

⁶Some exceptions exist. [Bodvarsson, Van den Berg, and Lewer \(2008\)](#) examine the 1980 "Mariel boatlift" and find strong increases in spending and labor demand in Miami's retail sector following the massive, sudden influx of Cuban immigrants. [Olney \(2015\)](#) studies remittances as a source of variation in immigrants' spending in local economies and identifies negative effects of remittance outflows on natives' wages in Germany. [Hong and McLaren \(2015\)](#) document positive effects of immigration on the diversity of local services offered, as well as employment and wages in the local non-tradable sector in the US. Lastly, [Dustmann, Schönberg, and Stuhler \(2017\)](#) suggest that when the demand channel is suppressed, such as in the case of Czech workers who commuted across the Germany-Czech border to work and did not live and consume in affected areas, an immigration-induced increase in local labor supply could result in significant negative effects on natives' employment and wages in the short-run.

⁷For recent reviews of this literature, see [Blau and Kahn \(2015\)](#), [Dustmann, Schönberg, and Stuhler \(2016\)](#), and [Blau and Mackie \(2017\)](#).

2 Data

This paper draws on various data sources to measure foreign enrollment and construct individual and establishment outcomes at the local labor market level. In this section, I briefly discuss each data source and summarize the most relevant features for my analysis. As a starting point, I use the concept of commuting zones developed by [Tolbert and Sizer \(1996\)](#) to approximate local labor markets. These geographic units represent clusters of US counties characterized by strong commuting ties within each cluster and have the advantage of being nationally comprehensive. This is important because alternative measures of local labor markets that have been used in the immigration literature, such as metropolitan statistical areas (MSAs), typically focus on large population centers and thus exclude small rural college towns where demand shocks generated by international students might prove relatively more impactful.⁸ Furthermore, weak between-cluster commuting ties ensure that both the incidence and the effects of local demand shocks generated by international students are better contained within a commuting zone, especially if increases in local demand primarily affect the non-tradable sector. Accordingly, my empirical analysis focuses on 722 commuting zones that cover the entire US continental territory.

2.1 International students

Data on international students come from administrative records provided by the US Department of Homeland Security (DHS) via a Freedom of Information Act (FOIA) request. These records cover the universe of students on F-1 visas who enrolled in a higher education institution in the US between 2003 and 2015. The data contain biographic information of students, including country and city of origin, as well as detailed information regarding their study programs, such as school name and address, program level, and program start and end dates.⁹

⁸Examples of recent migration studies that use commuting zones as the units of analysis include [Smith \(2012\)](#) and [Derenoncourt \(2022\)](#).

⁹As part of the Illegal Immigration Reform and Immigrant Responsibility Act of 1996, the DHS were mandated by US Congress to collect and maintain current information on all international students throughout their courses of

I use these data to measure the size of the international student population in each commuting zone by year. Specifically, using program start and end dates, I define foreign enrollment in a commuting zone-year as the total number of international students enrolled in a postsecondary institution within that commuting zone for any part of the year. Although these administrative data capture the entire international student population of interest, some limitations may introduce measurement error. For example, there is no information on students' places of residence. While unlikely, some students may have commuted long distances to schools and did not reside within the same commuting zones as their programs. Moreover, many students may have terminated their studies before the reported program end dates, either to transfer to a new program or leave the US. Consequently, OLS estimates of the economic impacts of international students may be biased due to these data limitations.

As discussed in the next section, I use a shift-share instrumental variable estimation strategy to address measurement error and other endogeneity issues related to the distribution of international student enrollment across commuting zones and time. This approach involves isolating plausibly exogenous variation in the inflows of students from different countries of origin into the US using postsecondary enrollment patterns observed in Australia, Canada, and the United Kingdom. Data used to measure origin-specific foreign enrollment in these three countries come from the Australian Department of Home Affairs (DHA), Immigration, Refugees and Citizenship Canada (IRCC), and the UK Higher Education Statistics Agency (HESA).

2.2 Natives' employment, wages, and educational attainment

For my main analysis, I use American Community Survey (ACS) data from 2005 to 2016, extracted from the Integrated Public Use Microdata Series (IPUMS), to construct local labor market outcomes ([Ruggles et al. 2022](#)). Focusing on working-age individuals (16–64) who are not

study. Schools have the legal responsibility to submit the necessary documentation to a US government electronic database called SEVIS (Student and Exchange Visitor Information System) upon admitting a student and before they can apply for a visa and gain entry into the US.

living in institutionalized group quarters, I first identify commuting zones of residence based on respondents' county of residence, which is available for over half of the IPUMS sample. For respondents without county identifiers, I assign commuting zones using Public Use Microdata Area (PUMA) information. Because a PUMA may cross commuting zone boundaries, I use a statistical procedure employed by [Smith \(2012\)](#) and [David and Dorn \(2013\)](#) to obtain consistent estimates of commuting zone outcomes. This procedure involves duplicating observations from PUMAs that overlap with multiple commuting zones and re-weighting these observations according to the fraction of a PUMA's population that is estimated to reside within each commuting zone.

I focus on the (working-age) employment-to-population ratio and average hourly wages among those working at least 35 hours a week as the main outcomes. Total wage and salary earnings in the previous 12 months as well as the product of the number of weeks worked and the usual number of hours worked per week are first aggregated to the commuting zone level. Average hourly wages are then calculated by dividing total wage and salary earnings by the estimated number of hours worked in a commuting zone. All wages are inflated to the year 2020 using the Bureau of Labor Statistics' Consumer Price Index.

In addition to employment and wages, I also examine whether changes in labor market opportunities induced by international students may affect natives' incentives to invest in education, particularly the decisions to attend college by young adults ([Charles, Hurst, and Notowidigdo 2018](#)). For this analysis, I use administrative survey data from the Integrated Postsecondary Education System (IPEDS). For each commuting zone, I calculate the total number of first-time, first-year, degree-seeking domestic students enrolled in the fall, looking separately at the two-year and four-year levels. I then divide these numbers by the size of the local 18-25 adult population to measure enrollment per capita.¹⁰ Lastly, I also use ACS data to construct a set of covariates that control for changes in commuting zone characteristics.”

¹⁰Data on commuting zone population come from the Survey of Epidemiology and End Results (SEER).

2.3 Job flows

To measure local job flows, I leverage both aggregate data from US Census Business Dynamics Statistics and annual establishment-level time-series data from the Your-Economy Time Series (YTS) database, the latter of which is maintained by the Business Dynamics Research Consortium (BDRC) at the University of Wisconsin. The YTS attempts to track all in-business establishments at their unique locations across the US every year, commencing from 1997. This encompasses establishments that are intent on conducting commercial activities or have a physical location, including for-profit, non-profit, and government establishments.¹¹ An important advantage of the YTS data lies in the availability of establishment-level sales and employment information, which allows me to conduct heterogeneity analysis by establishment performance. To this end, I restrict my YTS sample to all for-profit establishments that were in operation at some point between 2004 and 2016 and have existed for at least two years in the database. Additionally, I exclude those with less than two employees to avoid nonemployer businesses. Further details on variable construction are discussed in Section 5.

3 Empirical Methodology

My empirical analysis exploits variation in the distribution of international students across US commuting zones between 2005 and 2015 to study their effects on local labor markets and establishments. Figure 3 depicts the cross-sectional distribution of students in 2005 (panel A) and the average annual change in enrollment over the entire 2005-2015 period (panel B) across commuting zones.¹² As shown, there are considerable spatial differences in the number of students attending universities and colleges in each commuting zone. Within the study period, commuting zones that were initially popular destinations appeared more likely to sustain strong enrollment

¹¹Holding companies and those created for tax purposes are excluded from the YTS. For more description of the database, see <https://wisconsinbdrc.org>.

¹²See appendix table A1 for a tabulation of summary statistics.

growth subsequently over the long term. In this section, I first describe the estimation equation and discuss the challenges associated with the spatial correlation approach. I then introduce an instrumental variable estimation strategy aimed at addressing these issues and provide evidence that supports the validity of the approach.

3.1 Estimation equation

To examine how local labor markets and establishments respond to an increase in foreign enrollment, I estimate specifications of a stacked first-difference model that has been used in the immigration literature (e.g., [Monras 2020](#))

$$(1) \quad \Delta y_{c,t+1} = \gamma_t + \beta \frac{\Delta IS_{c,t}}{Pop_{c,t-1}} + \Delta X'_{c,t} \Gamma + \Delta \epsilon_{c,t}$$

where $t \in [2006, 2015]$, $\Delta z_t = z_t - z_{t-1}$, and γ_t denotes a vector of year fixed effects. The main explanatory variable of interest, $\Delta IS_{c,t}/Pop_{c,t-1}$, is the period change in the number of international students enrolled in a postsecondary institution in commuting zone c standardized by the size of the commuting zone's working-age population at the beginning of the period. This specification thus allows the effects of changes in international student enrollment to vary by the size of the local economy while avoiding the potential pitfalls that arise when there are changes in the local population due to migratory responses by natives.¹³ Furthermore, the lag structure of the independent variables accommodates a short delay before the effects of international students on workers and establishments can be observed.

Since I estimate my econometric model in stacked first differences, any unobserved time-invariant heterogeneity across commuting zones will be removed without imposing more restrictive assumptions on the error structure.¹⁴ To further account for potentially confounding changes

¹³An alternative specification that has also been used in literature regresses changes in the outcome on changes in the *population share* of immigrants (or international students in this case), though results will be mechanically biased if there are migratory responses by natives as a result of immigration ([Card and Peri 2016](#)).

¹⁴A fixed-effect specification assumes no serial correlation in the error term while first-difference estimators are more efficient if the errors follow a random walk ([Wooldridge 2010](#)). In practice, I cluster standard errors on commut-

in underlying local economic conditions, I include a large set of covariates, X_{ct} , that control for changes in commuting zone characteristics. These include log population; the share of females; the shares of the population over 64 years old; the shares of the population by education (some college, college or professional degree, and advanced degrees); and the share of non-citizen workers in the population. Finally, as discussed below, in IV specifications where changes in foreign enrollment are predicted by a shift-share instrument, I also include the sum of exposure shares interacted with period fixed effects as controls. With some exceptions, all regressions are weighted by commuting zone population in 2005.

3.2 Identification challenges

The main difficulty in estimating β , which captures the short-term effects of international students on local labor markets and firms, is to account for bias associated with the potentially endogenous distribution of international students across commuting zones and time. For example, enrollment by international students could be driven by negative local economic shocks. Recent studies have identified economic recessions and the resultant declines in state support for higher education as strong drivers of international enrollment ([Bound et al. 2020](#); [Bound et al. 2021](#)). [Bound et al. \(2020\)](#) find a 10 percent decrease in state appropriations results in a 16 percent increase in the enrollment of students from overseas at public research universities and a 22 percent increase at the more resource-intensive Association of American Universities (AAU) institutions. To the extent that areas hardest hit by a recession also experienced the sharpest declines in state support for higher education, OLS estimates of the effects of international students on local economies will be biased downward.

On the other hand, the arrival of students from overseas into a commuting zone can also be driven by positive local labor demand shocks. This particular concern has often plagued the immigration literature because areas experiencing strong growths in labor demand also tend to attract

ing zones to obtain estimates robust to either structure.

more foreign-born workers. If international students can predict these positive shocks and account for the increases in accessibility to local training and employment opportunities upon graduation when making enrollment decisions, OLS estimates of their effects on local economies could also be biased upward.¹⁵

In addition to the endogenous sorting of international students across commuting zones, measurement error in the size of the foreign student population may further complicate identification. As mentioned in the previous section, the obtained administrative data, despite being the best data source available that tracks international students in the US, do not contain information on the actual termination date of a student's course of study. Consequently, the estimated number of students present in a commuting zone each year, which I construct using students' anticipated program end dates, might overstate the actual number if some students left their programs early, resulting in a downward bias.

3.3 Instrumental variable approach

To address biases resulting from the endogenous distribution of international students, I use a shift-share instrumental variable approach that isolates the plausibly exogenous, supply-driven variation in enrollment. I isolate this supply-driven component by using observed changes in the combined number of international students from each country of origin that enrolled in a higher education institution in three other leading English-speaking destinations, Australia, Canada, and the United Kingdom, which collectively host an almost equal number of international students as does the US. The average pairwise correlation coefficient between US inflows and inflows in these three destinations over the 2005-2015 period across different origins is about 0.7, which suggests the existence of a common set of factors that exert strong influences on the total supply of students wishing to study abroad from each source country. For example, these could be underlying changes

¹⁵Ruiz (2014) suggests that, among international students who engaged in temporary post-graduation employment through Optional Practical Training (OPT) between 2008 and 2012, about 45 percent remained in the same metropolitan area where they studied. Similarly, Beine, Peri, and Raux (2023) suggest that foreign graduates who transition into the US labor force typically secure their first job in the same state where they completed their study programs.

in demographics, family income, and/or institutional background within each source country. Indeed, [Khanna et al. \(2023\)](#) show that the rise in the number of international students from China, which accounted for much of the increase in global outflow, was largely driven by growth in family income and, therefore, students' ability to afford an education abroad. Hence, fluctuations in the number of international students studying in Australia, Canada, and the UK are strong predictors of the realized changes in enrollment in the US across origins but are arguably not related to pull factors that arise from changes in local economic conditions in the US. Furthermore, students from each country of origin tend to apply to the same programs that previous cohorts have attended ([Beine, Noël, and Ragot 2014](#); [Shih 2017](#)). Accordingly, this network tendency causes supply shocks from each source country to have differential effects across US commuting zones that vary with the strength of the network.

To implement these ideas, I construct my instrument by interacting the distribution of international students by country of origin across commuting zones in 2003 with observed period changes in combined enrollment from each country of origin in Australia, Canada, and the UK. Specifically, let k denote a country of origin, the predicted change in enrollment in commuting zone c from $t - 1$ to t is taken as

$$(2) \quad \widehat{\Delta IS}_{c,t} = \sum_k \frac{IS_{c,k,2003}}{IS_{k,2003}} \times \Delta IS_{t,k}^{\text{Australia, Canada, UK}}$$

where $\Delta IS_{t,k}^{\text{Australia, Canada, UK}}$ is period change in the enrollment of international students from country k in the three mentioned destinations. The share component, $\frac{IS_{c,k,2003}}{IS_{k,2003}}$, is the fraction of students from country k that ever enrolled in a US higher education institution in commuting zone c within the 2001-2002 period. This instrumental variable estimation approach is thus similar in spirit to a growing number of studies in the immigration literature that use supply-push factors as the shift component ([Card 2001](#); [Stuen, Mobarak, and Maskus 2012](#); [Peri, Shih, and Sparber 2015](#); [Shih 2017](#); [Monras 2020](#); [Derenoncourt 2022](#)), and is most closely related to [Stuen, Mobarak, and Maskus \(2012\)](#) who also use foreign enrollment at non-US destinations to predict enrollment in

the US.

3.4 Validity of the instrument

For the instrumental variable estimation approach to work, the constructed shift-share instrument must satisfy the relevance and exclusion restrictions. Here, I address these two conditions before briefly discussing issues related to statistical inference.

Relevance restriction.—As mentioned, there is a strong correlation between changes in foreign enrollment across countries of origin between the US and the other three English-speaking destinations, driven by significant underlying increases in the supply of internationally mobile students, particularly from emerging markets (appendix figure B1). In a simple regression not reported here, yearly changes in combined total enrollment in Australia, Canada, and the UK explain more than half of the variation in changes in US enrollment across all countries of origin between 2005 and 2015. Figure 4 depicts the first-stage relationship between the predicted and actual changes in international student enrollment, both adjusted by start-of-period commuting zone population, via a binned scatterplot. The obtained F-statistic is 57.2, suggesting that my instrument provides a sufficient source of identifying variation.

Exclusion restriction.—Recent work by Borusyak, Hull, and Jaravel (2022; hereafter BHJ) shows how identification based on shock exogeneity can be achieved with a shift-share research design, as applied in this setting.¹⁶ Specifically, since the sum of exposure shares, $\sum_k \frac{IS_{c,k,2003}}{IS_{k,2003}}$, varies across commuting zones and is likely endogenous, BHJ’s equivalence results suggest that consistent estimates can be obtained as long as the following two conditions are met: (1) the shifters are “idiosyncratic,” and (2) a simple adjustment is made by either controlling for the sum of exposure shares or constructing a recentered instrument that subtracts the sum from the original formula. In other words, with this adjustment, the constructed shift-share instrument can be used to identify causal effects, provided that changes in foreign enrollment in Australia, Canada, and the

¹⁶See Goldsmith-Pinkham, Sorkin, and Swift (2020) for a discussion of settings in which identification rests on exogenous shares.

UK are orthogonal to (share-weighted) unobserved factors affecting local labor market conditions in the US.

To assess the plausibility of the identifying assumption, I first conduct falsification tests of shock orthogonality using BHJ's prescribed shock-level regressions. This exercise involves averaging past changes in commuting zone characteristics and labor market conditions (outcomes) and future changes in foreign enrollment (treatment), using exposure shares as weights, to obtain country-of-origin-level aggregates. The aggregated outcome variables are then regressed on the aggregated treatment variable with changes in foreign enrollment in non-US destinations used directly as an instrument. The outcomes analyzed include past changes in state appropriations per public full-time equivalent (FTE) student, the share of foreign-born workers with a college degree in the population, the working-age employment-to-population ratio, and average wages. If changes in foreign enrollment outside the US are as-good-as-randomly assigned, they should not predict these predetermined variables. Indeed, panel A of table 1 indicates that there is no significant correlation between future changes in foreign enrollment, as predicted by shocks in non-US destinations, and past changes in commuting zones' characteristics.

Next, I perform falsification tests of the exogeneity of the shift-share instrument, which follows from shock orthogonality according to BHJ's equivalence results. In panel B of table 1, I present both OLS and IV estimates obtained from regressing past changes in commuting zones' outcomes on future changes in foreign enrollment, controlling for a full set of second-stage covariates. OLS estimates suggest that commuting zones experiencing increases in foreign enrollment tend to also experience, in prior years, decreases in state funding for higher education, increases in high-skilled immigrants, increases in employment, and decreases in average wages. By contrast, the variation in foreign enrollment generated by the shift-share instrument exhibits no significant correlation with these outcomes. Taken together, these results support the validity of the instrument that rests on the quasi-randomness of changes in foreign enrollment in non-US destinations across countries of origin.

Statistical inference.—[Adao, Kolesár, and Morales \(2019\)](#) demonstrate that a shift-share in-

strumental variable design, such as the one used in this setting, might yield standard errors that are too conservative if regression residuals are somehow correlated across commuting zones (e.g., among those with similar share profiles). To explore the robustness of conventional clustered standard errors, I follow the randomization procedure as conducted in [Adao, Kolesár, and Morales \(2019\)](#), where I randomly generate non-US enrollment shocks (i.e., the shift components) using a normal distribution then interact these simulated shocks with the original shares to construct the instrument and re-estimate equation 1. I repeat this procedure 5,000 times each for commuting zone employment-to-population ratios and average wages. Reassuringly, I obtain significant estimates at the 5% level in only 9 iterations for employment and 10 iterations for wages. These results suggest that using conventional robust standard errors clustered at the commuting zone level is unlikely to lead to over-rejections in my setting.

4 Effects of International Students on Local Employment and Wages

In this section, I quantify the impacts of international student enrollment on local labor markets. I first focus on overall employment and wage effects, then examine heterogeneity across industries and types of workers to shed light on the nature of labor demand shocks that may take place due to potential surges in local consumption generated by international students. To conserve space, I only report OLS and IV estimates for the main analysis. While OLS estimates generally have the same signs as their IV counterparts, only the latter are economically and statistically significant across specifications.

4.1 Overall employment and wage effects

In table 2, I report the results obtained from estimating equation 1 for employment and wage outcomes. Panel A presents the overall results, while panels B and C provide separate estimates for men and women. The OLS estimates in column 1 suggest that an increase in foreign enrollment by one student per thousand residents raises the overall employment-to-population ratio by 0.05 percentage points. The corresponding increases among men and women are 0.07 and 0.03 percentage points, respectively, though none of these OLS estimates are significant at the 5 percent level. In contrast, the corresponding IV estimates are 0.19, 0.20, and 0.19 percentage points, all of which are strongly statistically significant and economically substantial. Given a one standard deviation change in foreign enrollment of 0.79 students per thousand residents across commuting zones, my IV estimates imply a one standard deviation increase in foreign enrollment is associated with a 0.15 percentage point increase in the local employment rate. Furthermore, the overall increase in foreign enrollment during the study period may have led to the creation of 1.17 million jobs, which is equivalent in magnitude to about 49-59% of the displacement impact stemming from the increase in import competition from China between 1999 and 2011 ([Acemoglu et al. 2016](#)).

These employment effects, though substantial, are plausible for several reasons. First, as shown below, the amount of resources students bring into a local economy is a key determinant of the size of their impact. A portion of students' spending goes directly toward paying for tuition and fees, which have been shown to have a large effects on local employment and earnings. For instance, [Kantor and Whalley \(2014\)](#) find that each dollar increase in university spending generates an 89-cent increase in non-education labor income, implying a multiplier of approximately 1.9 for university-related activity. Additionally, students' spending on accommodation leads to higher housing prices ([Mocanu and Tremacoldi-Rossi 2023](#)), which further increases local labor demand ([Charles, Hurst, and Notowidigdo 2018](#)). Consequently, my estimates capture both the direct effects of students' expenditures on local goods and services, as well as indirect effects from increased natives' earnings and housing values. As a back-of-the-envelope calculation, approxi-

mately 1.3 million international students were enrolled in U.S. higher education in 2018, generating an estimated \$47.3 billion in education-related revenue. Assuming a multiplier of 1.9 and an employment impact of 2.47 million jobs, these figures imply a cost per job created of \$36,384, which is very close to a recent finding of \$30,000 from the literature ([Serrato and Wingender 2016](#)).

Turning to wage effects, columns 3 and 4 present the effects of international students on local (log) average wages. Both OLS and IV estimates are positive and strongly significant in this case, though IV coefficients are larger in magnitude across the board. The IV results (column 4) suggest that one additional international student per thousand residents increases overall average wages by 0.48 percent, with corresponding increases of 0.46 percent for men and 0.54 percent for women.

Given the sizable impact of international students on local employment, some portion of the observed increase in average wages may reflect changes in the composition of local workers rather than the increased returns from working. To address this complication, I consider an alternative measure of wages that explicitly accounts for changes in the composition of local workers. Specifically, I first regress individual log wages on a set of characteristics, including a quadratic in potential experience, educational attainment (some college, college or professional degrees, and advanced degrees), gender, race (white, black, Hispanic, and Asian), and commuting zone fixed effects, then use the aggregated residuals at the commuting zone level as my measure of average wages. As shown in columns 5 and 6, both OLS and IV estimates remain very similar to those obtained using unadjusted wages as the outcome. The stability of the wage effects implies that most of the observed impact of international students on local earnings reflects better local labor market conditions instead of mere changes in the composition of local workers.

Are these findings the results of positive demand shocks arising from students' spending in local economies? As mentioned earlier, the growth in foreign enrollment between 2005 and 2015 was primarily driven by an increase in the number of self-funded students. To the extent that a student's total funding, as reported in the administrative i20 data, reflects his or her family's financial capacity and serves as a good proxy for potential local spending, one can utilize this information to explore heterogeneity in local labor market effects by the magnitude of local demand shocks. Table

3 presents the results of this analysis. Columns 1 and 2 report estimates obtained from separately examining labor market effects in commuting zones that experienced larger versus smaller period changes in the average amount of total funding per student, respectively. As expected, the positive effects of an increase in foreign enrollment on local employment and wages are notably stronger among commuting zone-years that experienced above median changes in average funding per student. By contrast, there is a negative, though statistically insignificant effect of foreign enrollment on local employment among areas with decreases in average funding per student. In appendix table A2, I further explore the potential labor supply contribution of international students in the short-run by regressing changes in the population share of working non-citizens who are enrolled in a higher education institution, calculated using ACS data, on foreign enrollment. Consistent with visa restrictions on employment for students in their first academic year, the results in column 1 show no significant change in the employment rate of this group immediately following an enrollment increases. There is a modest rise after two years (column 2), though the point estimate is very small and only significant at the 10 percent level. Overall, these results indicate that the observed impact of international students on local labor markets operate large through demand-side effects.

I conclude this section with a brief discussion of issues related domestic enrollment. One natural question to ask is whether the short-run impact of an increase in foreign enrollment resembles that of an increase in domestic enrollment. There are two reasons why this might not be the case. As discussed previously, international students studying in the US are in general not allowed to undertake paid work. Moreover, a large portion of domestic students may choose to live with their parents and attend local universities and colleges, which does not lead to a surge in local demand for housing. Hence, the demand effects stemming from an increase in domestic enrollment could be smaller in magnitude and also counteracted by local labor supply increases, leading to smaller net effects. In appendix table A3, I present OLS estimates obtained from regressing labor market outcomes on changes in total domestic enrollment in higher education (overall and out-of-state), calculated from ACS data. As expected, point estimates are much smaller than those provided in table 2 and not distinguishable from zero in the case of employment.

Lastly, are these observed demand shocks the result of an increase in the capacity of US higher education to tap into a large supply of self-funded foreign students, or does foreign enrollment simply crowd out domestic students? In appendix table A4, I explore the effects of international students on first-time, first-year domestic enrollment at two- and four-year programs, separately by sector. While an increase in foreign enrollment does lead to a statistically significant decline in the enrollment of first-time domestic students, this effect concentrates entirely at public, two-year programs, most likely due to improvements in local labor market conditions and thus increases in the opportunity cost of attending community colleges (Charles, Hurst, and Notowidigdo 2018). At the four-year level, there is small negative, but statistically significant, effect on enrollment at private, non-profit institutions, although corresponding point estimates for public institutions and overall are positive, albeit imprecisely estimated. As documented by recent studies in the literature, this latter pattern is most likely attributable to cross-subsidization that takes place within public universities (Shih 2017; Zhu 2024).

4.2 Effects by industry

Which industries are most likely to benefit from the increases in local demand spurred by international students? Construction seems to be a natural candidate, given the increase in housing needs that would stimulate the construction and renovation of rental apartments. Furthermore, spending on personal items, groceries, entertainment, and social gatherings, besides education and healthcare, should further contribute to the local demand for labor in retail, transportation, and services.

Figure 5 shows the effects of international students on local employment in different industries, both overall and separately for men and women. I provide point estimates and confidence intervals obtained from IV specifications that are similar to the one estimated in column 2 of table 2, with the outcomes here being changes in the industry-specific employment share of the population. In line with expectations, construction accounts for a large portion of the impact of

international students on local employment. The IV estimate suggests that an increase of one additional international student per thousand residents leads to a 0.10 percentage point increase in the share of population employed in construction. The remaining portion of the employment effect can be attributed to service industries including education and healthcare (0.08 points), leisure and hospitality (0.07 points), professional and business services (0.04 points), and finance, real estate, and insurance (0.02 points), though some of the latter estimates lack precision due to the small sample size. Note that the combined increase in employment shares in these industries exceeds the net effect of international students on local employment reported in section 4.1 because of some between-industry reallocation of labor away from manufacturing.¹⁷ Overall, these results demonstrate that the observed positive impact of foreign enrollment on local employment is driven almost entirely by labor demand shocks in the non-tradable sector.

4.3 Effects by education and age

The observed effects of international students on local industry employment suggest that both college- and non-college-educated workers should experience an improvement in labor market conditions. Positive labor demand shocks in construction, retail, and personal services would likely translate into substantial employment and wage increases among workers without a college degree. Likewise, increased labor demand in education, healthcare, professional, and business services, which collectively employ about half of college-educated workers, should also result in better labor market outcomes among college-educated workers.

Figure 6 summarizes the effects of international students on local employment and wages for workers with and without a bachelor's degree. While the results confirm the above intuitions, it appears somewhat surprising that the point estimates are slightly larger for college-educated workers, given that construction, retail, and personal services bear most of the local employment impact of an increase in foreign enrollment. There are at least three potential explanations for why this

¹⁷I discuss the effects of international students on between-industry and within-industry labor reallocations in detail in section 5.

is the case. First, some of the observed increases in labor demand among non-college workers in these industries might be offset by a reallocation of labor away from manufacturing, agriculture, and extraction. Second, as shown later in section 5, demand shocks generated by international students also lead to substantial labor reallocations within industries from seemingly low-productivity to high-productivity establishments. To the extent that more productive firms employ a relatively higher share of skilled workers (Engbom and Moser 2017) or that more educated workers face relatively lower adjustment costs (Dix-Carneiro 2014), such reallocations could contribute to the higher net increase in employment among college-educated workers. Third, as discussed, increases in foreign enrollment also result in labor supply adjustments among young natives in the short run, whereby improvements in local labor market opportunities reduce first-time, full-time enrollment of natives at public, two-year colleges. Accordingly, the endogenous labor supply adjustments of natives toward labor force participation and away from college training could further offset the initial effects of international students on non-college workers' employment and earnings.

Turning to the employment and wage effects for workers in different age groups, I consider young (16-29), middle-aged (30-49), and older workers (50 and above). The results summarized by figure 7 indicate that an increase in foreign enrollment has similar effects on employment and earnings across these three groups.

Taken together, the broad pattern of results discussed in this section provides strong evidence for the existence of positive local labor demand shocks induced by increases in the enrollment of international students. These shocks are concentrated in the non-tradable sector, and significant across different types of workers. While these findings highlight the immediate economic benefits of international students through increased local employment and earnings, they also raise questions about potential longer-term effects. Specifically, the observed labor market dynamics may trigger changes in local business environments that could lead to sustained improvements in aggregate productivity. The next section explores this possibility by examining how international students affect local job flows and labor reallocation across establishments. Before moving on, I briefly discuss the robustness of the main results presented in this section to alternative sample

restrictions and measures of foreign enrollment.

4.4 Robustness checks

In appendix table A5, I assess the robustness of my baseline estimates to several alternative sample restrictions. One concern with the baseline results is that native workers' migratory responses may counteract the initial effects of the labor demand shocks (Blanchard et al. 1992; Bound and Holzer 2000; Cadena and Kovak 2016; Monras 2020; Notowidigdo 2020). Though such responses are unlikely to be strong in the short run, they could render my baseline estimates lower bounds of the true effects. I follow Charles, Hurst, and Notowidigdo (2018) and address this concern by constructing employment and wage outcomes using a sample of natives living in their state of birth—those who are less likely to have moved across labor markets for employment reasons. Panel A presents IV estimates for this sample, which are nearly identical to baseline estimates. These suggest that endogenous migration is not an overly important concern in this setting, especially given the recently documented evidence on US citizens' low and declining mobility rates at the state and commuting zone level (Basso and Peri 2020). In panels B and C, I repeat the baseline analysis but exclude either the top 10% of commuting zones with the highest number of international students or those with no international students in 2005. The corresponding IV estimates of the employment and wage effects of international students remain similarly positive and statistically significant, suggesting it is unlikely that any particular commuting zone is driving the observed results.

In appendix table A6, I consider the robustness of my baseline results to alternative measures of foreign enrollment. In panel A, I present results from estimating equation 1 using an alternative shift-share instrument that leverages changes in foreign enrollment across all non-US destinations, calculated from aggregate UNESCO Institute of Statistics data. This approach serves two main purposes. First, it mitigates concerns about unobserved US-specific shocks that could affect foreign enrollments in particular destinations, such as Australia, Canada, and the UK. Second, to the

extent that my baseline results capture local average treatment effects, using an alternative instrument based on global enrollment patterns may be more informative of average treatment effects. As shown, however, the results remain virtually unchanged despite a drop in the first-stage F-statistics. In panel B, I exclude graduate students from my measure of foreign enrollment. The obtained IV estimates are larger than the baseline, suggesting that my results are not picking up the effects of high-skilled immigration. In panel C, I exclude the largest group of foreign students in the US— those from China. The obtained estimates remain positive and statistically significant, indicating that my baseline results are not driven solely by the effects of Chinese students.

5 Effects of International Students on Local Job Flows

Another important benefit that an increase in international student enrollment could provide to local economies, in addition to the employment and wage impact documented in the previous section, is improvements in aggregate productivity. One channel through which these improvements may occur is a between-firm selection process by which labor and market share are reallocated toward more efficient establishments as demand shocks generated by international students heightens competition in potentially both the product and labor markets.¹⁸ In particular, spending on local goods and services by international students would likely stir entry and expansion among establishments that are potentially most capable of taking advantage of local demand shocks. Increased competition for market share and labor leads to a reduction in average mark-ups (Melitz and Ottaviano 2008) as well as a rise in real wages (Melitz 2003), forcing the least productive establishments to shrink or exit altogether. In light of these theoretical possibilities, this section examines the effects of international students on local job flows and discusses their distributional implications.

I begin the empirical analysis in this section by decomposing the net employment impact of

¹⁸Aggregate productivity gains could also occur through within-establishment efficiency improvements, though documenting such dynamics is outside the scope of this study. See Syverson (2011) for a recent discussion of this literature.

international students, as analyzed in section 4, into effects on gross job flows. To do so, I turn to aggregate data from the BDS as well as establishment-level data from the YTS to measure annual changes in employment due to establishment entry, exit, expansion, and contraction at the commuting zone level. Excluding a minimal amount of employment change due to business relocations across commuting zones, these job flow components can be related to net employment growth via the following identity

$$(3) \quad \frac{\Delta E_{c,t}}{\bar{P}_{c,t}} = \underbrace{\frac{E_{c,t}^{\text{entry}}}{\bar{P}_{c,t}} - \frac{E_{c,t}^{\text{exit}}}{\bar{P}_{c,t}}}_{\text{Extensive margin}} + \underbrace{\frac{E_{c,t}^{\text{expansion}}}{\bar{P}_{c,t}} - \frac{E_{c,t}^{\text{contraction}}}{\bar{P}_{c,t}}}_{\text{Intensive margin}}$$

where $\bar{P}_{c,t} = (P_{c,t-1} + P_{c,t})/2$ is the mid-point non-institutionalized population aged 16 and above and not living in group quarters of commuting zone c between $t - 1$ and t , computed using ACS data. $E_{c,t}^{\text{entry}}$ and $E_{c,t}^{\text{exit}}$ are gross job creation and destruction along the extensive margin due to establishment entry and exit, respectively, and $E_{c,t}^{\text{expansion}}$ and $E_{c,t}^{\text{contraction}}$ analogously defined along the intensive margin due to establishment expansion and contraction. Similar to the analysis in the previous section, I first estimate regression equation 1 using net employment growth and each of the four job-flow components in equation 3 as the outcomes. I then explore heterogeneity by industry and establishment performance.

5.1 Overall effects on local job flows

Table 4 presents OLS and IV estimates of the effects of an increase in foreign enrollment on net employment growth (row 1) and local job flows (rows 2-5), where each reported coefficient comes from a separate regression. By construction, the coefficients on foreign enrollment from job flow regressions sum up to those from the net growth regressions. Columns 1-4 report estimates of the effects of an increase in foreign enrollment on local net employment growth and gross job flows across all industries. Both OLS and IV estimates for net employment change, obtained through analyzing BDS (columns 1 and 3) and YTS (columns 2 and 4) data, are statistically significant and

similar in magnitude to the estimated effects on the employment-to-population ratio, which are analyzed in the previous section using ACS data. Here again, IV coefficients are larger than their OLS counterparts and imply that one additional international student per thousand residents leads to a net increase in local employment equivalent to 0.17-0.20 percent of the population.

Turning to the overall effects on local job flows, the results suggest that international students have a large and positive impact on local business dynamism in the short run. The IV estimates indicate that an increase in foreign enrollment results in not only job creation due to establishment entry and expansion but also substantial job destruction due to establishment exit and contraction. These coefficients are generally larger in magnitude compared to the net growth coefficients, suggesting that international students lead to gross job reallocations that are 6-15 times larger than the net effects. These findings are consistent with the existing literature, which has shown that net employment changes can mask substantial labor market activity (Davis et al. 1996; Davis, Faberman, and Haltiwanger 2012).

The positive and significant impact of international students on both the creation and destruction of jobs indicates that enrollment-induced local demand shocks reallocate a substantial number of workers from one set of establishments to another. A natural question to ask is whether workers are being reallocated from non-exposed industries to those most impacted by these demand shocks or, instead, from within industries and among establishments that produce broadly similar products and services. As mentioned, within-industry reshufflings of labor may reflect general equilibrium dynamics that have potentially important consequences for the composition of local businesses and aggregate productivity.

In columns 5 and 6, I consider the effects of international students on local employment growth and job flows separately for the traded sector (*Traded*) and the local sector (*Local*), using industry classifications from the US Cluster Mapping Project (Delgado, Porter, and Stern 2016).¹⁹ As shown, the IV estimate for net employment growth in the traded sector is indistinguishable from zero, suggesting that demand shocks generated by international students are unlikely to induce an

¹⁹These classifications, which are applied to 6-digit NAICS, separate industries in which establishments serve external markets from those in which establishments tend to sell goods and services to local markets, respectively.

economically meaningful reallocation toward the local sector. An increase in foreign enrollment has very modest effects on job creation and destruction in this sector. On the other hand, the impact on business dynamism within the local sector is much more pronounced. Here, the estimates concerning gross job-flow components are all strongly significant and much larger in magnitude.

5.2 Effects by industry

A key insight from the results discussed above is that positive demand shocks generated by international students lead to a substantial reallocation of labor within rather than away from the traded sector. This implies that within-industry labor flows likely drive such a reallocation due to Melitz-type general equilibrium effects. Furthermore, the degree to which reallocation occurs should thus depend on the magnitude of the demand shock as well as the costs of adjustment for establishments and workers within each industry.

To shed light on these issues, I examine heterogeneity in the effects of international students on local job flows across more narrowly defined industries. Figure 8 plots coefficients obtained from regressing industry-specific job-flow components on an increase in foreign enrollment using BDS data. The results display a notable pattern: Industries that experience larger effects of international students on job creation (through establishment entry and expansion) also tend to experience larger effects on job destruction (through establishment exit and contraction). Not surprisingly, these effects concentrate in services and retail, industries most impacted by demand shocks and characterized by relatively low costs of entry and/or high labor turnover rates. Results based on YTS data tell a similar story and are presented in appendix figure B2. These patterns are consistent with findings from prior literature showing that a large fraction of labor reallocation occurs within industries (e.g., [Davis and Haltiwanger 1999](#); [Foster, Haltiwanger, and Krizan 2001](#)) and point to heightened competition as the driving force that causes within-industry reallocations among competing establishments.

5.3 Effects by establishment performance

What determines the observed differences in establishments' responses to local demand shocks generated by international students? In particular, why do some establishments enter the market and expand while others within the same industry contract or exit following an increase in foreign enrollment? One possible answer is that not all establishments are equally capable of profiting from the induced demand shocks. An establishment's ability to benefit from an increase in the size of the local market may depend on its location, product and service offerings, and, as well, on how costly it is to scale up production. Thus, establishments that enter and expand are likely to be relatively more productive. At the same time, the resultant increase in competition for market shares and workers should reallocate resources away from the less profitable.

In this section, I construct a measure of establishment performance based on YTS sales data and examine whether the heterogeneous responses to local demand shocks by establishments within the same industry are driven by differences in their performance. My primary objective is to determine whether the observed effects of international students on local job flows are productivity-enhancing via a between-establishment selection process through which the most productive ones survive. In the absence of ideal data to construct a measure of establishment productivity, such as total factor productivity or value-added per worker, I rely on establishment-level growth in total sale volume, which is available for an establishment each year it appears in the YTS data, to measure performance. This measure most likely reflects an establishment's profitability, which is ultimately what selection should be on (Foster, Haltiwanger, and Krizan 2006; Foster, Haltiwanger, and Syverson 2008), rather than productivity per se, though to the extent that an establishment's profitability is correlated with its underlying productivity the evidence presented in this section will provide indirect evidence on the impact of international students on aggregate productivity.

To allow comparability across establishments within an industry, I define each establishment's performance to be the average annual growth rate in total sale volume, calculated using all the years

in which an establishment exists in my sample.²⁰ Specifically, the performance of establishment i is constructed as

$$(4) \quad \text{Performance}_i = \frac{1}{\bar{t} - \underline{t}} \sum_{j=\underline{t}}^{\bar{t}} \frac{\text{sales}_{i,j} - \text{sales}_{i,j-1}}{\text{sales}_{i,j-1}}$$

where \underline{t} and \bar{t} denote the earliest and latest year in which establishment i exists in the sample, respectively.²¹ Based on this measure, I sort establishments within each industry-commuting zone-year into three terciles, where industries are defined by 3-digit NAICS codes, and aggregate job flows in each performance tercile to the commuting zone-year level. This approach thus assumes a single, time-invariant measure of performance for each establishment but allows its ranking to potentially vary across years due to changes in the composition of local businesses.

Table 5 reports IV estimates obtained from regressing job flows in each performance tercile on changes in international student enrollment. Column 1 first reproduces the overall effects of international students on job flows as reported in column 4 in table 4.

Focusing on the effects of international students on job creation due to establishment entry, the results indicate no clear pattern. Specifically, an increase in foreign enrollment results in job creation through establishment entry uniformly across the three performance terciles. This could be because establishments face ex-ante uncertainty about their productivity, which nevertheless can be learned over time through the process of production (Davis and Haltiwanger 1992; Melitz 2003; Melitz and Ottaviano 2008). On the other hand, job creation due to expansions is driven entirely by high-performance incumbents. The IV estimate suggests that one additional student per thousand residents results in a 0.36 percentage point increase in the rate of job creation due to expansion among establishments in the highest performance tercile. This effect is significant at the 1 percent level and explains 82% (0.036/0.044) of the overall effect of international students on job creation through establishment expansion. In stark contrast, the impact of an increase in foreign

²⁰This measure of performance thus assumes it takes time for establishments to realize their productivity (Asquith et al. 2019).

²¹Following the literature, I set the growth rate between t and $t + 1$ to -1 if an establishment exits during this period (e.g., Lentz and Mortensen 2008; Kosova 2010).

enrollment on job destruction is driven mostly by deaths and contractions among low-performance establishments. The IV estimates for exit and contraction in the lowest performance tercile are 0.029 and 0.009, explaining all and 45% of the overall effects, respectively.

Taken together, the various results discussed in this section demonstrate that the growing presence of international students in local US economies may also have led to Melitz-type local aggregate productivity gains in the non-tradable sector. In particular, only a selective set of potentially the most efficient firms seemed able to reap the benefits from enrollment-induced positive demand shocks, whereas increases in competition in possibly both the product market and the labor market forced the least productive firms to shrink or exit altogether. The local labor market effects of an increase in international student enrollment are therefore *not* without distributional consequences. For example, to the extent that more educated, highly skilled workers are more likely to be employed at or reallocated to the most productive firms (Engbom and Moser 2017; Gilje, Taillard, and Zeng 2022) or face lower adjustment costs (Dix-Carneiro 2014) the overall positive impact of international students on local jobs and earnings might also have accentuated the recent rise in wage inequality across workers.²²

6 Conclusion

Rapid growth in income per capita and the concurrent surge in demand for quality education in many emerging economies have led to a staggering increase in the global number of students pursuing higher education outside their home countries, from 2.1 million students in 2000 to 6 million students in 2019 (UNESCO Institute for Statistics 2021). As the leading destination, the US has absorbed a significant portion of this supply shock, currently receiving over a million students and more than 40 billion dollars in higher education revenue alone from abroad each year. These trends have attracted a considerable amount of attention from both economists and policymakers,

²²For recent reviews on the topic of wage inequality, see Katz and Autor (1999), Lemieux (2008), Autor, Katz, and Kearney (2008), and Card et al. (2018).

though little research has been done to systematically assess the broader effects of international students on local economies surrounding US universities and colleges.

Using large-scale administrative and survey data, this paper seeks to narrow this gap by investigating the short-run effects of international students on local labor markets and firms via increases in local consumption. I implement an instrumental variable estimation approach that takes advantage of the supply-push components of changes in US enrollment, proxied by changes in the outflows of international students across countries of origin to other top English-speaking destinations. Through a series of balancing tests, I demonstrate that this strategy allows me to purge foreign enrollment in the US of confounding changes in local economic conditions. My results suggest that international students substantially increase local employment and earnings. In particular, one additional student per thousand residents raises the employment-to-population ratio by 0.19 percentage points and average wages by 0.48%, with most of these effects occurring in construction and services. Interestingly, the economic impact of international students closely mirrors that of an export shock, albeit in the non-tradable sector: As a result of increases in competition in the product and labor markets induced by local demand shocks, an increase in foreign enrollment also leads to substantial within-industry resource reallocations toward high-performance establishments. These results thus imply that the overall increase in the enrollment of international students in US universities and colleges over the past few decades has led to increases in not only employment and earnings but also aggregate productivity in the surrounding local economies.

It is worth emphasizing that my analysis focuses on the short-term effects of an increase in foreign enrollment, which may be larger than long-term effects due to responses from workers and establishments. For example, to the extent that enrollment-induced local demand shocks are persistent in some areas, native workers' migratory responses could be more pronounced over the long term, which would counteract the initial effects of these local shocks ([Monras 2020](#)). Firms facing tighter local labor markets might also start investing in labor-saving technology ([Clemens, Lewis, and Postel 2018](#); [San 2023](#)). Most importantly, a good number of international students will transition into US employment upon graduation, many of whom would likely become an integral

part of the high-skilled workforce. In this case, the labor-supply effects of international students on local US economies, which have traditionally been the primary focus of the broader immigration literature, might prove particularly important ([Hunt and Gauthier-Loiselle 2010](#); [Peri, Shih, and Sparber 2015](#); [Hanson, Kerr, and Turner 2018](#)). These issues are beyond the scope of this study and should be investigated by future research.

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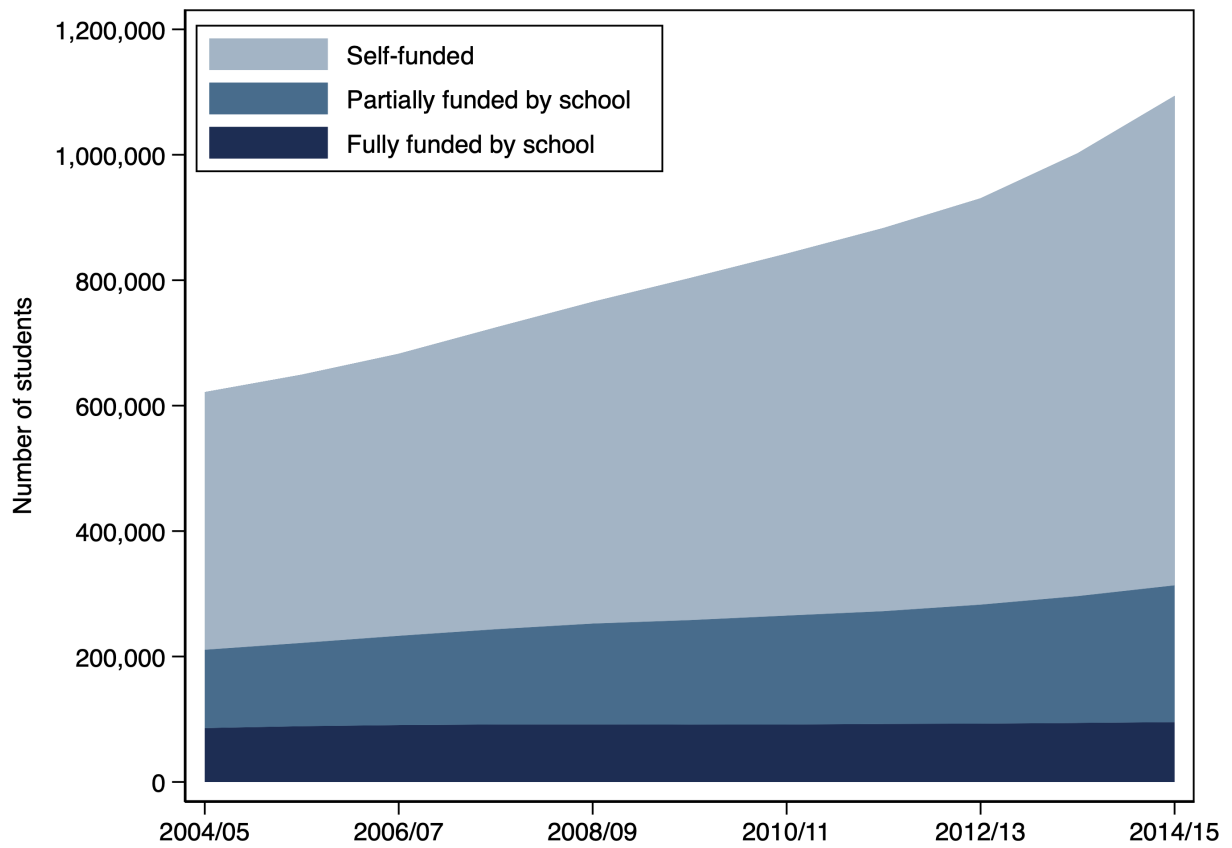
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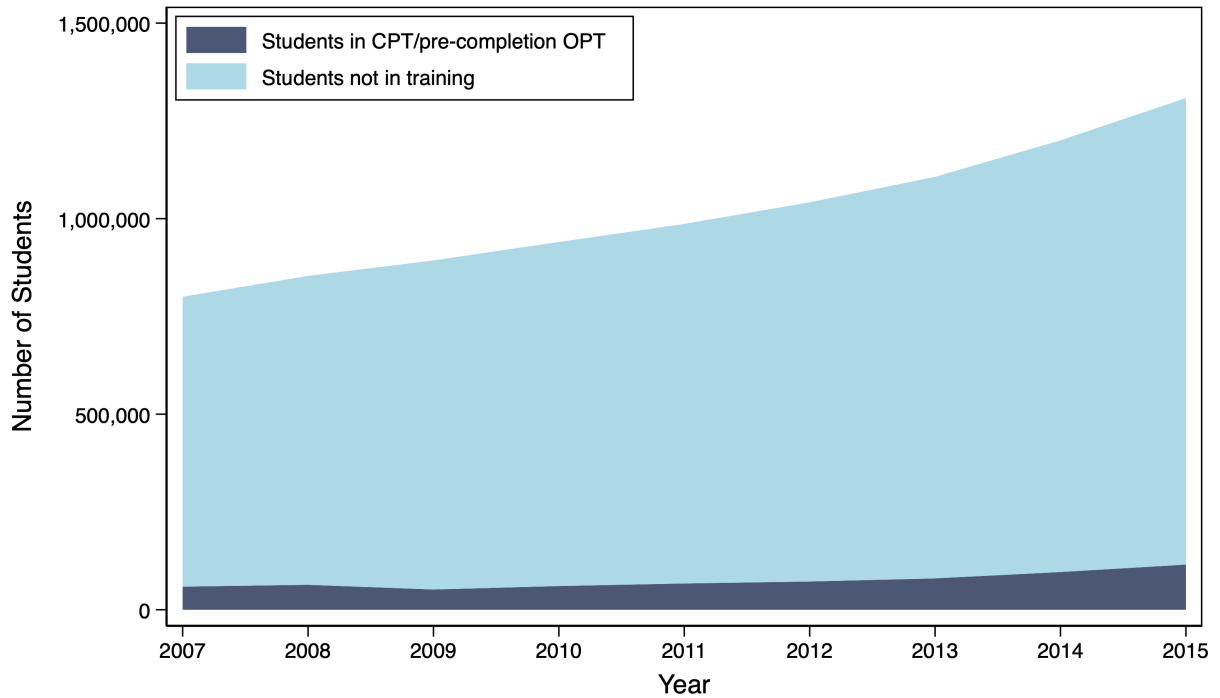
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Figure 1: Trends in International Student Enrollment in US Higher Education by Funding Status.



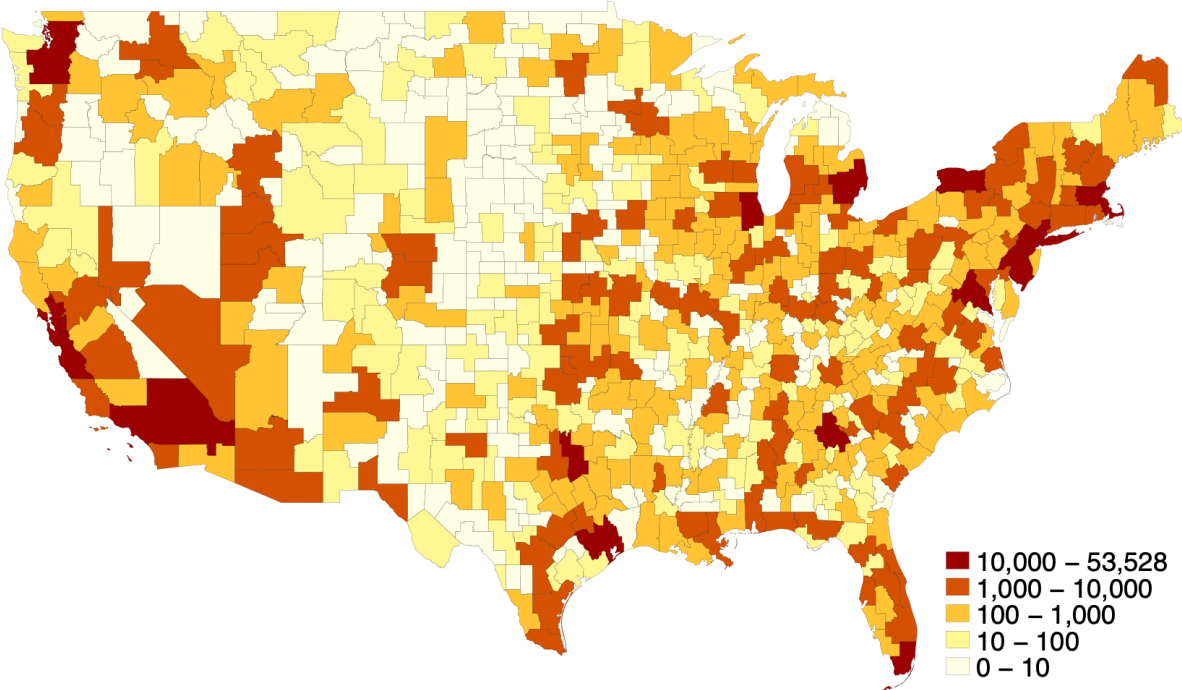
Source: Author's calculations based on administrative data from US Department of Homeland Security (2004-2014).

Figure 2: Foreign Enrollment and Participation in Authorized Employment, 2007-2015

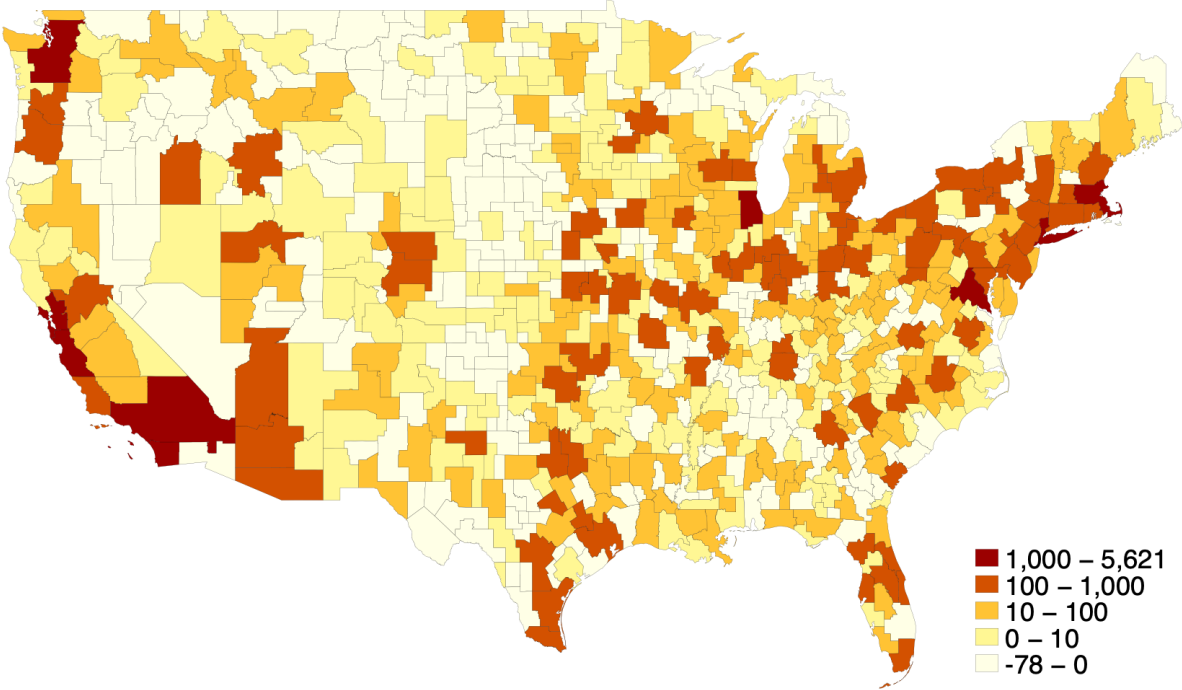


Source: Author’s calculations based on administrative data and reports from the U.S. Department of Homeland Security (DHS). Data on Curriculum Practical Training (CPT) authorizations are sourced from the DHS report, “2007 to 2023 Annual Growth in OPT, STEM OPT, and CPT Authorizations and Employment Authorization Document (EAD) Issuances.” Data on pre-completion Optional Practical Training (OPT) authorizations are drawn from the “Students with Approved OPT from 2006–2016” database, accessed via the U.S. Immigration and Customs Enforcement FOIA library.

Figure 3: Spatial Distribution of International Students in Higher Education Across Commuting Zones, 2005-2015

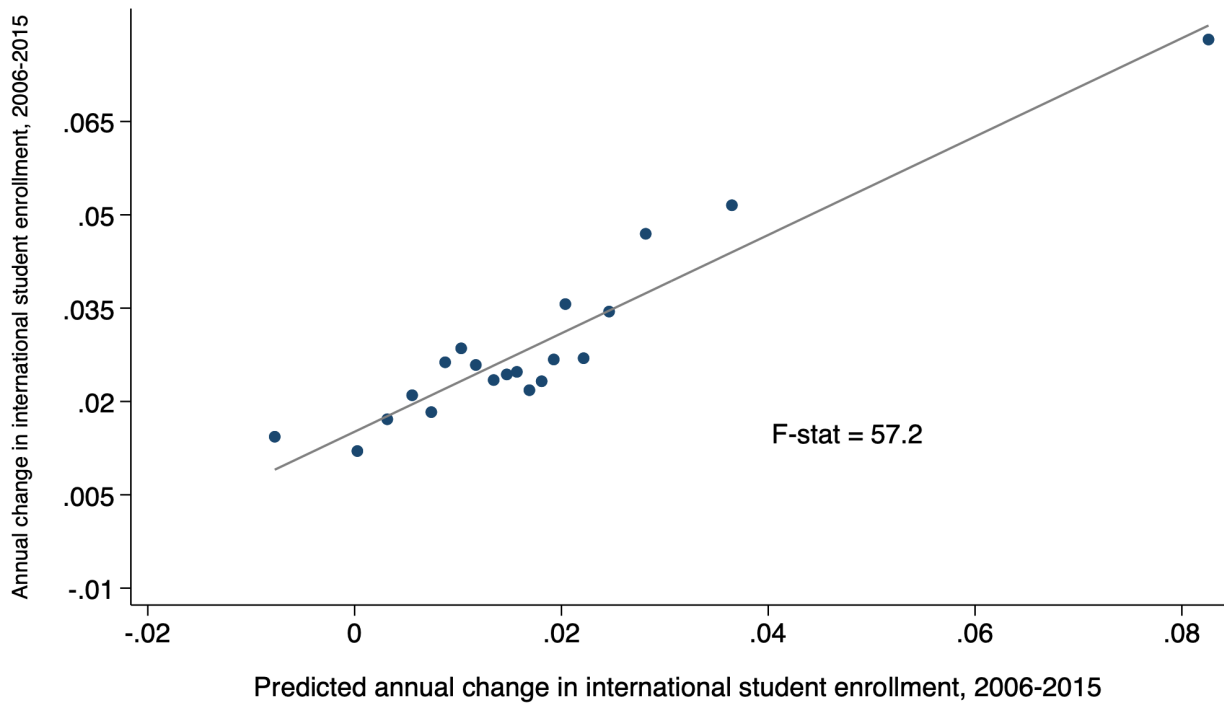


Panel A. Number of International Students, 2005



Panel B. Average Annual Growth in Enrollment, 2005-2015

Figure 4: IV First Stage



Notes—This binned scatterplot shows the first-stage relationship between predicted and actual annual change in international student enrollment between 2006 and 2015. The right hand side variable is grouped into 20 bins. Both left- and right-hand-side variables have been residualized on a set of covariates that include changes in (log) population, the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), the population share of non-citizen workers, and the sum of the share components of the instrument interacted with year fixed effects. Regression is weighted by commuting zone population in 2005.

Table 1: Falsification Tests Using Past Changes in Commuting Zone Characteristics,
Stacked First Differences

Outcome variables	OLS		IV	
	Coef.	SE	Coef.	SE
	(1)	(2)	(3)	(4)
Panel A. Country-of-origin-level regressions				
Δ_t State appropriations per public FTE			0.018	(0.067)
Δ_{t-1} State appropriations per public FTE			-0.030	(0.063)
Δ_t Pop. share of foreign-born workers with a college degree			0.002	(0.003)
Δ_{t-1} Pop. share of foreign-born workers with a college degree			0.000	(0.003)
Δ_t Employment rate			0.005	(0.010)
Δ_{t-1} Employment rate			0.008	(0.010)
Δ_t Average wages			-0.001	(0.022)
Δ_{t-1} Average wages			0.014	(0.016)
Panel B. Commuting-zone-level regressions				
Δ_t State appropriations per public FTE	-0.052***	(0.017)	0.022	(0.045)
Δ_{t-1} State appropriations per public FTE	-0.035*	(0.020)	-0.022	(0.067)
Δ_t Pop. share of foreign-born workers with a college degree	0.003***	(0.001)	0.002	(0.001)
Δ_{t-1} Pop. share of foreign-born workers with a college degree	0.003***	(0.001)	0.000	(0.002)
Δ_t Employment rate	0.010***	(0.003)	0.007	(0.006)
Δ_{t-1} Employment rate	0.010***	(0.003)	0.008	(0.007)
Δ_t Average wages	-0.010	(0.007)	-0.008	(0.014)
Δ_{t-1} Average wages	-0.021***	(0.007)	0.012	(0.016)

Notes—Panel A reports estimates obtained from transformed, shock-level regressions based on the method outlined in Borusyak, Hull, and Jaravel (2022). Outcome variables and changes in foreign enrollment from $t - 1$ to t are first residualized on a set of covariates (see description of equation 1), then aggregated at the country-of-origin level using exposure shares as weights. Changes in foreign enrollment are then instrumented directly by the shocks, i.e. changes in foreign enrollment in non-US destinations. Robust standard errors are reported in parentheses. Panel B reports coefficients obtained from estimating equation 1, where changes in foreign enrollment are predicted by the shift-share instrument in columns 3 and 4. Robust standard errors in parentheses are clustered at the commuting zone level.

Table 2: Effects of International Students on Local Employment and Wages,
ACS Estimates, Stacked First Differences, 2006-2015

	Employment Rate		Log (Avg. Wages)		Avg. Residualized Log Wages	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. All workers						
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.005*	0.019***	0.033***	0.048***	0.023***	0.045***
	(0.003)	(0.006)	(0.009)	(0.016)	(0.006)	(0.014)
Panel B. Men						
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.007*	0.020**	0.038***	0.046**	0.025***	0.039**
	(0.004)	(0.009)	(0.010)	(0.021)	(0.007)	(0.018)
Panel C. Women						
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.003	0.019***	0.024***	0.54***	0.021***	0.054***
	(0.003)	(0.007)	(0.009)	(0.019)	(0.007)	(0.017)
First-stage <i>F</i> -stat		57.2		57.2		57.2
Observations	7,220	7,220	7,220	7,220	7,220	7,220

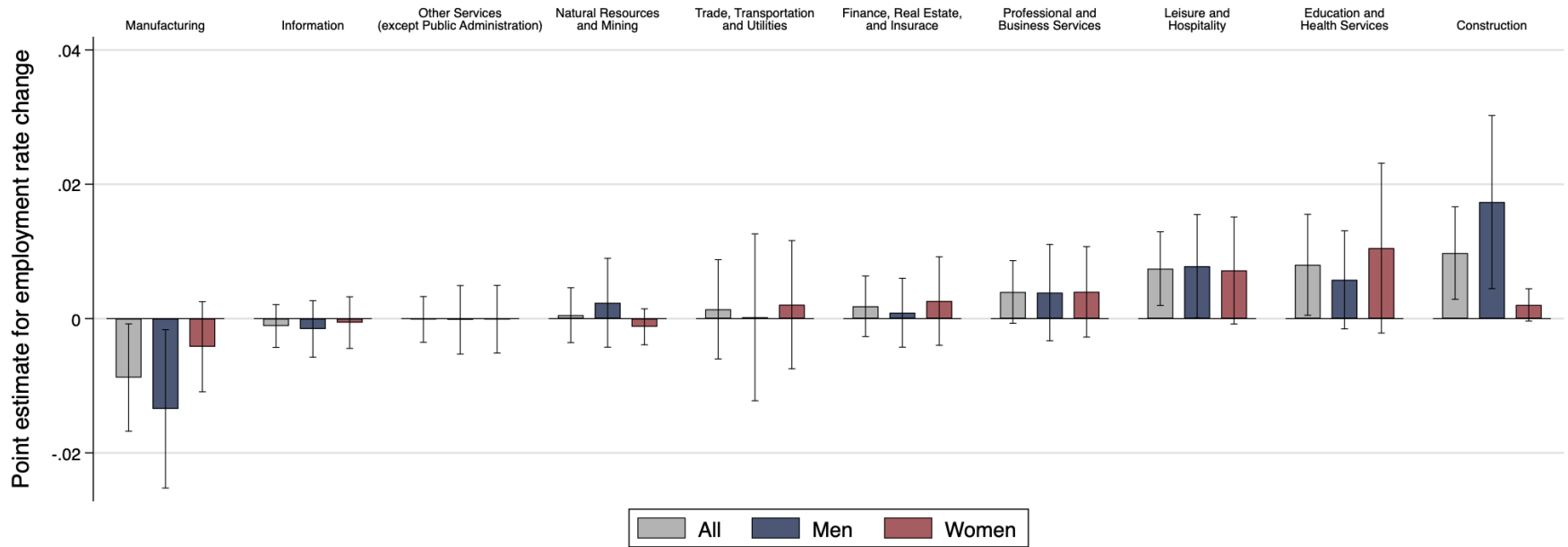
Notes—Outcomes are period changes from t to $t+1$. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), and the population share of non-citizen workers. Specifications (2), (4), and (6) further control for the sum of the share components of the instrument interacted with year fixed effects. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Table 3: Effects of International Students on Local Employment and Wages by Student Characteristics, ACS Estimates, Stacked First Differences, 2006-2015

	Heterogeneity: Change in Average Total Funding Per Student	
	Below Median CZs	Above Median CZs
	(1)	(2)
Panel A. Outcome: Employment Rate		
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	-0.017 (0.019)	0.029*** (0.009)
First-stage <i>F</i> -stat	38.6	42.4
Observations	3,610	3,610
Panel B. Outcome: Log (Avg. Wages)		
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.004 (0.044)	0.063*** (0.018)
First-stage <i>F</i> -stat	38.6	42.4
Observations	3,610	3,610
Panel C. Outcome: Avg. Residualized Log Wages		
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.010 (0.035)	0.053*** (0.016)
First-stage <i>F</i> -stat	38.6	42.4
Observations	3,610	3,610

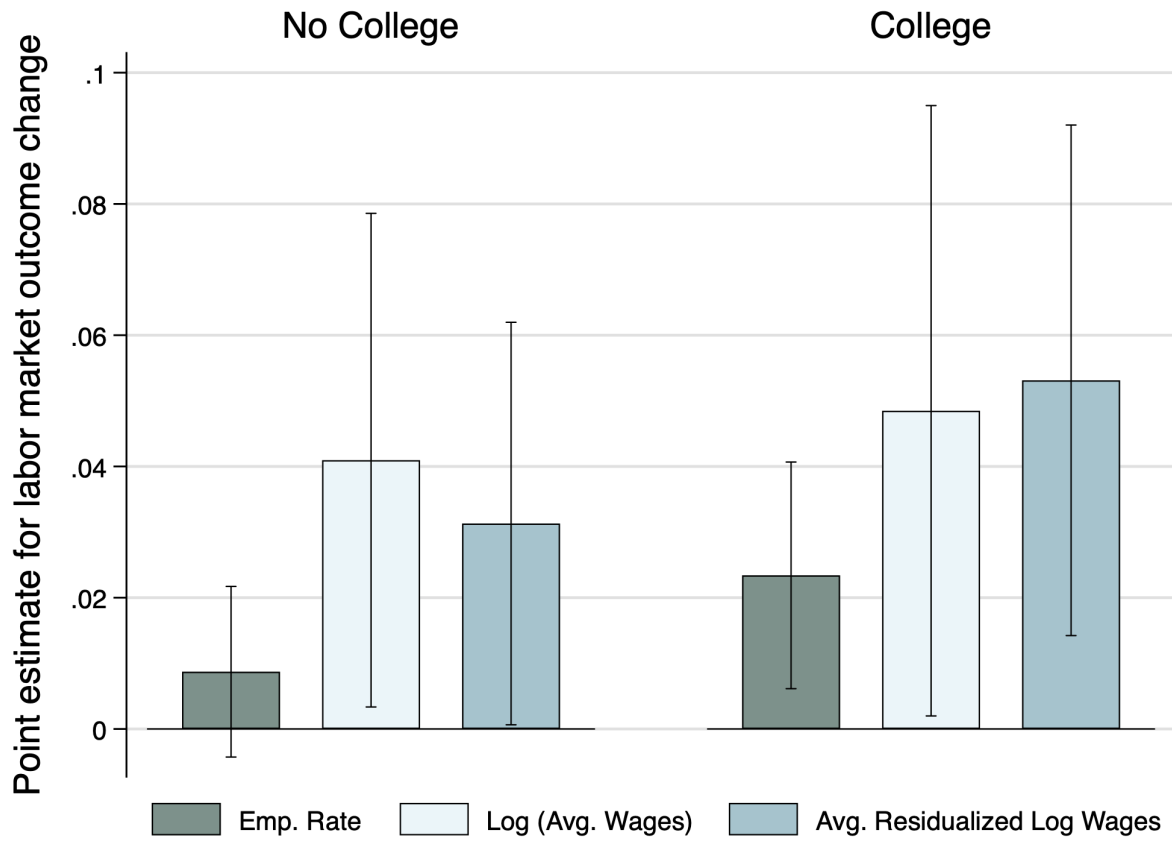
Notes—Outcomes are period changes from t to $t+1$. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), the population share of non-citizen workers, and the sum of the share components of the instrument interacted with year fixed effects. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Figure 5: Effects of International Students on Industries, ACS Estimates



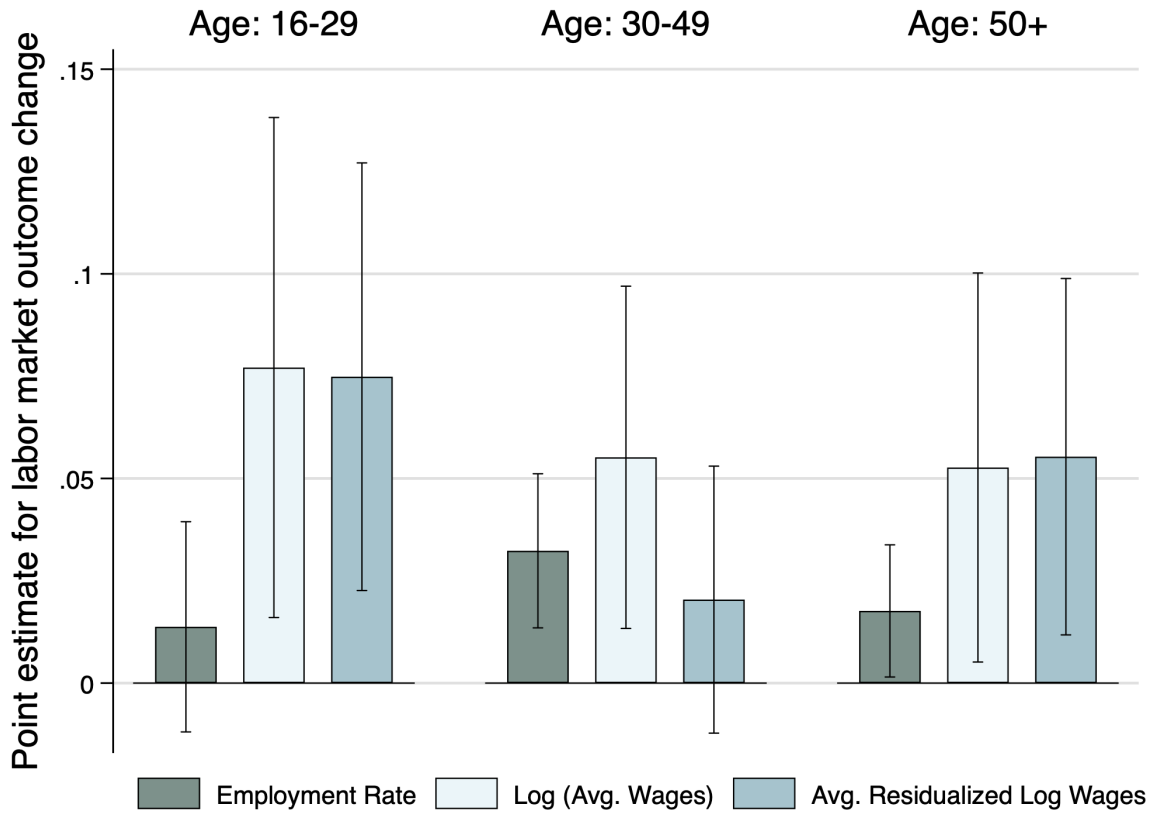
Notes—This figure presents estimates of the effects of international students on changes in industry employment-to-population ratios. The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in column 2 of Table 2.

Figure 6: Effects of International Students on Employment and Wages by Education, ACS Estimates



Notes—This figure presents estimates of the effects of international students on changes in employment and wage outcomes of natives with different education levels (no college, college degree). The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in columns 2, 4, and 6 of table 2.

Figure 7: Effects of International Students on Employment and Wages by Age, ACS Estimates



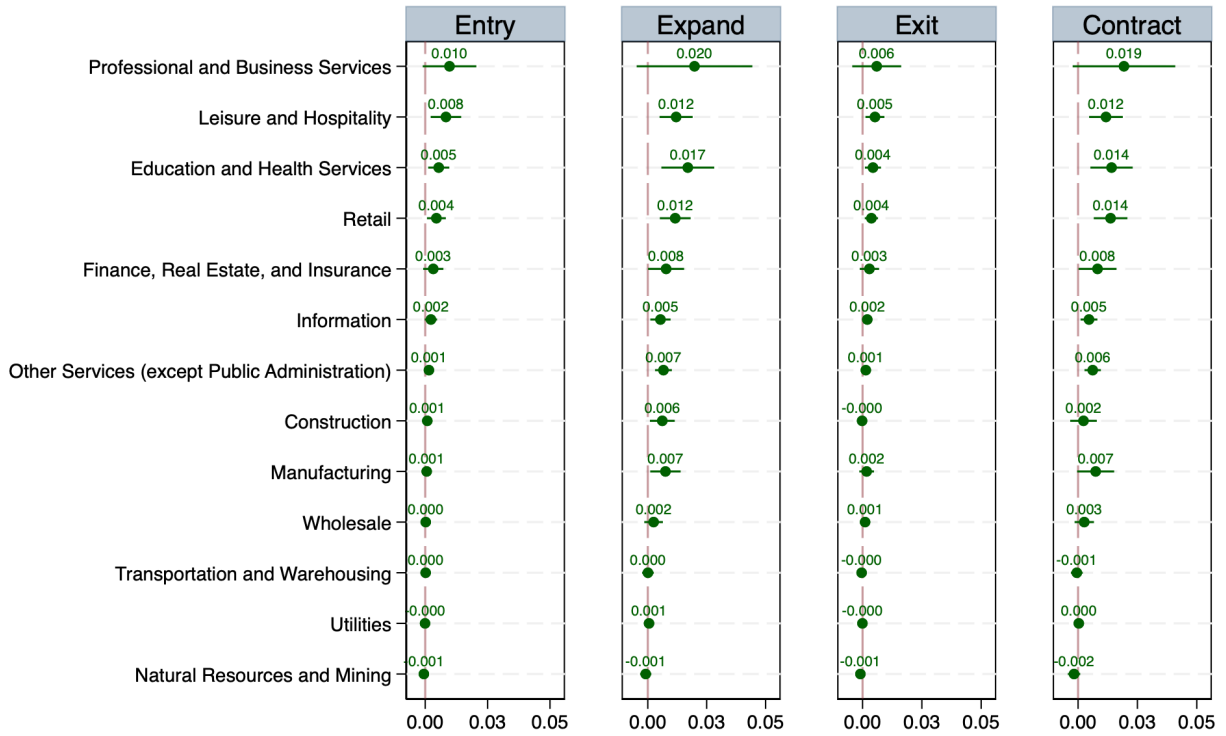
Notes—This figure presents estimates of the effects of international students on changes in employment and wage outcomes of natives in different age groups. The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in columns 2, 4, and 6 of table 2.

Table 4: Effects of International Students on Local Job Flows, Stacked First Differences, 2006-2015

Independent variable: $\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	Overall				By Sector	
	OLS	OLS	IV	IV	Traded	Local
	(1)	(2)	(3)	(4)	IV	IV
Net employment growth	0.006** (0.003)	0.004** (0.002)	0.017* (0.010)	0.020*** (0.006)	0.001 (0.002)	0.019*** (0.004)
Job flows						
Entry	0.002 (0.003)	0.010*** (0.003)	0.036** (0.016)	0.024*** (0.009)	0.005** (0.002)	0.019*** (0.007)
Expand	0.017** (0.007)	0.017*** (0.004)	0.096*** (0.034)	0.044*** (0.013)	0.010*** (0.004)	0.034*** (0.010)
Exit	0.001 (0.003)	0.015*** (0.005)	0.027* (0.014)	0.028** (0.013)	0.008* (0.004)	0.020** (0.009)
Contract	0.012** (0.005)	0.008*** (0.002)	0.088*** (0.031)	0.020*** (0.007)	0.006*** (0.002)	0.014*** (0.005)
Source	BDS	YTS	BDS	YTS	YTS	YTS
First-stage <i>F</i> -statistic		57.2		57.2		57.2
Observations	7,220	7,220	7,220	7,220	7,220	7,220

Notes—Outcomes are period changes from t to $t+1$. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), and the population share of non-citizen workers. Specifications (3)-(6) further control for the sum of the share components of the instrument interacted with year fixed effects. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Figure 8: Effects of International Students on Job Flows by Industry, BDS Estimates



Notes—This figure presents estimates of the effects of international student enrollment on changes in job flows in each industry at the commuting zone level. The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in column 3 of table 4.

Table 5: Effects of International Students on Local Job Flows by Establishment Performance Tercile, YTS Estimates, Stacked First Differences, 2006-2015

Independent Variable: $\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	Overall	Lowest Tercile	Middle Tercile	Highest Tercile
	(1)	(2)	(3)	(4)
Entry	0.024*** (0.009)	0.010*** (0.004)	0.006** (0.002)	0.008*** (0.003)
Expand	0.044*** (0.013)	0.002*** (0.001)	0.006*** (0.002)	0.036*** (0.011)
Exit	0.028** (0.013)	0.029*** (0.010)	-0.000 (0.001)	-0.000 (0.003)
Contract	0.020*** (0.007)	0.009*** (0.003)	0.005*** (0.002)	0.006*** (0.002)
First-stage <i>F</i> -statistic	57.2	57.2	57.2	57.2
Observations	7,220	7,220	7,220	7,220

Notes—Outcomes are period changes from t to $t+1$. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), the population share of non-citizen workers, and the sum of the share components of the instrument interacted with year fixed effects. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

ONLINE APPENDIX

The Local Economic Impact of International Students: Evidence from US Commuting Zones

Tung Dang*

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Appendix Table A1: Growth in Foreign Enrollment Across Commuting Zones, 2005-2015

	Mean	p10	p25	p50	p75	p90	p95	p99
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Panel A. Number of international students</i>								
2005	1,254	5	30	181	777	2,817	5,427	18,578
2015	2,279	5	51	276	1,473	4,668	10,440	34,729
Δ	+1,125	+0	+21	+95	+696	1,851	5,013	16,151
<i>Panel B. Population share of international students (%)</i>								
2005	0.209	0.007	0.034	0.098	0.252	0.517	0.798	1.680
2015	0.342	0.007	0.048	0.155	0.391	0.827	1.188	3.520
Δ	+0.08	+<0.001	+0.014	+0.057	+0.140	+0.310	+0.390	+1.840

Source: Author's calculations from administrative data from US Department of Homeland Security.

Notes—Tabulations on 722 commuting zones. Sample includes all international students enrolled in a US higher education institution (undergraduate and graduate level) under F-1 visa status for any portion of the year in 2005 and 2015.

Appendix Table A2: Short-Run Labor Supply Contribution of Foreign Enrollment, ACS Estimates, Stacked First Differences, 2006-2015

	Outcome: Change in Pop. Share of Working Non-Citizens Enrolled in Higher Education			
	From t to $t+1$		From $t+1$ to $t+2$	
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.000 (0.000)	0.001 (0.001)	0.000 (0.000)	0.002* (0.001)
First-stage F -statistic		57.2		57.2
Observations	7,220	7,220	7,220	7,220

Notes—All specifications include year fixed effects and current period changes in (log) population, the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), and the population share of non-citizen workers. Specifications (2) and (4) further control for the sum of the share components of the instrument interacted with year fixed effects. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Appendix Table A3: Effects of Domestic Students on Local Employment and Wages, OLS Estimates, Stacked First Differences, 2006-2015

	Employment Rate	Log (Avg. Wages)	Avg. Residualized Log Wages
	(1)	(2)	(3)
<i>Panel A. Total Enrollment</i>			
$\Delta \text{Domestic Students}_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.000 (0.000)	0.002*** (0.001)	0.002*** (0.000)
<i>Panel B. Out-of-State Enrollment</i>			
$\Delta \text{Domestic Students}_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.000 (0.000)	0.003*** (0.001)	0.002*** (0.001)
Observations	7,220	7,220	7,220

Notes—Outcomes are period changes from t to $t+1$. Domestic enrollment is constructed using ACS data, with out-of-state enrollment defined using a sample of individuals whose state of residence differs from their state of birth. All specifications include year fixed effects and current period changes in (log) population the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), and the share of population that are working foreign-borns. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Appendix Table A4: Effects of International Students on Natives' College Attendance, IV Estimates, Stacked First Differences, 2006-2015

	First-Time, First-Year Domestic Enrollment	
	2-Year (1)	4-Year (2)
<i>Panel A. All Colleges and Universities</i>		
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	-0.018** (0.009)	0.006 (0.006)
<i>Panel B. Public</i>		
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	-0.016* (0.008)	0.008 (0.006)
<i>Panel C. Private, Non-Profit</i>		
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	-0.001 (0.001)	-0.002** (0.001)
<i>Panel D. Private, For-Profit</i>		
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	-0.001 (0.002)	0.000 (0.000)
First-stage <i>F</i> -statistic	41.4	41.4
Observations	5,330	5,330

Notes—Observations = 533CZ x 10. Outcomes are period changes (from t to $t+1$) in first-time, first-year domestic enrollment, constructed using IPEDS data, adjusted by CZ 18-25 population. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), the population share of non-citizen workers, and the sum of the share components of the instrument interacted with year fixed effects. Regressions are weighted by commuting zone 18-25 population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Appendix Table A5: Robustness Checks—Baseline IV Estimates with Alternative Sample Restrictions, ACS

	Emp. Rate	Log (Avg. Wages)	Avg. Residualized Log Wages
	(1)	(2)	(3)
<i>Panel A. Same state of birth workers</i>			
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.021*** (0.08)	0.068*** (0.021)	0.059*** (0.018)
First-stage <i>F</i> -statistic	57.2	57.2	57.2
Observations	7,220	7,220	7,220
<i>Panel B. Exclude CZs with the highest numbers of international students in 2005 (top 10%)</i>			
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.031** (0.013)	0.094*** (0.028)	0.073*** (0.026)
First-stage <i>F</i> -statistic	59.4	59.4	59.4
Observations	7,120	7,120	7,120
<i>Panel C. Exclude CZs with no international students in 2005</i>			
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.019*** (0.006)	0.052*** (0.017)	0.048*** (0.015)
First-stage <i>F</i> -statistic	55.8	55.8	55.8
Observations	5,530	5,530	5,530

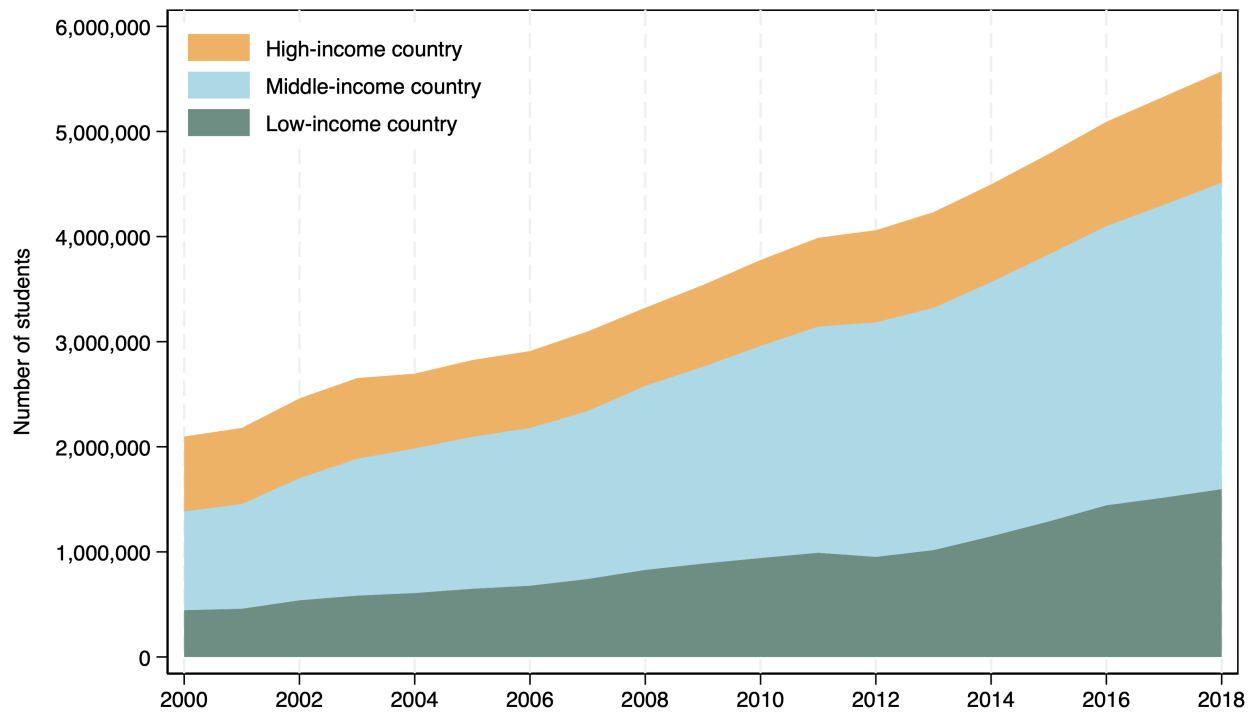
Notes—Outcomes are period changes from t to $t+1$. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), the population share of non-citizen workers, and the sum of the share components of the instrument interacted with year fixed effects. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Appendix Table A6: Robustness Checks—Baseline IV Estimates with Alternative Measures of Foreign Enrollment, ACS

	Emp. Rate	Log (Avg. Wages)	Avg. Residualized Log Wages
	(1)	(2)	(3)
Panel A. Alternative instrument^(a)			
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.019** (0.008)	0.054** (0.022)	0.061*** (0.018)
First-stage <i>F</i> -statistic	35.4	35.4	35.4
Observations	7,220	7,220	7,220
Panel B. Exclude international graduate students			
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.028*** (0.010)	0.070*** (0.025)	0.065*** (0.024)
First-stage <i>F</i> -statistic	25.1	25.1	25.1
Observations	7,220	7,220	7,220
Panel C. Exclude Chinese students			
$\Delta IS_{c,t} / \text{Pop}_{c,t-1} \times 100$	0.066*** (0.023)	0.165*** (0.054)	0.154*** (0.048)
First-stage <i>F</i> -statistic	24.1	24.1	24.1
Observations	7,220	7,220	7,220

Notes—Outcomes are period changes from t to $t+1$. (a) Instrumental variable constructed using changes in foreign enrollment in all non-US destinations as shocks (data from UNESCO Institute for Statistics 2021). All specifications include year fixed effects and current period changes in (log) population, the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), the population share of non-citizen workers, and the sum of the share components of the instrument interacted with year fixed effects. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

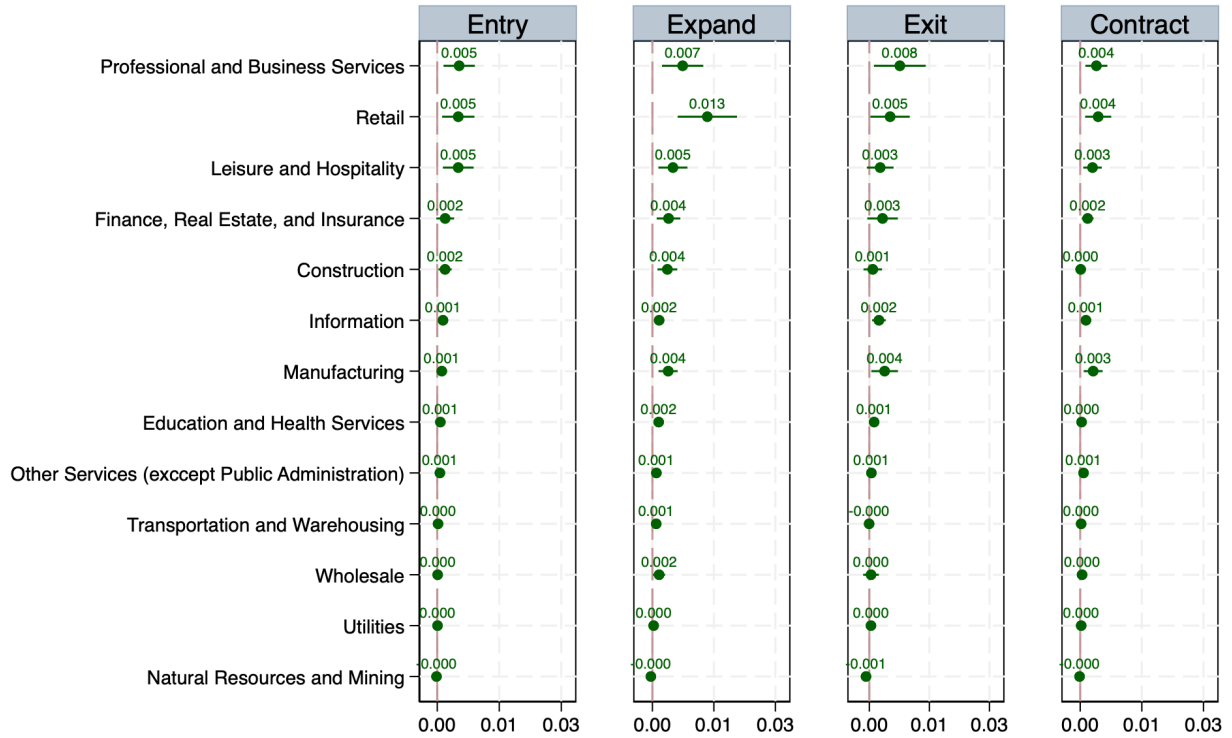
Appendix Figure B1: Internationally Mobile Students by Country of Origin, 2000-2018



Source: UNESCO Institute for Statistics.

Notes—Income assignments are based on World Bank 2000 classifications.

Appendix Figure B2: Effects of International Students on Job Flows by Industry, YTS Estimates



Notes—This figure presents estimates of the effects of international student enrollment on changes in job flows in each industry at the commuting zone level. The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in column 4 of table 4.