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

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Abstract

This paper studies the economic impact of international students on local labor markets and establishments in the United States. Identification rests on a shift-share instrumental variable estimation strategy that exploits plausibly exogenous variation in the outflows of students across countries of origin to other top English-speaking destinations. I find that one additional student per thousand residents increases the employment-to-population ratio by 0.36 percentage points and average hourly wages by 1.06 percent. Consistent with theories with heterogeneous firms, local demand shocks induced by an increase in enrollment also result in substantial within-industry reallocations of labor toward potentially more productive establishments, particularly in the non-tradable sector. These findings thus highlight important economic benefits from international students in the form of increases in local income and aggregate productivity.

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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. 2020). 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.[1]

In this paper, I examine how local demand shocks induced by an increase in foreign enrollment affect local labor markets and establishments. My empirical investigation aims to quantify the overall impact of international students on local employment and wages as well as document the distributional consequences of a reallocation of labor across establishments. These distributional effects are theoretically predicted by a class of general equilibrium models with heterogeneous firms, whereby local demand shocks result in 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 increasing the competition for market shares and workers. However, as US visa policy does not allow the vast majority of international students to work throughout their courses of study, the surge in local labor demand might not be compensated by an increase in labor supply, leading to higher wages. Increases in labor costs and a reduction in markups force the least productive establishments to contract or exit altogether. Thus, the presence of international students could improve

[1] Foreign 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).

[2] For recent reviews of models of trade that incorporate firm heterogeneity, see Bernard et al. (2007) and Redding (2011).

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 2001 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 variation 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 admin-

istrative 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 substantial increases in local employment and earnings. At the commuting zone level, an increase in enrollment by one student per thousand residents (approximately 3 sample standard deviations) raises the employment-to-population ratio by 0.36 percentage points and average hourly wages by 1.06%. These effects are economically large and indicate that the overall growth in the number of foreign students in US higher education between 2005 and 2015 has led to the creation of over 413,000 jobs, an increase in employment equivalent in magnitude to about 17-21% of the displacement effect of the rise in import competition from China (Acemoglu et al. 2016). In line with expectations, increases in local labor demand are concentrated entirely in the non-tradable sector, particularly in construction, transportation, retail, and services. Improved labor market opportunities are observed across different types of workers and are slightly more pronounced among college-educated individuals.

Next, I use longitudinal establishment data from the Your-Economy Time Series database to study the effects of international students on local job flows. The database 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 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 the recent growth in the export of US educational services may also have led to improvements in local aggre-

gate productivity via a between-establishment selection process driven by increases in intramarket 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 2022), 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, 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 lacuna by taking a first step toward assessing the broader effects of international students on local labor markets and establishments.

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.[3] 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.[4]

Finally, this paper also relates to a body of literature that assesses how competition can spur

[3]Some 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. 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 lead to significant negative effects on natives' employment and wages in the short-run.

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

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.

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.[5] 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 2001 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.[6]

I use these data to measure the size of the international student population in each commuting zone each year. Specifically, based on program start and end dates, I construct international enrollment in a commuting zone-year to be the total number of international students enrolled in a postsecondary institution within that commuting zone for any portion of the year. Although the administrative data cover the universe of the international student population of interest, some limitations lead to measurement error concerns. For example, there is no information regarding students' residential addresses. Some students might have traveled a long distance to schools or engaged in remote learning and did not reside within the same commuting zones as their programs.[7] Furthermore, many students might have terminated their studies before the reported program end dates,

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

[6] As 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 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.

[7] However, this is unlikely during my study period, which was before the COVID-19 pandemic.

either to transfer to a new program or to leave the US. OLS estimates of the economic impacts of international students could thus be biased due to measurement error.

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

I use 2005-2016 American Community Survey (ACS) data extracted from the Integrated Public Use Microsamples (IPUMS) database to construct local labor market outcomes (Ruggles et al. 2022). In each survey year, I restrict my sample to non-institutionalized individuals not living in group quarters.

I construct local labor market outcomes by first assigning commuting zones to individuals using information on their county of residence, which is available for over half of the sample extracted from IPUMS. To assign commuting zones to the rest of the sample, for whom county identifiers are not available, I rely on Public Use Microdata Area (PUMA) and a statistical procedure implemented by Smith (2012) and David and Dorn (2013). This procedure, which results in consistent estimates of outcomes, involves duplicating observations whose PUMAs are overlapped with multiple commuting zones and re-weighting each of these observations by the respective fraction of a PUMA population that lives within each commuting zone.

I focus on the employment-to-population ratio and average hourly wages of the working-age population (16-64) as the main labor market outcomes. Hourly wages are computed by dividing

total wage and salary earnings in the previous 12 months by the product of weeks worked and the usual number of hours per week among those who work at least 35 hours per week, excluding non-citizens. Hourly wages are set not to exceed top-coded yearly earnings divided by 50 weeks times 35 hours and also winsorized at $2 per hour. Finally, 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 each year to measure enrollment per capita.

Data used to estimate commuting zones' population each year are from the Survey of Epidemiology and End Results (SEER). As discussed in section 3, I also use the ACS to construct a large set of control variables at the commuting zone level.

2.3 Job flows

To measure gross job flows, I use annual establishment-level time-series data from the Your-Economy Time Series (YTS) database, 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, starting from 1997. These cover all establishments that are intent on conducting commercial activities or have a physical location, including for-profit, non-profit, and government establishments.[8] Detailed information, including an establishment's name, location (e.g., county and zip code), industry affiliation (6-digit NAICS),

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

number of employees, and sales, is collected from each location each year and linked longitudinally to assemble time series.

For my analysis, I restrict my sample to all establishments that were in operation at some point between 2003 and 2016 and have existed for at least two years in the database. Furthermore, I exclude non-profits and establishments with less than two employees at any point during this period to avoid nonemployer businesses. Based on this sample of establishments and their locations, I construct commuting zone gross job flows and decompose the net impact of international students on employment growth into separate effects on job creation (through establishment entry and expansion) and job destruction (through establishment exit and contraction). In addition, I also use information on industry affiliation and sales to conduct heterogeneity analysis by industry and establishment performance. I discuss variable construction in more details 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 2 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. 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 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 the following stacked first-difference model

$$\Delta y_{c,t+1} = \gamma_t + \beta \frac{\Delta \text{IS}_{c,t}}{\text{Pop}_{c,t-1}} + \Delta X'_{c,t}\Gamma + \Delta \epsilon_{c,t} \tag{1}$$

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, $\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1}$, is the period change in the number of international students enrolled in a postsecondary institution in commuting zone c normalized by the size of the commuting zone's 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.[9] 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.[10] To further account for potentially confounding changes in underlying local economic conditions, I include a large set of covariates, X_{ct}, that control for changes in commuting zone characteristics. These include changes in log population; the share of females; the shares of the population by age (16-34, 35-49, 50-64, and over 65) and education (some college, college or professional degree, and advanced degrees); the share of the population that is working foreign-born; and the share of the population employed in construction, retail, and

[9] An alternative specification that has been used in the immigration 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).

[10] A 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 commuting zones to obtain estimates robust to either structure.

services. With some exceptions, all regressions are weighted by commuting zone working-age 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 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.[11]

In addition to the endogenous sorting of international students across commuting zones, mea-

[11] Ruiz (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, a recent study by Beine, Peri, and Raux (2022) concludes that foreign graduates who transition into the US labor force typically find their first job within the state of their programs.

surement 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 in demographics, family income, and/or institutional background within each source country. Indeed, Khanna et al. (2020) 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 2001 and 2002 with observed period changes in combined enrollment from each country of origin in Australia, Canada, and the UK.[12] 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

$$\widehat{\Delta \text{IS}}_{c,t} = \sum_{k} \frac{\text{IS}_{c,k,2001-2002}}{\text{IS}_{k,2001-2002}} \times \Delta \text{IS}_{t}^{\text{Australia, Canada, UK}} \tag{2}$$

where $\Delta \text{IS}_{t}^{\text{Australia, Canada, UK}}$ is period change in the enrollment of international students from country k in the three mentioned destinations. The share component, $\frac{\text{IS}_{c,k,2001-2002}}{\text{IS}_{k,2001-2002}}$, 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 very 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).

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 in the previous subsection, there is a strong correlation

[12] I pool data from 2001 and 2002 to increase the sample size and the precision of the share estimates, though my results remain quantitatively similar if I only use enrollment patterns in 2001.

between changes in international student enrollment across countries of origin between the US and the other three English-speaking destinations. In a simple regression, yearly changes in combined total enrollment in Australia, Canada, and the UK explain about two-thirds of the variation in the changes in enrollment in the US across all countries of origin between 2005 and 2015. Figure 3 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 53.2, suggesting that my instrument provides a sufficient source of identifying variation.

Exclusion restriction.—Recent work by Borusyak, Hull, and Jaravel (2022) shows how identification can be achieved in this setting. With many periods as well as a large number of shocks per period, shift-share IV estimates are shown to be numerically equivalent to those obtained by fitting transformed, shock-level regressions in which both the outcome and treatment variables are weighted by the shares while the shifts serve directly as instruments for the weighted treatment variable.[13] Consequently, a shift-share strategy will result in consistent estimates if the shifts are idiosyncratic with respect to share-weighted averages of unobserved factors that determine the outcomes. This condition will hold if shocks to the enrollment of international students in Australia, Canada, and the UK are unrelated to changes in local economic conditions in the US, regardless of whether local exposures to these shocks (i.e., variation in the share component) are endogenous.

To (indirectly) assess the validity of the identifying assumption, I conduct a series of falsification tests in which I regress lagged outcomes on actual and predicted changes in foreign enrollment. If the instrument succeeds in isolating the quasi-experimental portion of the variation in enrollment, we would expect no significant correlations between predicted enrollment and past outcomes. Table 1 reports IV estimates obtained from regressing lagged changes in commuting zone employment-to-population ratios (starting from period changes from $t-4$ to $t-3$ to period changes from $t-1$ to t) on changes in enrollment. Reassuringly, points estimates are all close to zero and statistically insignificant. In Appendix Table A1, I report additional tests analyzing

[13] See Goldsmith-Pinkham, Sorkin, and Swift (2020) for a discussion of settings in which identification is driven by the share component.

lagged changes in state appropriations per full-time equivalent (FTE) student (constructed using IPEDS data), the share of foreign-born college graduates in employment, and average wages as the outcomes. Obtained IV estimates are likewise small in magnitude and insignificant. Thus, these results imply that the supply-driven variation in foreign enrollment that is predicted by the instrument is not correlated with changes in commuting zones' underlying economic conditions.

Statistical inference.—Adao, Kolesár, and Morales (2019) demonstrate that a shift-share instrumental 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 16 iterations for employment and 50 iterations for wages. These results suggest that using conventional robust standard errors clustered at the commuting zone level is unlikely to lead to over-rejection 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 outcomes. While OLS estimates generally

have the same signs as their IV counterparts, only the latter are economically and statistically significant across specifications. This pattern, which is in line with findings from recent studies and the evidence discussed in the previous section, suggests that foreign enrollment tends to be countercyclical. In particular, declines in local economic conditions and particularly state funding for higher education appear to be strong drivers of increases in local reliance on tuition revenue from abroad and, consequently, in the enrollment of international students (Bound et al. 2020; Bound et al. 2021).

4.1 Overall employment and wage effects

Table 2 reports regressions of changes in the employment-to-population ratio and (log) average wages on changes in international student enrollment per capita. Panel A presents overall results, while panels B and C look at the outcomes of men and women, respectively. Columns 1 and 2 show that increases in foreign enrollment have a positive and statistically significant impact on local employment. OLS estimates suggest that an increase in enrollment by one student per thousand residents (approximately 3 sample standard deviations) on average would lead to a 0.11 percentage point increase in the overall employment-to-population ratio, with similar effects on both men and women (increases of 0.13 and 0.08 percentage points, respectively). The corresponding IV estimates are 0.36, 0.37, and 0.34 percentage points and are all significant at the 1 percent level. To contextualize the economic impact of international students on local employment, I multiply the obtained IV coefficient with observed period changes in enrollment at the national level, then multiply these products with the size of the US working-age population in each corresponding year and add up the results over the study period. Accordingly, the overall increase in foreign enrollment between may have resulted in the creation of over 413,000 jobs. This effect is equivalent in magnitude to about 17-21% of the displacement effect of the increase in import competition from China over the 1999-2011 period and is thus economically significant (Acemoglu et al. 2016).

Columns 3 and 4 examine the local labor demand effects of international students regarding changes in average wages. Likewise, both OLS and IV results are positive and strongly significant, though the IV estimates are much larger in magnitude. The preferred IV specifications suggest that one additional international student per thousand residents would increase average wages by 1.06 percent overall and 0.90 and 1.26 percent for men and women, respectively.

Given the large effect 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 issue, I consider alternative measures of wages that are robust to compositional changes in the local labor force. These include wages adjusted by the probability of employment (Charles, Hurst, and Notowidigdo 2018; Notowidigdo 2020), residualized wages obtained from regressing individual log wages on observable characteristics (Notowidigdo 2020), and average wages constructed at the commuting zone-demographic level (Acemoglu and Restrepo 2020). Columns 5 and 6 present results using the changes in average wages adjusted by the probability of employment. Both OLS and IV estimates are economically large and strongly significant, suggesting that most of the observed effect on local wages indeed reflects increases in local labor market opportunities rather than changes in the composition of local workers. Estimates using the latter measures also strongly support this conclusion and are tabulated separately in Appendix Table A2.

4.2 Effects by industry

Which industries are most likely to benefit from the increases in local demand generated 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 4 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 3, with the outcomes here being changes in the industry-specific employment share of the population. In line with expectations, construction accounts for a major 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 0.24 percentage point increase in the share of population employed in construction. The remaining portion of the employment effect can be attributed to retail and personal services (0.13 points), education and healthcare (0.11 points), professional and technical services (0.08 points), and transportation and warehousing (0.04 points), though these estimates lack precision due to the small sample size. Note that the combined increase in employment shares in these sectors 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 agriculture and manufacturing.[14] 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.

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

Figure 5 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 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, 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. A summary of these results is provided in Appendix Table A3. 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 (16-34), middle-aged (35-49), and older workers (50 and above). The results summarized by Figure 6 indicate that an increase in foreign enrollment has similar effects on employment and earnings across these three groups.

Overall, 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. Given these substantial gains in local jobs and income, it might be

tempting to conclude that there can only be "winners" following an increase in the enrollment of students from overseas. Does their presence result in distributional consequences, if any? To answer this question, I analyze the impact of international students on local job flows in the context Melitz-type general equilibrium models with heterogeneous firms. Before moving on to the next section, 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 A4, 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 quantitatively similar to the 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's unlikely that any particular commuting zone is driving the observed results.

In Appendix Table A5, I consider the robustness of my baseline results to alternative measures

of foreign enrollment. In panel A, I exclude international graduate students from my constructed 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 panels B and C, I drop Chinese and Indian students, respectively. Corresponding point estimates are positive and statistically significant in each case, implying my baseline results are also not just capturing the local labor market effects of these two major groups of international students in the US.

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.[15] 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 international students, as analyzed in section 4, into effects on gross job flows. To do so, I turn to establishment-level data from the YTS and aggregate annual changes in employment due to estab-

[15] Aggregate 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.

lishment entry, exit, expansion, and contraction to 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

$$\frac{\Delta \mathrm{E}_{c,t}}{\bar{P}_{c,t}} = \underbrace{\frac{\mathrm{E}^{\text{entry}}_{c,t}}{\bar{P}_{c,t}} - \frac{\mathrm{E}^{\text{exit}}_{c,t}}{\bar{P}_{c,t}}}_{\text{Extensive margin}} + \underbrace{\frac{\mathrm{E}^{\text{expansion}}_{c,t}}{\bar{P}_{c,t}} - \frac{\mathrm{E}^{\text{contraction}}_{c,t}}{\bar{P}_{c,t}}}_{\text{Intensive margin}} \tag{3}$$

where $\bar{P}_{c,t} = (P_{c,t-1} + P_{c,t})/2$ is the mid-point working-age population of commuting zone c between $t-1$ and t. $E^{\text{entry}}_{c,t}$ and $E^{\text{exit}}_{c,t}$ are gross job creation and destruction along the extensive margin due to establishment entry and exit, respectively, and $E^{\text{expansion}}_{c,t}$ and $E^{\text{contraction}}_{c,t}$ analogously defined along the intensive margin due to establishment expansion and contraction.[16] 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 outcome variables. I then explore heterogeneity by industry and establishment performance.

Appendix Figure B1 shows the average contribution of each job-flow component to gross job creation and destruction between 2005 and 2006. As shown, the average fractions of job destruction due to establishment exits and contractions are very similar to those reported by Asquith et al. (2019), who analyze job flows between 1993 and 2011 using a different source of establishment microdata. On the other hand, establishment entry no longer plays a dominant role over expansion in creating new jobs between 2005 and 2016. This pattern is consistent with recent evidence of a secular decline in business dynamism and entrepreneurship in the US over the past few decades (Decker et al. 2016a; Decker et al. 2016b).

[16] I follow Asquith et al. (2019) and define each of these four dynamics at the establishment level rather than at the firm level (e.g., the opening of a new branch by a national chain is considered an entry).

5.1 Overall effects on local job flows

Table 3 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 add up to those from the net growth regressions.

Columns 1 and 2 report estimates of the effects of an increase in foreign enrollment on local net employment growth and gross job flows in all industries. While the obtained OLS result for net employment change is indistinguishable from zero, its IV counterpart is statistically significant at the 5 percent level and suggests that one additional international student per thousand residents leads to a net increase in local employment equivalent to 0.24 percent of the population. This result is very similar in magnitude to the estimated effect on the employment-to-population ratio, as documented in the previous section using ACS data.

Turning to the overall effects on local job flows, both OLS and IV estimates are highly significant and indicate that international students positively impact local business dynamism in the short term. In particular, 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. Focusing on IV estimates, job-flow coefficients are overall much larger in magnitude compared to the net growth coefficient. The results indicate that international students lead to a gross job reallocation that is 8.5 times larger than the observed net effect, consistent with findings from the literature suggesting that net changes in employment can conceal substantial gross flows (Davis et al. 1996; Davis, Faberman, and Haltiwanger 2012). In Appendix Table A6, I explore the robustness of these findings using publicly available aggregated job flow data from US Census Business Dynamics Statistics (BDS) and obtain qualitatively similar results.

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, a within-industry reshuffling of labor may reflect general equilibrium dynamics that have potentially important consequences for the composition of local businesses and aggregate productivity.

In columns 3-6, 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).[17] For the traded sector, both OLS and IV estimates on net employment growth are negative and insignificant, suggesting that demand shocks generated by international students are unlikely to induce an economically meaningful reallocation of labor toward the local sector. Indeed, an increase in foreign enrollment has no significant effect on job creation through establishment entry, and only modest, positive effects on the expansion, exit, and contraction components in the traded sector (columns 3 and 4). On the other hand, the increase in local business dynamism is much more pronounced within the local sector, as the obtained IV coefficients with respect to gross job-flow components are all statistically significant and larger in magnitude (columns 5 and 6).

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 the sector itself rather than away from the traded sector. This implies that within-industry labor flows likely drive such a rellocation due to Melitz-type general equilibrium effects. Furthermore, the degree to which reallocation occurs should therefore 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

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

on local job flows across more narrowly defined industries. Figure 7 plots coefficients obtained from regressing industry-specific job-flow components on an increase in foreign enrollment. The results display a striking pattern: industries that experience larger effects of international students on job creation (though establishment entry and expansion) tend to also experience larger effects on job destruction (through establishment exit and contraction). Not surprisingly, these effects are concentrated in retail and services, industries most impacted by demand shocks (as seen in section 3) and also characterized by relatively low costs of entry and/or high labor turnover rates. These patterns are thus consistent with findings from the literature suggesting that a large fraction of labor reallocation occur within industries (e.g., Davis and Haltiwanger 1999; Foster, Haltiwanger, and Krizan 2001) and point to an increase in competition being the driving force that causes within-industry reallocations among competing establishments.

5.3 Effects by firm performance

What determines the 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 heterogenous 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.[18] 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.[19] Specifically, the performance of establishment i is constructed as

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

where $\underline{t}$ and $\bar{t}$ denote the earliest and latest year in which establishment i exists in the sample, respectively. 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 4 reports IV estimates obtained from regressing job flows in each performance tercile on changes in international student enrollment. Column 1 first presents the overall effects of international students on job flows in the private sector, which are only slightly different from those

[18] This analysis excludes establishments in the public sector.

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

reported in table 3.

Turning to the effects of international students on job creation due to firm entry, the results indicate no clear pattern across the three performance terciles. 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 obtained IV estimate suggests that one additional student per thousand residents results in a 0.55 percentage point increase in the rate of job creation due to expansion among establishments in the highest performance tercile. This effect is strongly statistically significant and explains 81% (0.55/0.68) of the overall effect of international students on job creation through establishment expansion.

In stark contrast, the impact of an increase in foreign 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 0.041 and 0.013, which explain 95% (0.041/0.043) and 46% (0.013/0.028) 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 the 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.[20]

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, 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 0.36 percentage points and average wages by 1.06%, with most of these effects occurring in construction, retail, 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 compe-

[20] For 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).

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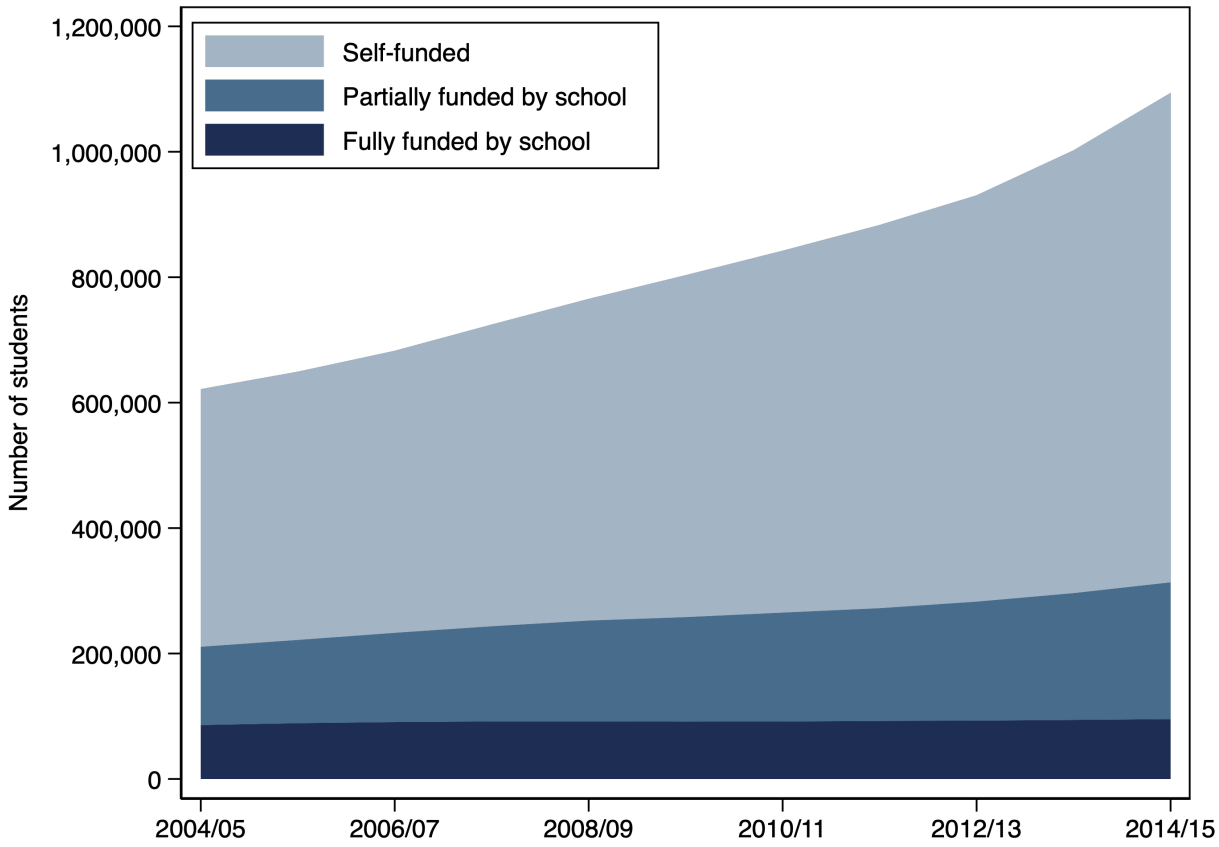
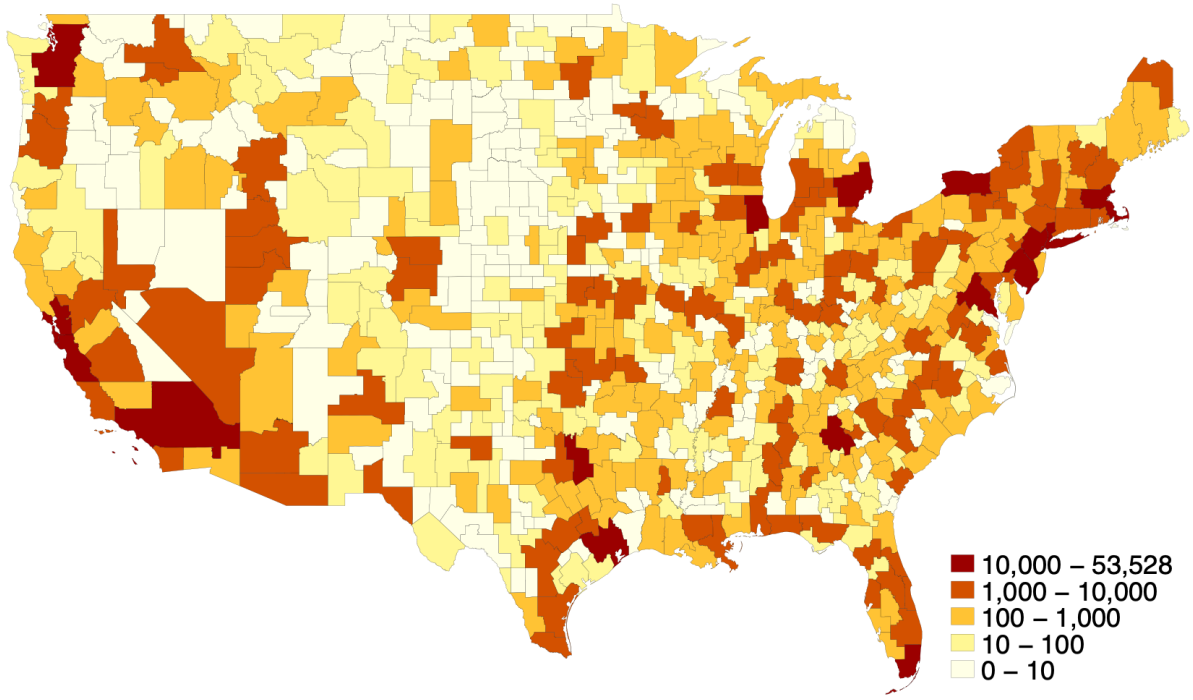
Figure 1. Trends in International Student Enrollment in US Higher Education by Funding Status.

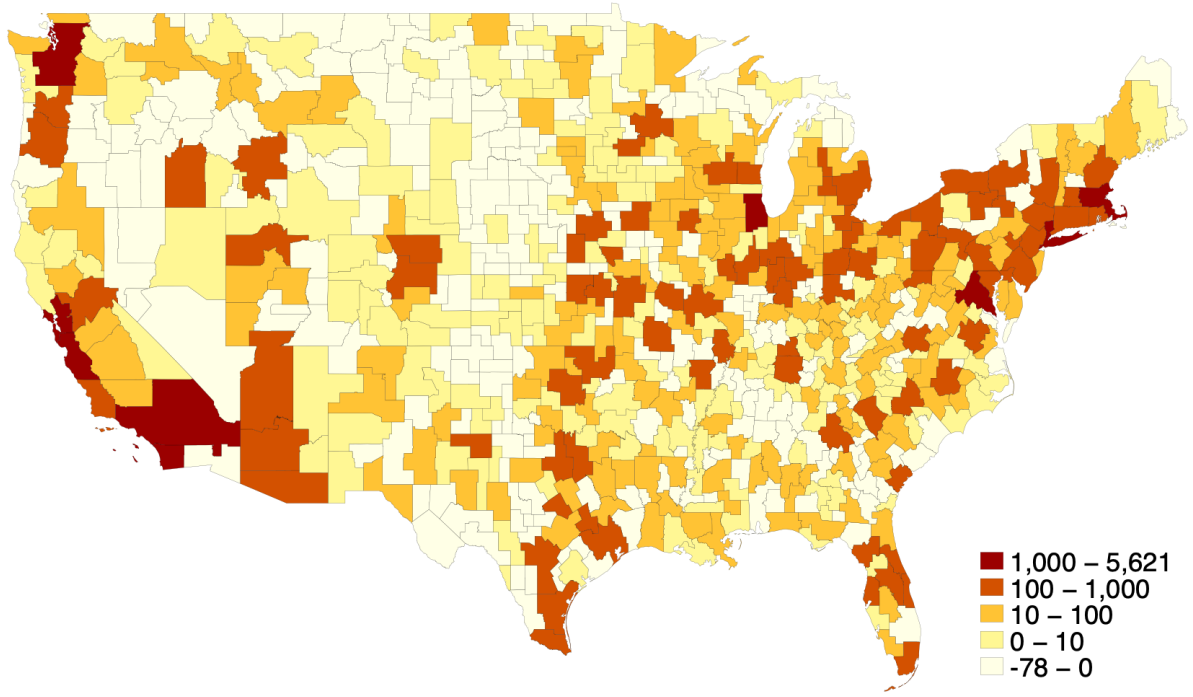


Source: Author's calculations based on administrative data from US Department of Homeland Security (2004-2014).

Figure 2. Spatial Distribution of International Students in Higher Education Across Commuting Zones, 2005-2015

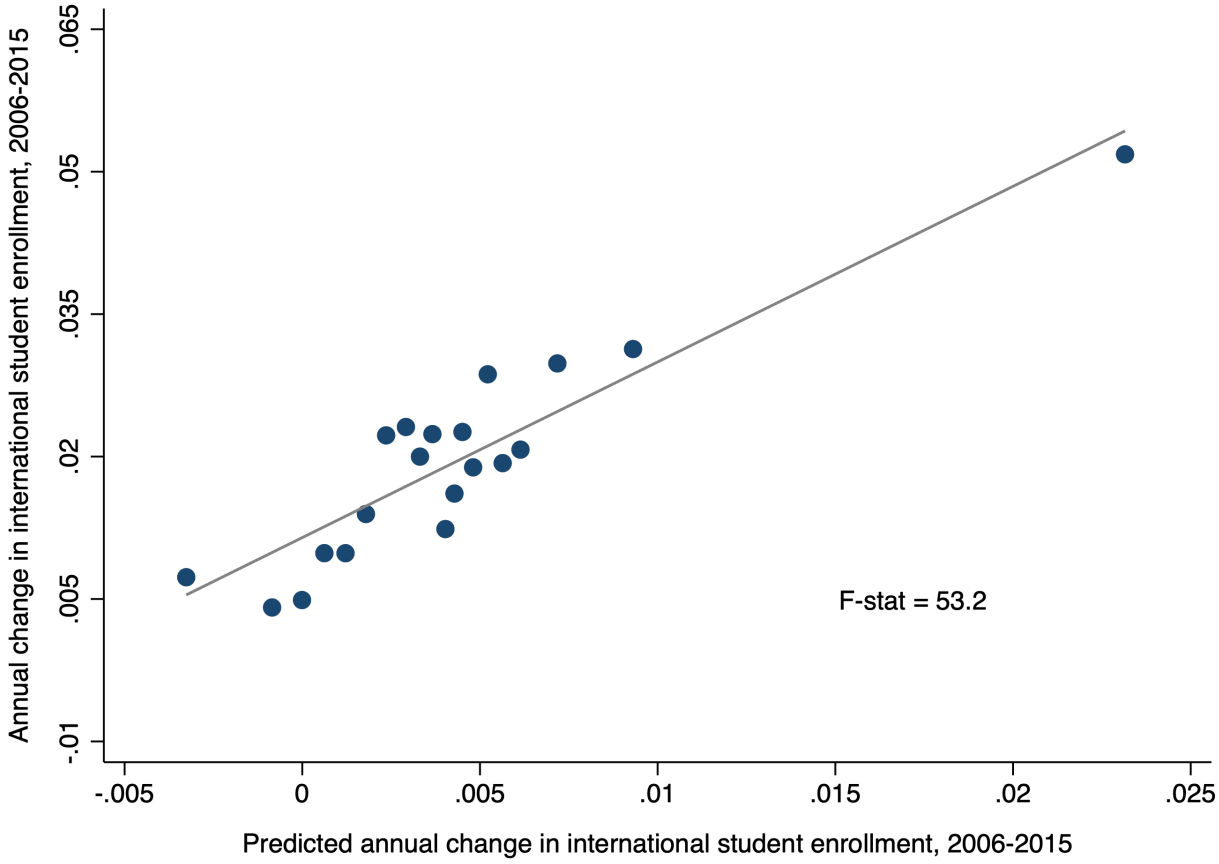


Panel A. Number of International Students, 2005



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

Figure 3: 2SLS 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 shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns. Regression is weighted by commuting zone working-age population in 2005.

Table 1: Falsification Tests of Identification Strategy Using Past Changes in Employment, ACS Estimates, Stacked First Differences

	Changes in Employment-to-Population Ratio			
	$t-4$ to $t-3$	$t-3$ to $t-2$	$t-2$ to $t-1$	$t-1$ to t
	(1)	(2)	(3)	(4)
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.011	0.013	0.010	0.010
	(0.014)	(0.010)	(0.010)	(0.07)
First-stage *F*-statistic	62.6	59.2	54.7	53.3
Observations	5,054	5,776	6,498	7,220

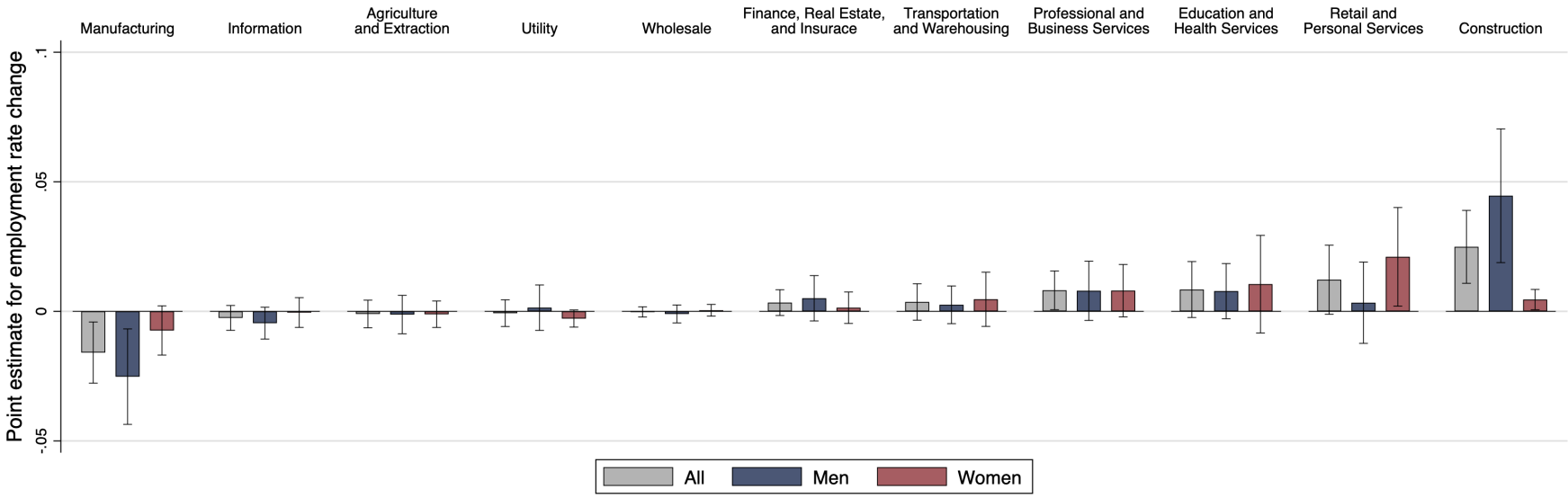
Notes—This table reports IV estimates obtained from regressing past changes in the employment-to-population ratio on instrumented annual changes in foreign enrollment between 2006 and 2015 at the commuting zone level. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns. Regressions are weighted by commuting zone working-age population prior to 2005. 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		Average Wages		Emp. Rate x Average Wages	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. All workers						
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.011	0.036	0.047	0.106	0.069	0.183
	(0.005)	(0.009)	(0.012)	(0.028)	(0.019)	(0.042)
Panel B. Men						
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.013	0.037	0.052	0.090	0.082	0.183
	(0.006)	(0.012)	(0.014)	(0.034)	(0.026)	(0.051)
Panel C. Women						
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.008	0.034	0.040	0.126	0.055	0.179
	(0.004)	(0.011)	(0.013)	(0.035)	(0.018)	(0.045)
First-stage *F*-stat		53.2		53.2		53.2
Observations	7,220	7,220	7,220	7,220	7,220	7,220

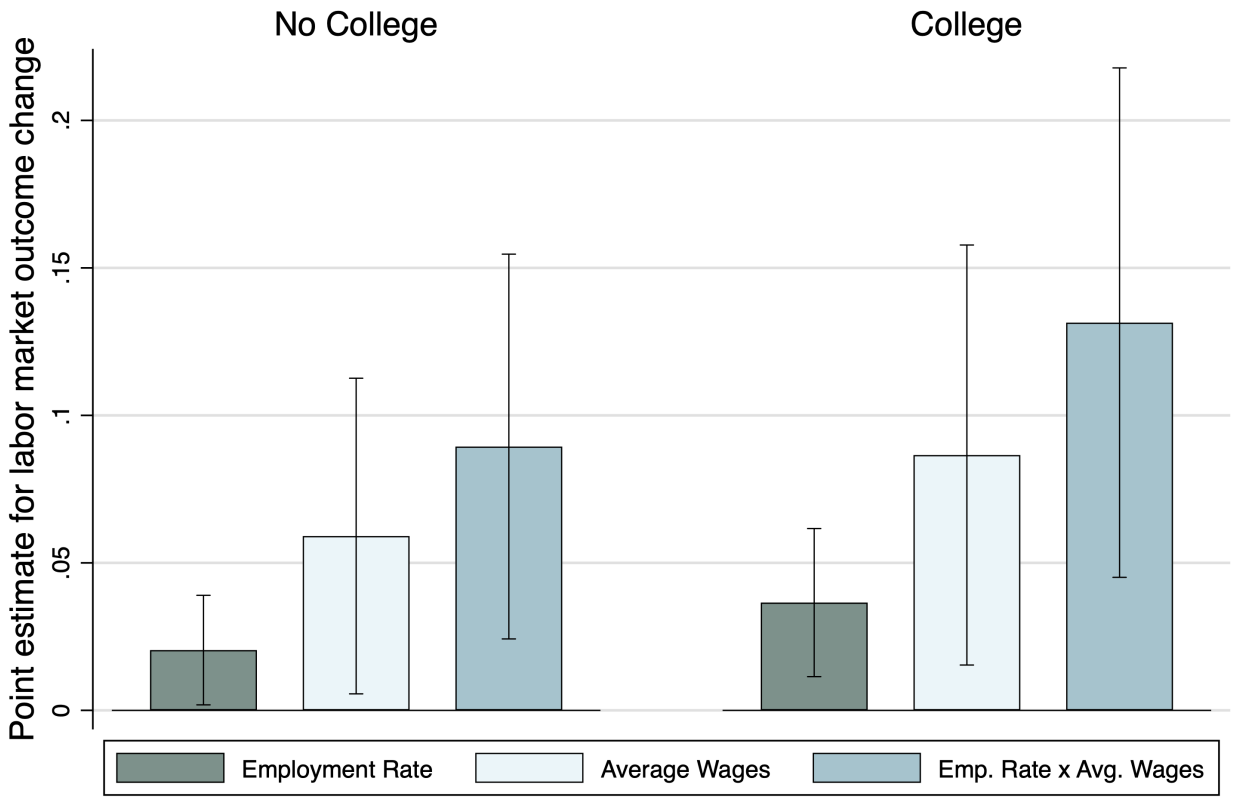
Notes—Outcomes are period changes from *t* to *t+1*. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns. Regressions are weighted by commuting zone working-age population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Figure 4: Effects of International Students on Industries, ACS Estimates



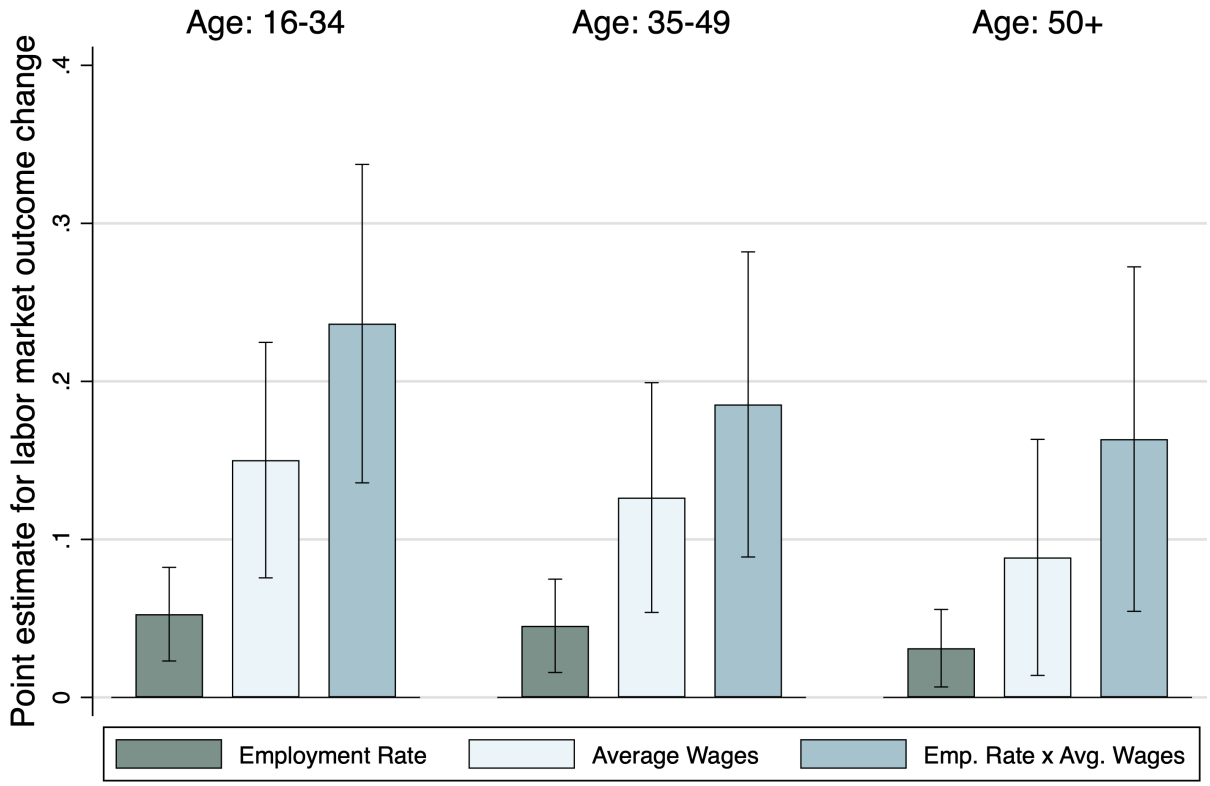
Notes—This figure presents estimates of the effects of international students on changes in industry employment-to-population ratios. The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in column 2 of Table 2.

Figure 5: 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 6. 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 (16-34, 35-49, 50+). 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 3: Effects of International Students on Local Job Flows, YTS Estimates, Stacked First Differences, 2006-2015

Independent variable: $\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	Overall		By Sector			
			Traded		Local	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Net employment growth	0.003	0.024	-0.001	-0.005	0.004	0.029
	(0.005)	(0.011)	(0.003)	(0.005)	(0.003)	(0.009)
Job flows						
Entry	0.009	0.038	0.003	0.004	0.006	0.033
	(0.004)	(0.016)	(0.002)	(0.004)	(0.003)	(0.012)
Expand	0.017	0.076	0.007	0.019	0.010	0.058
	(0.006)	(0.026)	(0.002)	(0.008)	(0.004)	(0.018)
Exit	0.012	0.052	0.007	0.017	0.005	0.034
	(0.006)	(0.024)	(0.003)	(0.009)	(0.003)	(0.015)
Contract	0.011	0.038	0.005	0.011	0.006	0.028
	(0.004)	(0.014)	(0.003)	(0.005)	(0.003)	(0.010)
First-stage *F*-statistic		53.2		53.2		53.2
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 shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns. Regressions are weighted by commuting zone working-age population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Figure 7: 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 2 of table 3.

Table 4: Effects of International Students on Local Job Flows by Establishment Performance Tercile, YTS Estimates, Stacked First Differences, 2006-2015

Independent Variable: $\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	Overall	Lowest Tercile	Middle Tercile	Highest Tercile
	(1)	(2)	(3)	(4)
Entry	0.033	0.010	0.010	0.013
	(0.014)	(0.005)	(0.004)	(0.005)
Expand	0.068	0.003	0.010	0.055
	(0.023)	(0.001)	(0.003)	(0.019)
Exit	0.043	0.041	0.001	0.002
	(0.022)	(0.016)	(0.002)	(0.005)
Contract	0.028	0.013	0.008	0.007
	(0.012)	(0.005)	(0.003)	(0.005)
First-stage *F*-statistic	53.2	53.2	53.2	53.2
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 shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns. Regressions are weighted by commuting zone working-age 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: Falsification Tests of Identification Strategy Using Past Changes in Commuting Zone Characteristics, Stacked First Differences

	State Appropriations per FTE (IPEDS)		Share of Foreign-Born College Graduates in Employment (ACS)		Average Wages (ACS)	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Outcomes: Changes from $t-1$ to t						
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	-0.077	0.024	0.004	0.005	-0.007	-0.020
	(0.028)	(0.072)	(0.002)	(0.004)	(0.011)	(0.023)
First-stage *F*-statistic		53.0		53.3		53.3
Observations	4,764	4,764	7,220	7,220	7,220	7,220
Panel B. Outcomes: Changes from $t-2$ to $t-1$						
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	-0.051	-0.024	0.007	-0.001	-0.034	0.006
	(0.031)	(0.072)	(0.002)	(0.004)	(0.012)	(0.028)
First-stage *F*-statistic		53.1		54.7		54.7
Observations	4,768	4,768	6,498	6,498	6,498	6,498

Notes—This table reports the results of regressing past changes in outcomes on annual changes in foreign enrollment between 2006 and 2015 at the commuting zone level. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns. Regressions in columns 3-6 are weighted by commuting zone working-age population in 2003 in panel A and 2004 in panel B. Robust standard errors in parentheses are clustered at the commuting zone level.

Appendix Table A2—Robustness Checks: Baseline IV Estimates with Alternative Wage Outcomes, Stacked First Differences, 2006-2015

	Baseline: Log Average Wages	Average Residualized Log Wages[(a)]	Log Average Wages at CZ x Demographic Cell Level[(b)]
	(1)	(2)	(3)
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.106	0.68	0.112
	(0.023)	(0.024)	(0.038)
First-stage *F*-statistic	53.2	53.2	45.6
Observations	7,220	7,220	86,634

Notes—(a) Log wages are residualized on gender, race (whites, blacks, Hispanics, and Asians), education (some college, college or professional degree, and masters or doctoral degree) and potential experience. (b) Demographic cells are constructed using gender, age (16-33, 34-49, 50-64), and education (no Bachelor's degree, Bachelor's degree). 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 shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns. Regressions in columns 1 and 2 are weighted by commuting zone working-age population and column 3 by total cell weights in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Appendix Table A3—Effects of International Students on Natives' College Attendance, IV Estimates, Stacked First Differences

	Changes in Natives' College Attendance from *t* to *t+1*		Changes in Natives' College Attendance from *t+1* to *t+2*	
	2-Year	4-Year	2-Year	4-Year
	(1)	(2)	(3)	(4)
Panel A. All Colleges and Universities				
$\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	-0.025	0.011	-0.010	0.015
	(0.012)	(0.010)	(0.008)	(0.015)
Panel B. Public				
$\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	-0.025	0.014	-0.007	0.015
	(0.012)	(0.010)	(0.007)	(0.015)
Panel C. Private, Non-Profit				
$\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	-0.002	-0.002	-0.003	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Panel D. Private, For-Profit				
$\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	0.001	-0.001	0.000	0.000
	(0.006)	(0.001)	(0.003)	(0.000)
First-stage *F*-statistic		41.8		41.8
Observations	5,330	5,330	5,330	5,330

Notes—Observations = 533CZ x 10. Outcomes are period changes in per capita first-time, first-year college enrollment by natives. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns. 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 A4—Robustness Checks: Baseline IV Estimates with Alternative Sample Restrictions, ACS

Independent Variable: $\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	Employment Rate	Average Wages	Emp. Rate x Average Wages
	(1)	(2)	(3)
Panel A			
Same state of birth workers	0.038	0.082	0.173
	(0.012)	(0.030)	(0.045)
First-stage *F*-statistic	53.2	53.2	53.2
Observations	7,220	7,220	7,220
Panel B			
Exclude CZ with the highest numbers of international students in 2005 (top 10%)	0.061	0.178	0.306
	(0.019)	(0.054)	(0.084)
First-stage *F*-statistic	37.6	37.6	37.6
Observations	7,120	7,120	7,120
Panel C			
Exclude CZ with no international students in 2005	0.036	0.117	0.191
	(0.010)	(0.030)	(0.044)
First-stage *F*-statistic	52.1	52.1	52.1
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 shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns. Regressions are weighted by commuting zone working-age 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 Measures of Foreign Enrollment, ACS

Independent Variable: $\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	Employment Rate	Average Wages	Emp. Rate x Average Wages
	(1)	(2)	(3)
Panel A			
Exclude international graduate students	0.073	0.279	0.413
	(0.025)	(0.082)	(0.117)
First-stage *F*-statistic	31.0	31.0	31.0
Observations	7,220	7,220	7,220
Panel B			
Exclude Chinese students	0.137	0.530	0.775
	(0.047)	(0.171)	(0.230)
First-stage *F*-statistic	15.3	15.3	15.3
Observations	7,220	7,220	7,220
Panel C			
Exclude Indian students	0.039	0.103	0.189
	(0.010)	(0.028)	(0.043)
First-stage *F*-statistic	55.9	55.9	55.9
Observations	7,220	7,220	7,220

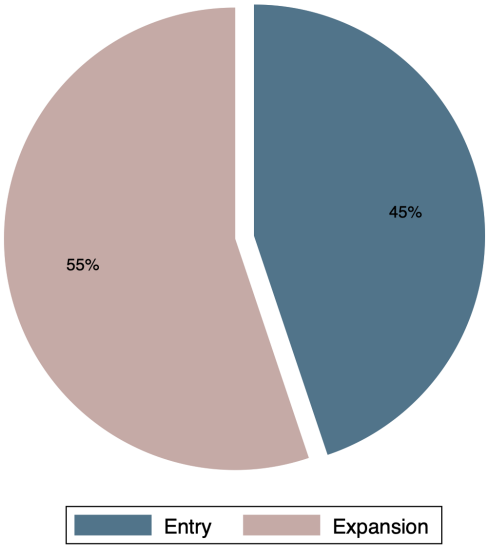
Notes—Outcomes are period changes from *t* to *t+1*. All specifications include year fixed effects and current period changes in (log) population, the population share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns Regressions are weighted by working-age commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Appendix Table A6: Effects of International Students on Local Job Flows, BDS Estimates, Stacked First Differences, 2006-2015

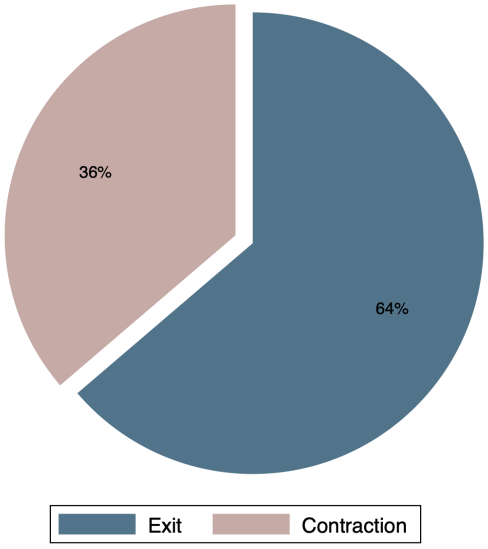
Independent variable: $\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	Overall	
	OLS	IV
	(1)	(2)
Net employment growth	0.012	0.026
	(0.006)	(0.013)
Job flows		
Entry	0.018	0.060
	(0.009)	(0.029)
Expand	0.059	0.155
	(0.017)	(0.061)
Exit	0.021	0.027
	(0.009)	(0.024)
Contract	0.045	0.140
	(0.013)	(0.057)
First-stage *F*-statistic		53.2
Observations	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 shares of the population by age (16-34, 35-49, 50-64, and over 65), education (some college, college or professional degree, and advanced degrees), the share of population working in construction, retail and personal services, and the share of population that are working foreign-borns. Regressions are weighted by commuting zone working-age population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

Appendix Figure B1: Employment Creation and Destruction between 2005 and 2016, YTS Estimates



(a) Job creation shares (average)



(b) Job destruction shares (average)