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. I find that one additional student per thousand working-age residents increases the employment-to-population ratio by 0.19 percentage points and average hourly wages by 0.48 percent. Increases in foreign enrollment also lead to substantial labor reallocations toward potentially more productive establishments, particularly within non-tradable industries. Heterogeneity analyses suggest that these effects are primarily driven by demand-side factors related to student spending, while labor supply contributions from student employment play a more limited role. Overall, these findings point to sizable local economic benefits linked to foreign student inflows through increased local income and business dynamism, and highlight the potential costs of rising trade tensions and restrictive immigration policies, which may slow or reverse recent enrollment trends.

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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 Fig. 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 effects of international students on local labor markets and establishments. Such effects differ fundamentally from those of other immigrant groups due to several important institutional constraints. Notably, US visa restrictions severely limit international students' ability to participate in local labor markets during their studies, primarily positioning them as consumers within the local economy. At the same time, the Curriculum Practical Training (CPT) and Optional Practical Training (OPT) programs offer avenues for limited training and temporary labor market participation before and upon graduation, provided employment relates to students' fields of study. Recent work by Beine, Peri, and Raux (2023) shows that a modest share of international students eventually transition into the U.S. workforce through the OPT program, particularly in high-skilled sectors. Building on these institutional details, this paper provides the first comprehensive evidence on the short-run economic impact of international students on local economies, and uses rich administrative data to disentangle the extent to which this impact reflects students' spending on local goods and services (demand channel) versus their participation in the labor market (supply channel).

My empirical analysis draws on several data sources and uses the concept of commuting zones

[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).

to approximate local labor markets. At its core is a rich administrative dataset covering all international students enrolled in US higher education under F-1 student visa status between 2003 and 2015. The 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, deteriorating local economic conditions may increase universities' reliance on international students for tuition revenue, potentially leading to a downward bias in OLS estimates of the effects of increased foreign enrollment on local labor markets and firms..

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 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 in-

crease in enrollment by one student per thousand working-age 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). These sizable estimates likely reflect both the direct employment supported by student expenditures and broader general equilibrium effects, such as increased local demand stemming from higher native earnings and housing wealth. Assuming a fiscal multiplier of 1.9 for university spending (Kantor and Whalley 2014), the implied cost of creating one job is approximately $36,000, consistent with recent evaluations of government spending programs (Serrato and Wingender 2016).

To disentangle the relative importance of the demand versus labor supply channels in generating these local labor market effects, I leverage detailed administrative data that allow me to measure students' potential contributions to local economies through their demand for local goods and services, as well as their direct labor market participation via CPT and OPT employment authorizations. I find that employment gains are larger and more pronounced in commuting zones experiencing above-median increases in students' reported financial resources, reflecting stronger local demand shocks driven by student expenditures. In contrast, heterogeneity analyses by local OPT intensity, measured by the number of full-time equivalent OPT participants per working-age resident, reveal no meaningful differences in local employment effects between commuting zones experiencing above- or below-median changes in student-driven labor supply. Consistent with the predominant role of the demand channel, employment effects are concentrated in the non-tradable sector, particularly in construction and services. Importantly, I show that these labor market effects reflect an expansion in the capacity of US higher education to attract international students, rather than displacement of domestic students from local labor markets.[2]

To better understand the sizable local employment effects documented above, I next examine

[2]I document a small decline in first-time, first-year domestic enrollment at two-year programs, likely driven by improved labor market conditions that raise the opportunity cost of attending community college.

the underlying job flow dynamics using Business Dynamics Statistics data as well as establishment microdata from the Your-Economy Time Series database. The latter tracks establishments across the US and contains detailed information on employment, industry affiliation, and sales, allowing me to measure how increases in foreign enrollment affect gross job creation and destruction. My analysis shows that the net increase in local employment conceals substantial churn at the establishment level, with significant job creation from entry and expansion alongside substantial job destruction due to exit and contraction. Importantly, are driven primarily by entry and expansion in service-oriented industries that tend to have relatively low barriers to entry. Using average annual sales growth to proxy for establishment performance, I further show that these dynamics reflect a reallocation of labor toward higher-performing establishments: expansions occur disproportionately among more productive firms, while job losses are concentrated among the least productive. These patterns are consistent with general equilibrium models featuring heterogeneous firms (e.g., Melitz 2003; Bernard, Redding, and Schott 2007; Melitz and Ottaviano 2008), which predict that positive local demand shocks, such as those induced by student spending, heighten competition and trigger reallocation toward more efficient producers. Thus, the presence of international students may not only raise local employment and earnings but also enhance aggregate productivity by reallocating labor and market shares to more capable firms.

My findings contribute to three separate strands of literature. First, existing studies on the impact of international students have largely focused on outcomes within the higher education sector, including school finance (Bound et al., 2020), domestic enrollment (Shih, 2017; Zhu, 2024), academic innovation (Chellaraj, Maskus, and Mattoo, 2008; Stuen, Mobarak, and Maskus, 2012), and domestic students' major and occupational choices (Anelli, Shih, and Williams, 2023). Beyond education-specific outcomes, recent work has begun to explore spillovers into other local markets. Mocanu and Tremacoldi-Rossi (2023), for example, show that international student inflows raised local rents and home prices. Beine, Peri, and Raux (2023) document that only a modest share of international graduates, particularly those in STEM fields, enter the US workforce through OPT, highlighting the important yet limited scale of their short-run labor supply contributions. Building

on this growing literature, my paper shifts attention to the broader short-run economic consequences of foreign enrollment, especially the role of international students in driving local labor demand and shaping within-industry resource reallocations. My findings speak directly to current policy concerns about the potential local economic costs of declining enrollment due to trade tensions (Khanna et al., 2023) and increasingly restrictive immigration policies (Peri, Shih, and Sparber, 2020; Feeney et al., 2023).

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 contribute to this demand-side perspective by studying a large and growing group of foreign-born individuals in the U.S. whose ability to participate in the labor market is severely limited due to visa restrictions. To the extent that their local spending generates employment, these effects may partially offset any labor supply pressures, helping explain why many empirical studies have found relatively modest impacts of immigration on natives' employment and wages.[4]

Lastly, 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

[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. 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.

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

2018). My findings reinforce the notion that competition can have productivity-enhancing effects (Syverson 2011) and underscore the significance of firm dynamics in shaping local economic adjustments to immigration (Glennon 2024).

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 4 presents results on the effects of international students on local employment and wages, and explores underlying mechanisms. Section 5 examines the effects on local job flows and their distributional implications. Section 6 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.

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

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 I-20 records cover the universe of F-1 visa holders enrolled in US higher education institutions between 2003 and 2015 and contain detailed student-level information, including country and city of origin, program level, field of study, school name and location, program start and end dates, and sources of financial support (e.g., personal funds, family support, school-based aid, or government sponsorship).

Using program start and end dates, I construct annual commuting zone-level measures of international student enrollment, defined as the number of students enrolled at any point during the year in institutions located within each commuting zone. I also use the reported financial support data to create a measure of average funding per student in each zone and year. This variable serves as a proxy for students' potential spending power and is used to examine heterogeneity in the local labor market impact of foreign enrollment, particularly by the strength of demand-side effects. In addition, I draw on a separate dataset of Optional Practical Training (OPT) authorizations available from the ICE FOIA library. These records include employer names, locations, and start and end dates of employment. I use this information to construct a measure of OPT intensity, expressed in full-time equivalent units based on employer address, which allows me to explore the potential contribution of international students to local labor supply in the short run.

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 space 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 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.[6] Lastly, I also use ACS data to construct a set of covariates that control for changes in commuting zone characteristics."

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.[7] 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

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

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

establishments. Fig. 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.[8] 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 a stacked first-difference model that has been used in the immigration literature (e.g., Monras 2020)

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

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 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.[9] Furthermore, the lag structure of the

[8] See Appendix Table A1 for a tabulation of summary statistics.

[9] An 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).

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] However, commuting zones may still differ systematically in time-varying characteristics that could predict unobserved shocks to local economic conditions. For instance, areas with a stronger international student presence may have younger, more educated populations or a higher share of foreign-born residents. To further account for such differences, I control for a set of time-varying population characteristics, X_{ct}, including changes in (log) population; the share of females; the share of residents aged 65 and older; the shares of the population by education (some college, college or professional degree, and advanced degrees); and the share of non-citizen workers. It is worth noting that, while some of these variables may be endogenous, my estimates are not sensitive to their inclusion. Lastly, 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 year 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

[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.

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, 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.

[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, 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.

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. (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

$$\widehat{\Delta \text{IS}}_{c,t} = \sum_{k} \frac{\text{IS}_{c,k,2003}}{\text{IS}_{k,2003}} \times \Delta \text{IS}_{t,k}^{\text{Australia, Canada, UK}} \tag{2}$$

where $\Delta \text{IS}_{t,k}^{\text{Australia, Canada, UK}}$ is period change in the enrollment of international students from country k in the three mentioned destinations. The share component, $\frac{\text{IS}_{c,k,2003}}{\text{IS}_{k,2003}}$, 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 Fig. 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. Fig. 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 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.[12] Specifically, since the sum of exposure shares, $\sum_k \frac{\text{IS}_{c,k,2003}}{\text{IS}_{k,2003}}$, 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 UK are orthogonal to (share-weighted) unobserved factors affecting local labor market conditions in the US.

To assess the validity of the identifying assumptions underlying the shift-share design, I implement two complementary falsification tests following the framework of Borusyak, Hull, and Jaravel (2022). These tests examine whether the variation used in estimation—either the shifters (shocks) or the instrument—predicts pre-determined, past changes in commuting zone characteristics.

Panel A of Table 1 tests the assumption that changes in foreign enrollment in non-US destinations (the shocks) are conditionally orthogonal to pre-existing trends in commuting zone characteristics. Specifically, I test whether share-weighted lagged changes in commuting zone outcomes are correlated with *future* changes in non-US foreign enrollment, after conditioning on baseline covariates. To implement this, I first residualize both past commuting zone outcomes and future foreign enrollment changes on baseline controls and aggregate the residuals to the country-of-origin level using exposure shares. Having aggregated these variables, I then regress past changes in commuting zones' outcomes on future changes in foreign enrollment, instrumented directly by

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

changes in non-US enrollment. Across a range of lagged outcomes—including changes in state appropriations for higher education, foreign-born high-skilled shares, employment rates, and average wages—there is no evidence of a significant correlation, supporting the plausibility of shock orthogonality.

Next, I test the exogeneity of the shift-share instrument itself, which follows from shock orthogonality under BHJ's equivalence results. Panel B of Table 1 reports both OLS and IV estimates from regressions of lagged changes in commuting zone outcomes on future changes in foreign enrollment, controlling for the full set of second-stage covariates. The OLS results show statistically significant correlations: commuting zones with subsequent increases in foreign enrollment tend to have experienced, in prior years, reductions in state higher education funding, increases in high-skilled immigration, rising employment, and falling average wages. These patterns suggest potential bias in naive OLS estimates. In contrast, when foreign enrollment is instrumented using the shift-share strategy, these relationships disappear—the estimated coefficients are near zero and statistically insignificant. This supports the validity of the instrument, consistent with the assumption that shocks to foreign enrollment in non-US destinations are plausibly orthogonal to pre-existing local trends in the US.

A final concern with the shift-share strategy is that enrollment patterns across destination countries may reflect some substitution effects among students who apply to programs in multiple destinations. In such cases, country-specific increases in enrollment in one destination may partly reflect declines in the US, complicating the interpretation of the shift-share estimates. In Section 4.2, I address this concern by constructing an alternative shift-share instrument based on enrollment changes across all non-US destinations, using data from the UNESCO Institute of Statistics. This broader measure of student mobility preserves the supply-driven variation in foreign enrollment while plausibly reducing the influence of substitution effects. The resulting estimates remain similar to the baseline, suggesting that substitution effects are not a major empirical concern in this setting. This makes intuitive sense, as there is a strong correlation (0.81) between enrollment changes in the US and combined changes in Australia, Canada, and the UK across years and coun-

tries of origin, reflecting the previously discussed overall increase in the global supply of students seeking to study overseas (Appendix Fig. B1).

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 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 aid readability, I report coefficients in terms of changes in foreign enrollment per 100 working-age residents in all tables, but interpret effect sizes in the text based on changes per 1,000 residents.

4.1 Overall employment and wage effects

Table 2 reports the effects of foreign enrollment on local employment and wage outcomes, estimated from equation 1. Focusing on employment effects (panel A), the OLS estimates in columns 1 and 2 suggest that an increase in foreign enrollment by one student per thousand working-age residents raises the overall employment-to-population ratio by 0.05 percentage points. These estimates, however, are only significant at the 10 percent level. By contrast, the corresponding IV estimates are substantially larger—0.17 (without controls) and 0.19 (with controls) percentage points—and are significant at the 1 percent level. Given a one standard deviation change in foreign enrollment of 0.79 students per thousand working-age 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, over the study period, the overall increase in foreign enrollment may have led to the creation of 1.17 million jobs, which is equivalent in magnitude to about 49-59% of the estimated displacement impact stemming from the increase in import competition from China between 1999 and 2011 (Acemoglu et al. 2016).

The employment effects implied by the estimates are economically meaningful and consistent with the scale of resources that international students bring into local economies. A large share of student spending goes toward tuition and fees, which have been shown to generate sizable spillovers in local labor markets. Kantor and Whalley (2014), for instance, estimate that each additional dollar of university spending increases non-education labor income by 89 cents, implying a local multiplier of roughly 1.9. Students also contribute to housing demand, which raises local prices (Mocanu and Tremacoldi-Rossi 2023) and stimulates further labor demand through increased construction and consumption effects (Charles, Hurst, and Notowidigdo 2018). As such, the estimates likely capture both the direct impact of student expenditures and broader general equilibrium effects tied to earnings and housing values. For context, in 2018, approximately 1.3 million international students generated an estimated $47.3 billion in education-related revenue. Applying a multiplier of 1.9 and attributing 2.47 million jobs to this activity yields an implied

cost per job of $36,384—broadly consistent with evaluations of recent public spending programs (Serrato and Wingender 2016).

Turning to wage effects, panel B shows that both OLS and IV estimates of the impact on commuting zones' (log) average wages are positive and statistically significant. Results from the IV specification with covariates (column 4) indicates that one additional international student per 1,000 working-age residents increases average wages by 0.48 percent. 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 panel C, 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 compositional shifts in the workforce.

To understand the mechanisms driving the observed labor market effects of international students, in Table 3, I explore heterogeneity along two distinct dimensions: by students' potential contributions to local economies through spending (Panel A) and labor supply (Panel B). Panel A examines whether the impact of foreign enrollment varies with changes in the average amount of financial resources reported per student.[13] As discussed earlier, the growth in foreign enrollment during the study period 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 administrative I-20 records, reflects their family's financial capacity and serves as a proxy for potential local spending, this

[13] Resources are adjusted for inflation using the Higher Education Price Index (HEPI) and converted to base year 2018.

measure captures variation in the strength of demand shocks across commuting zones. The results show that employment and wage effects of an increase in foreign enrollment are more pronounced among commuting zones experiencing above-median change in average student funding (average increase of $1,459 per student). By contrast, in commuting zones with below-median changes, where student funding declined on average (–$637 per student), enrollment increases have muted, statistically insignificant effects (and negatively signed, in the case of employment). This result pattern supports a demand-side interpretation, whereby financially better-resourced students generate stronger local spillovers through their spending on tuition, housing, goods, and services.

Next, I examine heterogeneity by changes in labor supply exposure, measured as the change in full-time equivalent (FTE) OPT participants per working-age resident.[14] On average, commuting zones hosted approximately 44 OPT FTEs during the study period, with the vast majority accounted for by post-completion participation. Commuting zones with above the median change saw a small average increase of 0.0336 FTE participants per thousand working-age residents, whereas below-median areas experienced an average decline of 0.0136 participants. In line with these figures, the results in Panel B imply no heterogeneity in employment effects, while wage and residual wage effects are somewhat smaller in commuting zones that experienced above-median increases in OPT intensity. One potential explanation for this pattern is that in these areas, the influx of OPT workers, who may compete with recent college graduates and other high-skilled workers, exerts downward pressure on wages in the short run.[15] Overall, given the limited participation of students in pre-completion training and the documented low transition rates into the local workforce, my results suggest that demand-side forces, particularly student spending and associated institutional activity, are likely the primary drivers of the observed labor market gains, whereas student-driven labor supply plays a more limited role in the short term.

I conclude this section with a brief discussion of issues related domestic enrollment. One nat-

[14] To construct the full-time equivalent measure, I use employment start and end dates to calculate the fraction of each calendar year during which an OPT participant, whether pre- or post-graduation, is employed.

[15] Beine, Peri, and Raux (2023) find that transitions from student status to local employment are relatively modest, and those that do occur are concentrated in STEM fields, suggesting that OPT participants may disproportionately compete with high-skilled native workers.

ural 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 A2, I present OLS estimates obtained from regressing labor market outcomes on changes in 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 A3, 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 Robustness checks

In Appendix Table A4, I assess the robustness of my baseline estimates to an alternative construction of the shift-share instrument and other measures of foreign enrollment. Panel A presents results using an instrument based on changes in international student enrollment across all non-US destinations, using data from the UNESCO Institute of Statistics. This approach addresses concerns that enrollment patterns across major English-speaking destinations—namely, Australia, Canada, and the UK—may reflect student preferences for a relatively narrow set of institutions or regions, leading to substitution effects between these countries and the US. For example, if students from a given origin country (e.g., China or India) tend to apply to a similar group of universities across destinations, an increase in enrollment in one destination country may come at the expense of another. By aggregating enrollment across all destination countries except the US, the alternative instrument preserves the supply-driven variation in foreign enrollment while plausibly reducing the influence of substitution effects across individual destinations. The resulting IV estimates remain similar in magnitude and significance despite a decline in first-stage strength, suggesting that my main results are not compromised by substitution effects across a narrow set of destinations.

In Panel B, I exclude graduate students from the measure of foreign enrollment. The resulting IV estimates are larger than the baseline, suggesting that the main effects are not driven by high-skilled immigration. In Panel C, I exclude the largest group of international students in the US—those from China. The estimates remain positive and statistically significant, indicating that my results are not solely driven by Chinese enrollment.

Appendix Table A5 presents additional robustness checks based on alternative sample restrictions. One potential concern is that migratory responses by native workers could offset the initial effects of the labor demand shock (Blanchard et al. 1992; Bound and Holzer 2000; Cadena and Kovak 2016; Monras 2020; Notowidigdo 2020). Although such responses are unlikely to be large in the short run, they could attenuate the estimated effects and render them lower bounds. Follow-

ing Charles, Hurst, and Notowidigdo (2018), I address this concern by restricting the sample to natives living in their state of birth—individuals less likely to have relocated in response to labor market shocks. Panel A shows that IV estimates for this sample are nearly identical to the baseline, suggesting that endogenous migration is not a major concern, especially in light of recent evidence on declining geographic mobility in the US (Basso and Peri 2020). In Panels B and C, I further test sensitivity by excluding, respectively, the top 10% of commuting zones with the highest number of international students and those with no international students in 2005. In both cases, the IV estimates for employment and wage effects remain positive and statistically significant, suggesting that the results are not driven by any particular commuting zone.

4.3 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.

Fig. 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 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 working-age 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.[16] 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.

4.4 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.

Fig. 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

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

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 Fig. 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 are significant across different groups of workers. While these findings highlight the immediate economic benefits associated with rising international student enrollment—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. I now turn to examine these dynamics in the next section.

5 Effects of International Students on Local Job Flows

Given the sizable employment and wage effects documented in the previous section, which are largely driven by enrollment-induced local demand shocks, a natural question is whether

these shocks also generate aggregate productivity gains by expanding market size.[17] One channel through which such gains may arise is a between-firm selection mechanism, in which labor and market share are reallocated toward more efficient establishments as increased demand heightens competition in both 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. Motivated by 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 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

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

where $\bar{P}_{c,t} = (P_{c,t-1} + P_{c,t})/2$ is the mid-point 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. $E^{\text{entry}}_{c,t}$ 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

[17] Recent studies show that immigration can influence firm entry, productivity, and reallocation mechanisms, and suggest that firm-level responses are a key component of local adjustments (e.g., Waugh 2018; Glennon 2024).

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

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 working-age 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 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

[19] These 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.

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. Fig. 7 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 (though 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 Fig. 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 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. 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

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

where $\underline{t}$ and $\bar{t}$ denote the earliest and latest year in which establishment i exists in the sample, respectively.[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.

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

[21] Following 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).

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 working-age 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 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 per capita income and the concurrent surge in demand for quality education in many emerging economies have led to a dramatic rise 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 from abroad each year. These trends have attracted growing attention from both economists and policymakers, yet 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 address 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 working-age residents raises the employment-to-population ratio by 0.19 percentage points and average wages by 0.48%. These effects are concentrated in the non-tradable sector, particularly in construction and services, and largely reflect increases in local

[22] 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).

demand for goods and services.

Further analysis shows that increased foreign enrollment also drives within-industry labor reallocations toward higher-performing establishments, consistent with models featuring firm heterogeneity and market competition. These findings indicate that international students not only boost short-run labor market outcomes but may also generate longer-run productivity gains. As such, they underscore the potentially high economic costs of rising trade tensions and restrictive immigration policies, which may slow or reverse recent enrollment growth.

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, many international students eventually transition into the US workforce, particularly in high-skilled sectors, highlighting a potentially important labor supply channel in the medium to long run (Hunt and Gauthier-Loiselle, 2010; Peri, Shih, and Sparber, 2015; Hanson, Kerr, and Turner, 2018; Beine, Peri, and Raux, 2023). These longer-term dynamics, while beyond the scope of this paper, merits closer attention in future work.

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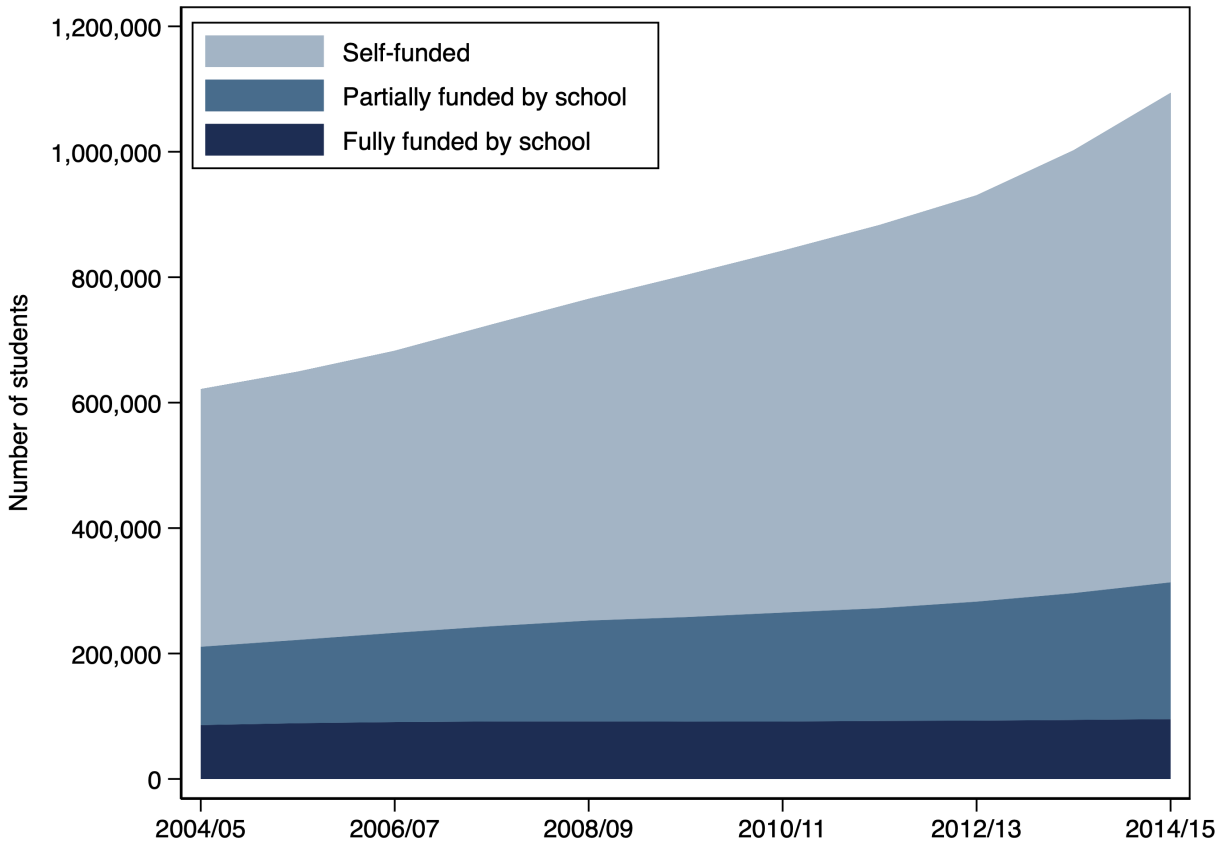
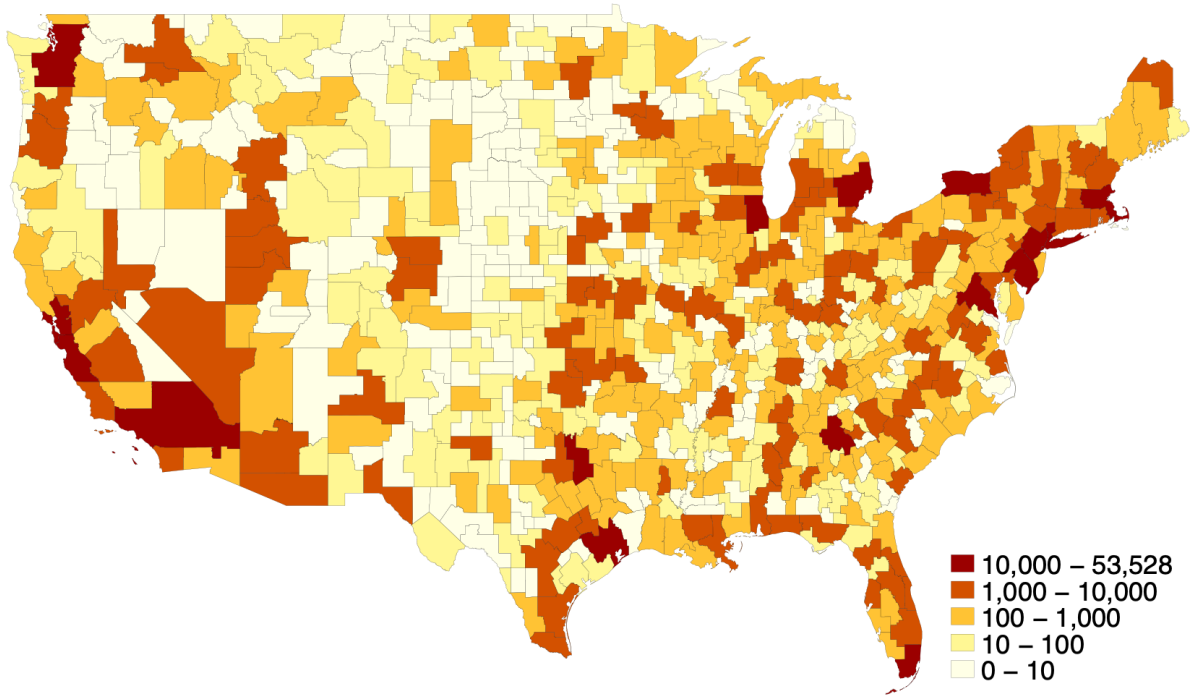
Figure 1: Trends in International Student Enrollment in US Higher Education by Funding Status.

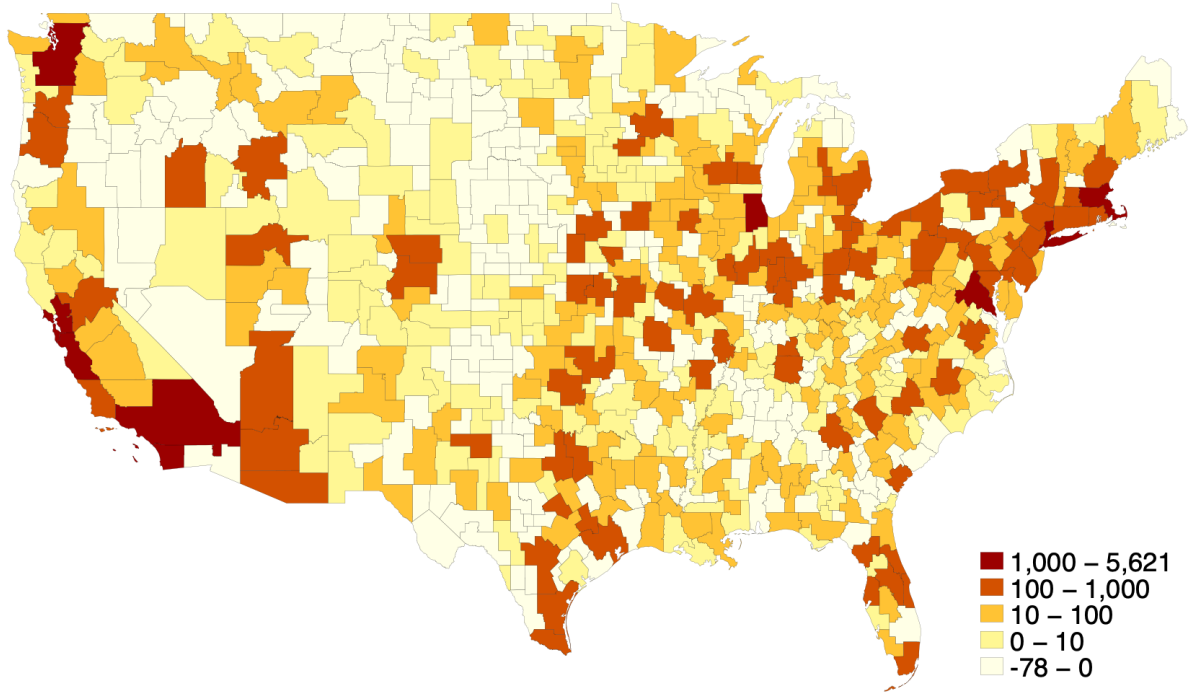


Source: Author's calculations based on administrative data from US Department of Homeland Security.

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

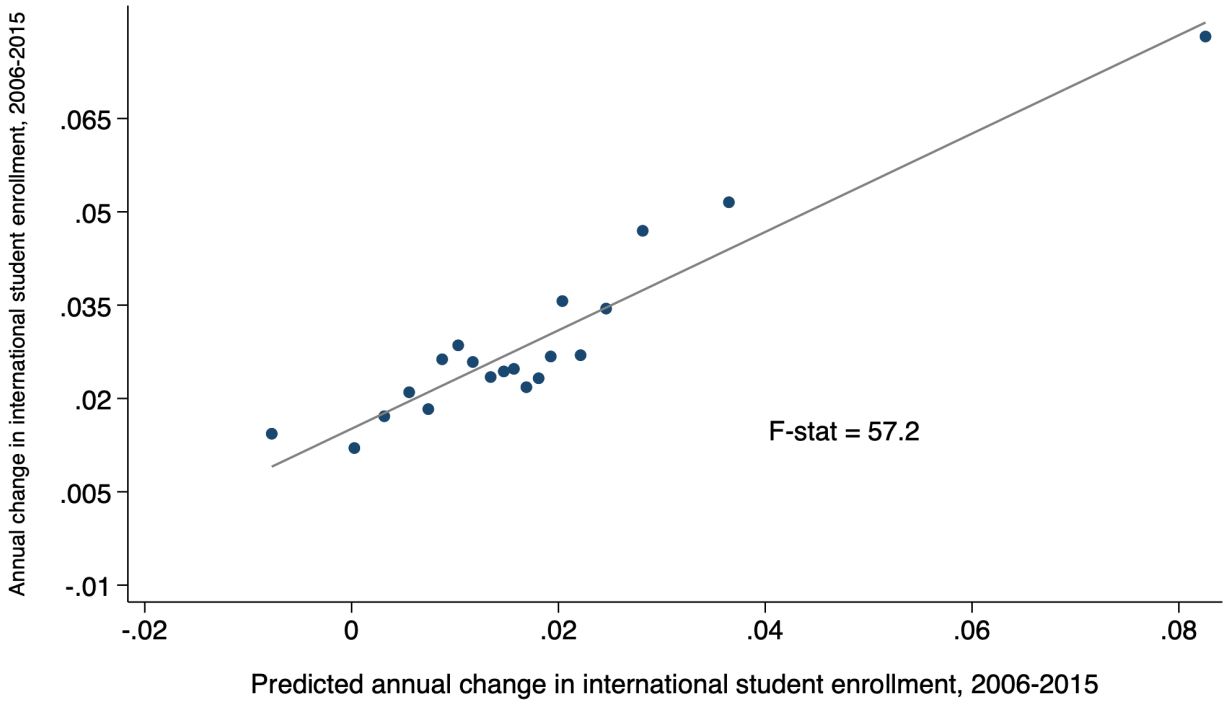


Panel A. Number of International Students, 2005



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

Figure 3: 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. (1)	SE (2)	Coef. (3)	SE (4)
Panel A. Country-of-origin-level regressions				
Δ_tState appropriations per public FTE			0.018	(0.067)
Δ_{t-1}State appropriations per public FTE			-0.030	(0.063)
Δ_tPop. 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_tEmployment rate			0.005	(0.010)
Δ_{t-1}Employment rate			0.008	(0.010)
Δ_tAverage wages			-0.001	(0.022)
Δ_{t-1}Average wages			0.014	(0.016)
Panel B. Commuting-zone-level regressions				
Δ_tState 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_tPop. 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_tEmployment rate	0.010***	(0.003)	0.007	(0.006)
Δ_{t-1}Employment rate	0.010***	(0.003)	0.008	(0.007)
Δ_tAverage 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

	OLS	OLS	IV	IV
	(1)	(2)	(3)	(4)
Panel A. Outcome: Employment rate				
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.005*	0.005*	0.017***	0.019***
	(0.003)	(0.003)	(0.006)	(0.006)
Panel B. Outcome: Log (average wages)				
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.035***	0.033***	0.067***	0.048***
	(0.009)	(0.009)	(0.018)	(0.016)
Panel C. Outcome: Avg. resid. log wages				
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.026***	0.023***	0.057***	0.045***
	(0.007)	(0.006)	(0.016)	(0.015)
First-stage *F*-stat			58.1	57.2
Characteristics controls	No	Yes	No	Yes
Observations	7,220	7,220	7,220	7,220

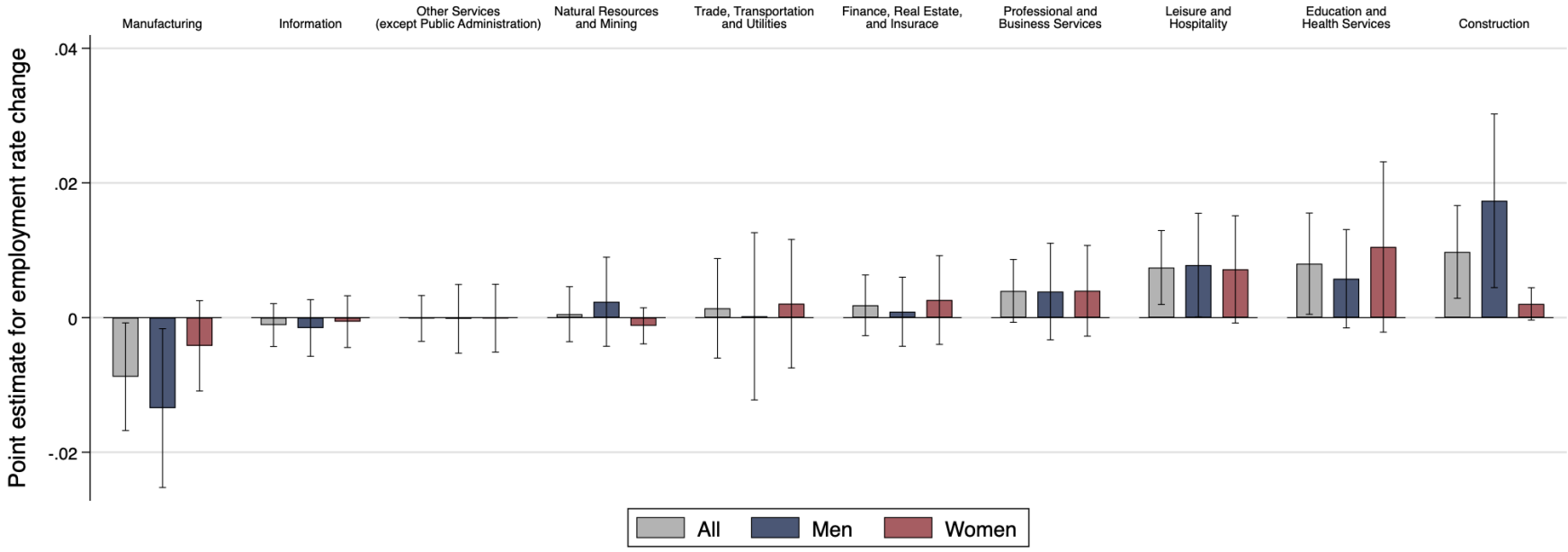
Notes—Outcomes are period changes from *t* to *t+1*. All specifications include year fixed effects Characteristics controls include current period changes in (log) population, the population share of females, the share of the population over 64 years old, the shares of the population by education (some college, college or professional degree, and advanced degrees), and the population share of non-citizen workers. Specifications (3) 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.

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

	Emp. Rate	Log Avg. Wages	Avg. Residualized Log Wages
	(1)	(2)	(3)
Panel A. Heterogeneity by Period Change in Average Student Funding			
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	-0.007	0.013	0.021
$\times$ Below Median Change	(0.016)	(0.028)	(0.023)
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100 \times$ Above Median	0.025***	0.057***	0.051***
$\times$ Above Median Change	(0.007)	(0.017)	(0.016)
p-value (Above = Below)	0.064*	0.119	0.171
First-stage F-stat	35.6	35.6	35.6
Observations	7,220	7,220	7,220
Panel B. Heterogeneity by Period Change in OPT Intensity Per Working-Age Resident			
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.019	0.109***	0.063***
$\times$ Below Median Change	(0.012)	(0.029)	(0.020)
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.019***	0.028*	0.039**
$\times$ Above Median Change	(0.007)	(0.016)	(0.016)
p-value (Above = Below)	0.990	0.013**	0.294
First-stage *F*-stat	31.8	31.8	31.8
Observations	7,220	7,220	7,220

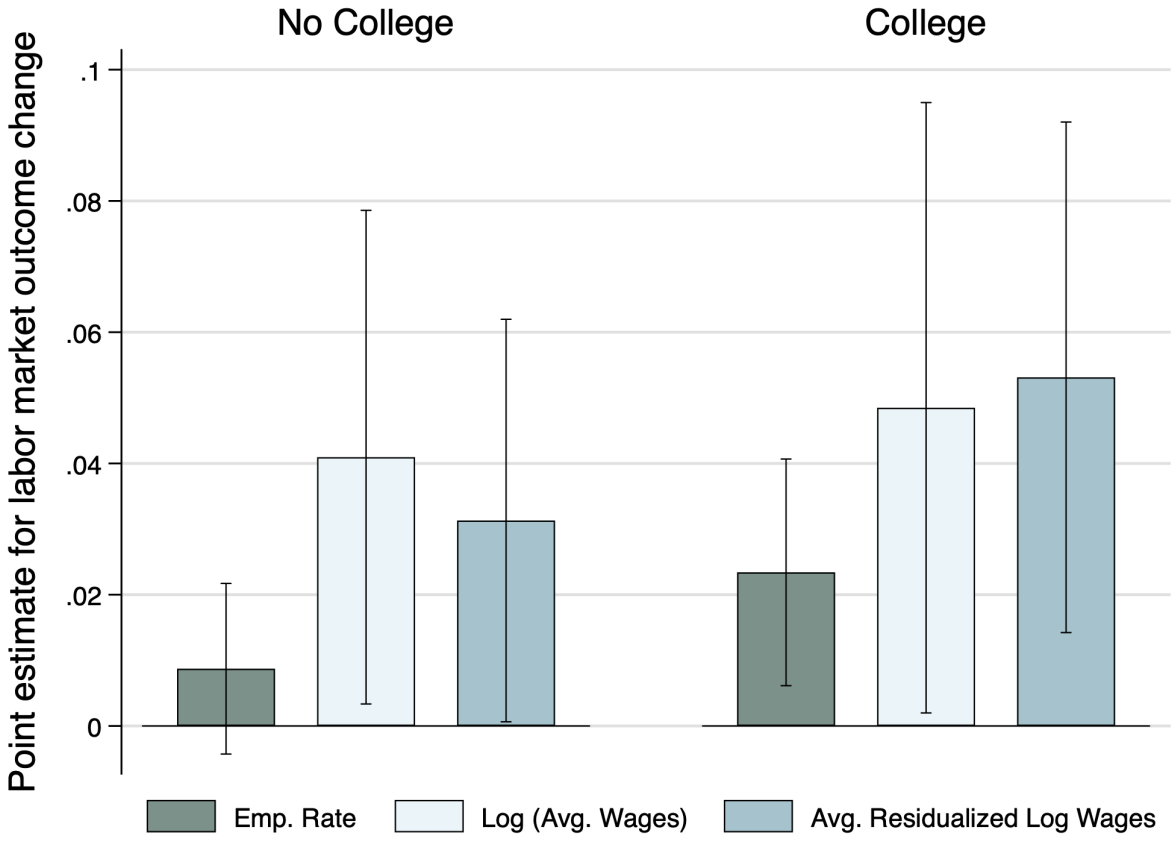
Notes—Outcomes are period changes from *t* to *t+1*. Panel A: Student funding includes all sources reported in I-20 records, averaged across total enrollment at the commuting zone level. Panel B: OPT intensity is measured as the number of full-time equivalent OPT participants working in the commuting zone per working-age resident. All specifications include the same set of covariates as described in the footnote of Table 2. Regressions are weighted by commuting zone 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



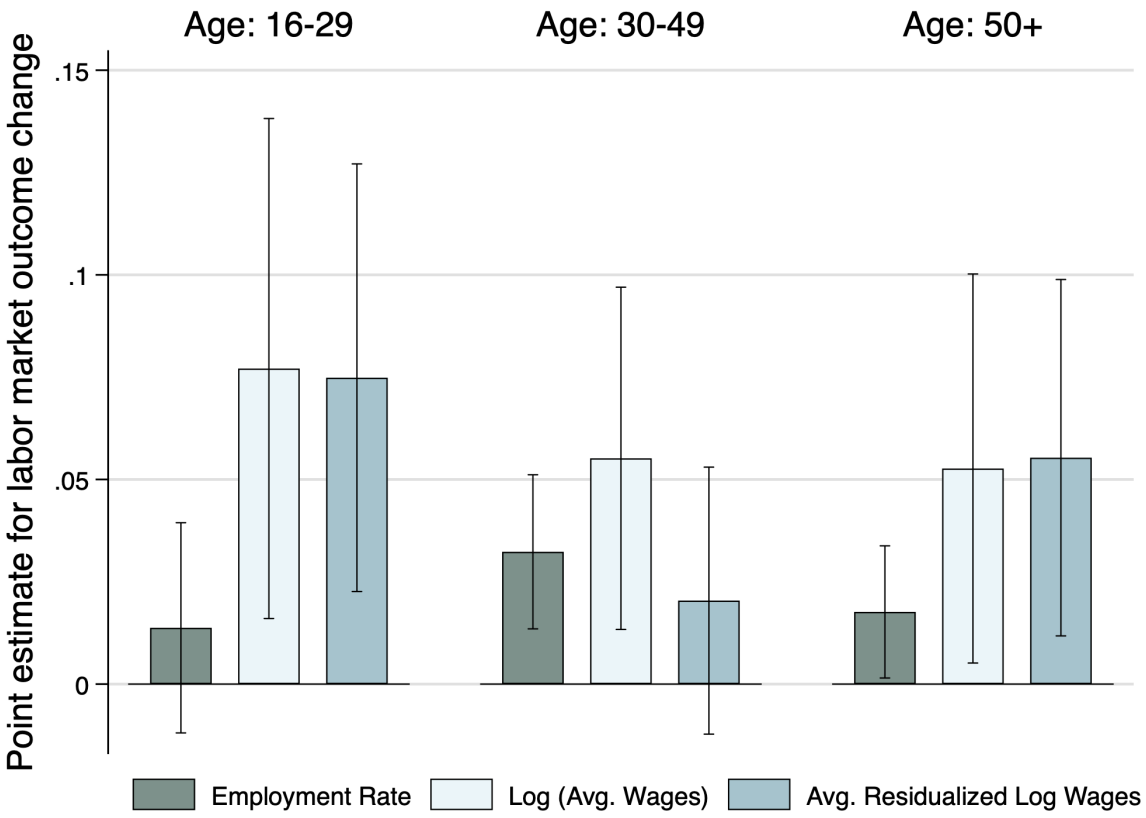
Notes—This figure presents estimates of the effects of international students on changes in industry employment-to-population ratios. The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in column 2 of Table 2.

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



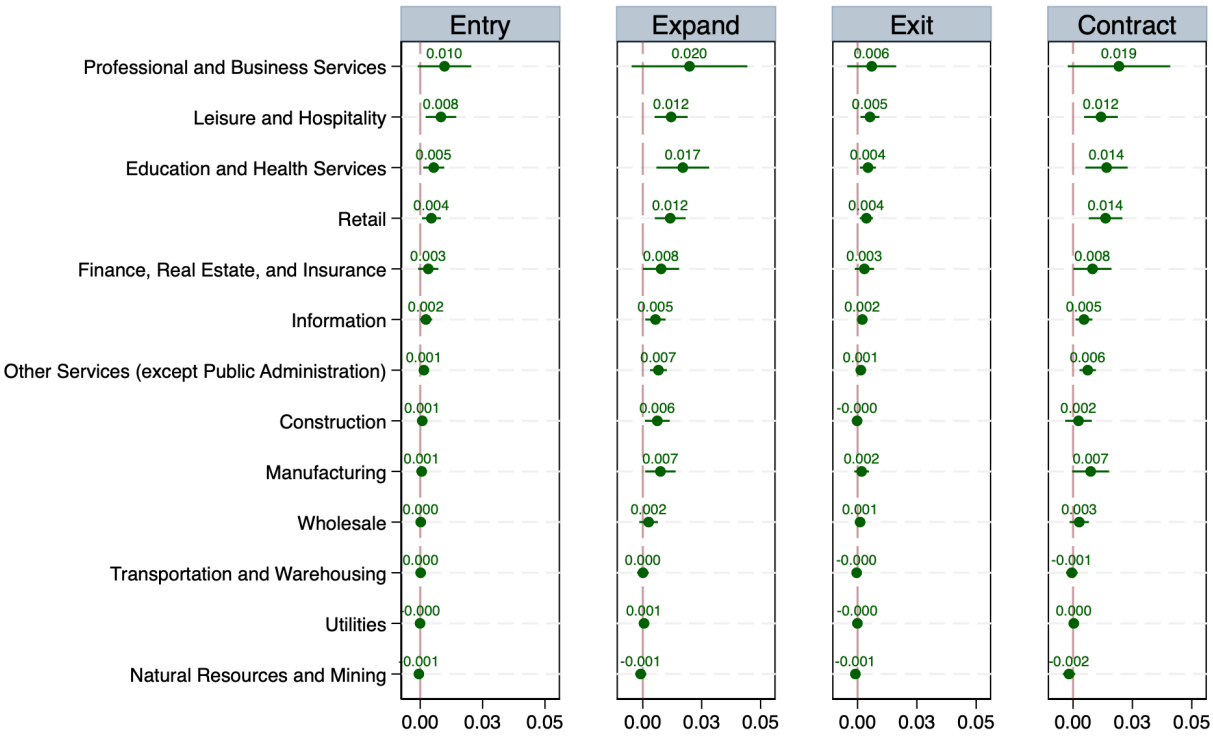
Notes—This figure presents estimates of the effects of international students on changes in employment and wage outcomes of natives in different age groups. The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in columns 2, 4, and 6 of 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	
					Traded	Local
	OLS	OLS	IV	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Net employment growth	0.006**	0.004**	0.017*	0.020***	0.001	0.019***
	(0.003)	(0.002)	(0.010)	(0.006)	(0.002)	(0.004)
Job flows						
Entry	0.002	0.010***	0.036**	0.024***	0.005**	0.019***
	(0.003)	(0.003)	(0.016)	(0.009)	(0.002)	(0.007)
Expand	0.017**	0.017***	0.096***	0.044***	0.010***	0.034***
	(0.007)	(0.004)	(0.034)	(0.013)	(0.004)	(0.010)
Exit	0.001	0.015***	0.027*	0.028**	0.008*	0.020**
	(0.003)	(0.005)	(0.014)	(0.013)	(0.004)	(0.009)
Contract	0.012**	0.008***	0.088***	0.020***	0.006***	0.014***
	(0.005)	(0.002)	(0.031)	(0.007)	(0.002)	(0.005)
Source	BDS	YTS	BDS	YTS	YTS	YTS
First-stage *F*-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 7: 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: $\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	Overall	Lowest Tercile	Middle Tercile	Highest Tercile
	(1)	(2)	(3)	(4)
Entry	0.024***	0.010***	0.006**	0.008***
	(0.009)	(0.004)	(0.002)	(0.003)
Expand	0.044***	0.002***	0.006***	0.036***
	(0.013)	(0.001)	(0.002)	(0.011)
Exit	0.028**	0.029***	-0.000	-0.000
	(0.013)	(0.010)	(0.001)	(0.003)
Contract	0.020***	0.009***	0.005***	0.006***
	(0.007)	(0.003)	(0.002)	(0.002)
First-stage *F*-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)
Panel A. Number of international students								
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
Panel B. Population share of international students (%)								
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: 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)
Panel A. Total Enrollment			
ΔDomestic Students$_{c,t}$/Pop$_{c,t-1} \times 100$	0.000	0.002***	0.002***
	(0.000)	(0.001)	(0.000)
Panel B. Out-of-State Enrollment	0.000	0.003***	0.002***
ΔDomestic Students$_{c,t}$/Pop$_{c,t-1} \times 100$	(0.000)	(0.001)	(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 A3: Effects of International Students on Natives' College Attendance, IV Estimates, Stacked First Differences, 2006-2015

	First-Time, First-Year Domestic Enrollment	
	2-Year	4-Year
	(1)	(2)
Panel A. All Colleges and Universities		
$\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	-0.018**	0.006
	(0.009)	(0.006)
Panel B. Public		
$\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	-0.016*	0.008
	(0.008)	(0.006)
Panel C. Private, Non-Profit		
$\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	-0.001	-0.002**
	(0.001)	(0.001)
Panel D. Private, For-Profit		
$\Delta IS_{c,t} / Pop_{c,t-1} \times 100$	-0.001	0.000
	(0.002)	(0.000)
First-stage *F*-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 A4: 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)]			
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.019**	0.054**	0.061***
	(0.008)	(0.022)	(0.018)
First-stage *F*-statistic	35.4	35.4	35.4
Observations	7,220	7,220	7,220
Panel B. Exclude international graduate students			
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.028***	0.070***	0.065***
	(0.010)	(0.025)	(0.024)
First-stage *F*-statistic	25.1	25.1	25.1
Observations	7,220	7,220	7,220
Panel C. Exclude Chinese students			
$\Delta IS_{c,t}/Pop_{c,t-1} \times 100$	0.066***	0.165***	0.154***
	(0.023)	(0.054)	(0.048)
First-stage *F*-statistic	24.1	24.1	24.1
Observations	7,220	7,220	7,220

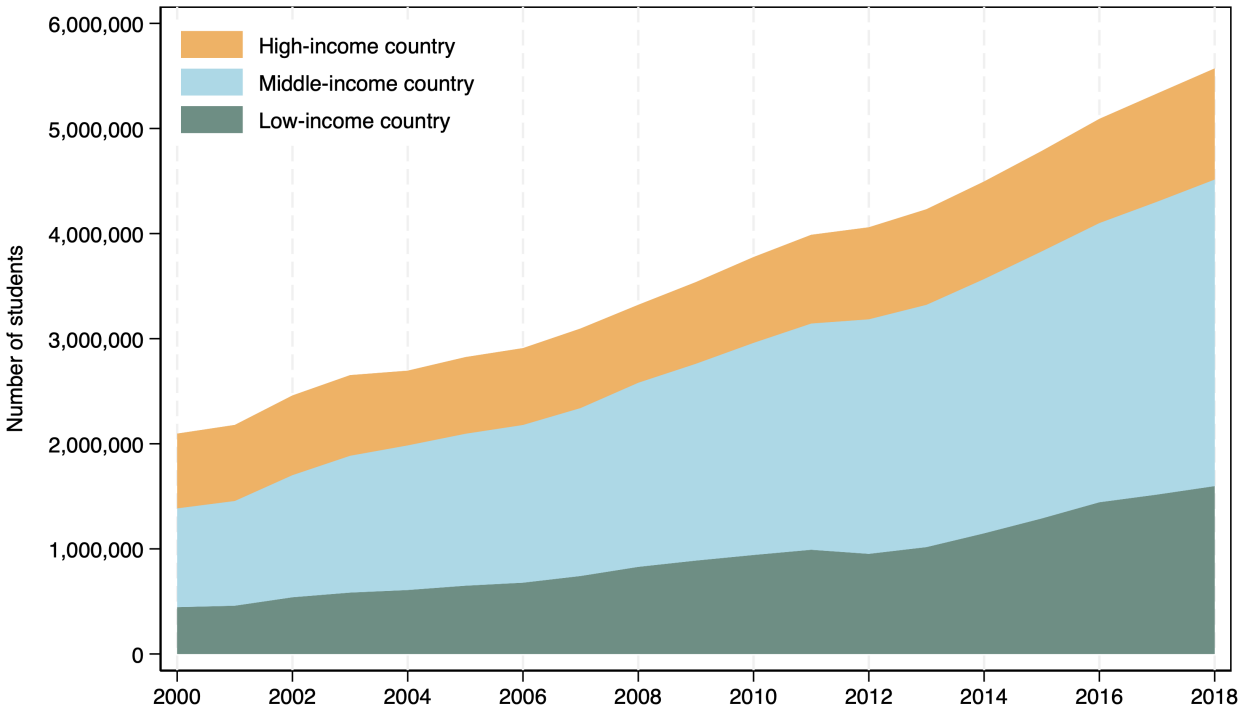
Notes—Outcomes are period changes from *t* to *t+1*. *(*a) Instrumental variable constructed using changes in foreign enrollment in all non-US destinations as shocks (data from UNESCO Institute for Statistics). All specifications include year fixed effects and current period changes in (log) population, 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 A5: Robustness Checks—Baseline IV Estimates with Alternative Sample Restrictions, ACS

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

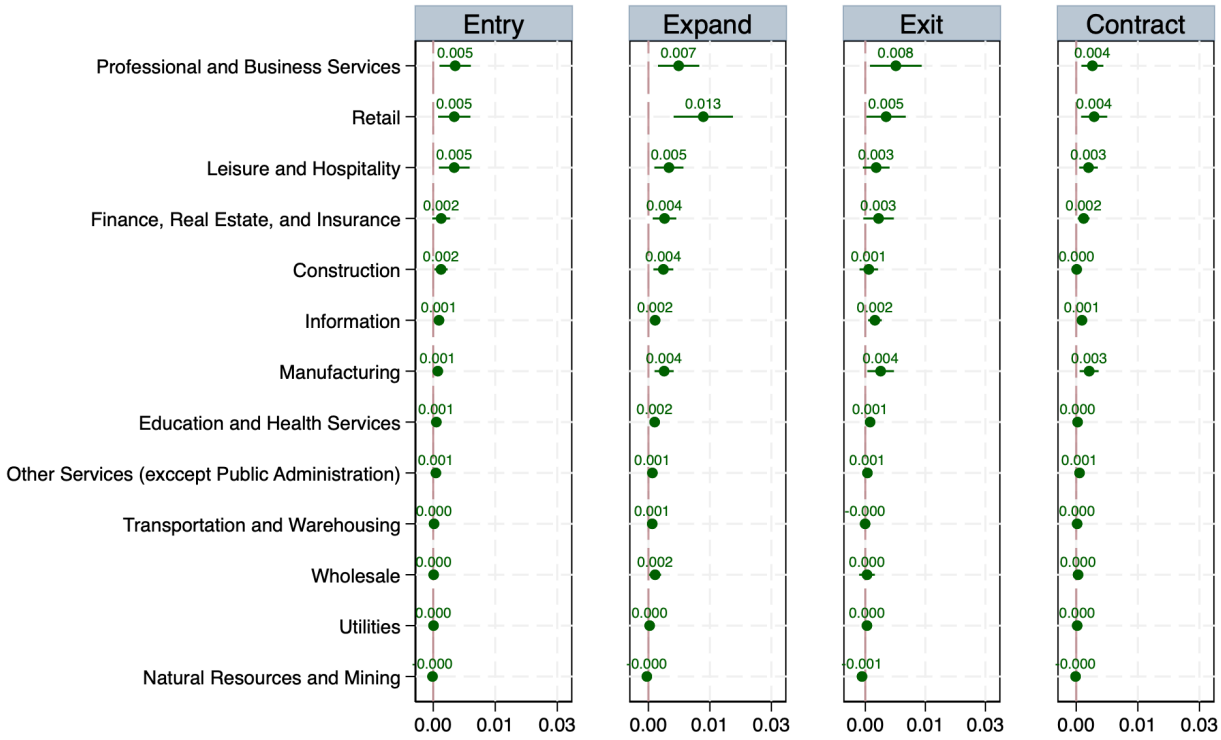
Appendix Figure B1: Internationally Mobile Students by Country of Origin, 2000-2018



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.