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

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Abstract

Despite the rising costs of higher education, enrollment of international students in the United States has grown dramatically over the past few decades. While increases in international enrollment have been shown to contribute to a vibrant higher education sector, the effects on local economies surrounding universities and colleges are less understood. This paper uses administrative data covering the universe of international students enrolled in US higher education between 2001 and 2015 to study their short-term effects on local labor markets and firms. I implement an instrumental variable estimation approach that takes advantage of the supply-push components of changes in US enrollment, proxied by fluctuations in the outflows of students across countries of origin to other English-speaking destinations. I show that international students lead to substantial increases in local jobs and earnings: one additional student per thousand residents increases the employment to population ratio by 0.39 percentage points and average wages by 0.83 percent. These effects are concentrated in non-tradable industries, particularly in construction, retail, and services. Consistent with general equilibrium models with heterogeneous firms, local demand shocks induced by an increase in enrollment also result in significant within-industry labor reallocations as more efficient firms enter and expand while the least efficient ones contract and exit. Overall, these findings highlight substantial economic benefits from foreign students in the form of increases in local income and aggregate productivity.

JEL Codes: F14, F16, F22, I23, J23, J31
Keywords: International students, Local labor markets, Labor demand, Firm dynamics.

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1 Introduction

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

In this paper, I examine the short-run effects of international students on local labor markets and firms. My empirical analysis is motivated by the predictions of general equilibrium models with heterogeneous firms, whereby demand shocks induced by international students result in not only a net increase in local labor demand but also within-industry reallocations of resources towards high-productivity firms (Melitz 2003; Melitz and Ottaviano 2008; Bernard, Redding, and Schott 2007).[2] Specifically, increases in local demand and profitability will likely stimulate entry as well as expansion among the more efficient incumbents, which increase the demand for labor. Since US visa policy prevents foreign students from working throughout their courses of study, the surge in labor demand may not be compensated by an increase in local labor supply, which then bids up real wages.[3] Higher labor costs, together with a potentially greater number of competitors in the product market, force the least efficient firms to contract or exit. Thus, an increase in international

[1] Foreign students generated $47.3 billion in higher education revenue alone in 2018, almost equivalent to US export of passenger cars in the same period (Bureau of Economic Analysis 2020).

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

[3] There are a few exceptions. International students can engage in on-campus work study and some forms of off-campus training opportunities that are related to their areas of study.

student enrollment could potentially improve local aggregate productivity through a reshuffling of labor and market share towards firms that are more capable of taking advantage of the induced local demand shocks.

Using several sources of data and the concept of commuting zones to approximate local labor markets, I find evidence consistent with these theoretical predictions. At the heart of my analysis is a large set of administrative data covering the universe of international students enrolled in US higher education between 2001 and 2015. The richness of the data allows me to overcome two empirical challenges. First, because I observe detailed information on each student's program of study, including school location, program level, start and end dates, I can measure precise enrollment in an area in a year and utilize the spatial variation in the distribution of international students across geographic locations to study their local impact. Second, I take advantage of available information on students' countries of origin to implement a shift-share instrumental variable estimation approach. As with other studies in the immigration and trade literature, a major concern with the spatial correlation approach is the existence of unobserved pull factors that may influence both foreign enrollment and local labor market outcomes. Bound et al. (2020), for example, show that declines in state support for higher education forced public research universities to adjust by increasing the enrollment of international students. If foreign enrollment responds positively to an economic recession due to such local pull factors, OLS estimates of the effects of international students on local labor markets and firms could be severely biased downward.

To overcome this identification challenge, I take advantage of fluctuations in the outflows of international students across countries of origin into other top English-speaking destinations, including Australia, Canada, and the United Kingdom, to isolate the supply-push components of changes in US enrollment. I combine these shocks with the tendency of students to apply to programs where others from the same countries of origin have attended to generate quasi-experimental variation across commuting zones. Through a series of balancing tests, as examined in section 3, I empirically show that the variation in inter-

national student enrollment predicted by my instrument is uncorrelated with underlying changes in local economic conditions.

In section 4, I combine administrative data on international students with data from the American Community Survey to examine the impact of an increase in enrollment on local labor demand. My results suggest that the presence of international students between 2005 and 2015 led to substantial increases in local employment and earnings: at the commuting zone level an increase in enrollment by one student per thousand residents raises the employment-to-population ratio by 0.39 percentage points and average hourly wages by 0.83%. These effects are economically large, and indicate that the growth in the number of foreign students in the US over this period has led to the creation of over 1.9 million jobs, an increase in employment equivalent in magnitude to more than 80% of the rise in import competition from China (Acemoglu et al. 2016; Abraham and Kearney 2020).[4] In line with expectations, I find that increases in local labor demand are concentrated entirely in the non-tradable sector, particularly in construction, transportation, retail, and services. Improved labor market opportunities are observed across different types of workers, with slightly larger effects among college-educated individuals.

In section 5, I use additional longitudinal establishment-level employment and sales data from the Your-Economy Time Series database, which covers the universe of establishments in the US between 2004 and 2017, to study the effects of international students on local firm dynamics. I show that the net local employment responses conceal significant gross job creation as well as job destruction across all margins. While there is a modest reallocation of labor away from agriculture, mining, and manufacturing, most of the observed turnover takes place within retail and services. In addition, I construct a measure of establishment performance based on sales data and show evidence consistent with the predictions of a general equilibrium model with heterogeneous firms, whereby job creation

[4]Though large, these estimates are not implausible, as they capture both the direct and indirect effects of international students on local demand. The latter is caused by a rise in product demand from natives as a result of increases in employment and earnings in the local economy.

is driven by entries as well expansions among the most efficient establishments and job destruction by exits and contractions among the least productive ones. These results suggest that the recent growth in US exports of educational services might also have led to local aggregate productivity gains through an increase in product and labor market competition.

My findings contribute to three strands of literature. First, on the economic impacts of international students, this paper takes a first step towards systematically assessing the broader effects of foreign enrollment on local labor markets and firms. I examine both overall effects and distributional consequences of an increase in enrollment through the lens of a general equilibrium model with heterogeneous firms. I take advantage of large-scale administrative data and an instrumental variable estimation approach that together address several identification challenges that arise due to the endogenous spatial distribution of foreign students. By contrast, existing studies in this literature have typically focused on the higher education sector, where the examined outcomes include school finance (e.g., Bound et al. 2020), domestic enrollment (e.g., Shih 2017; Zhu 2021), and academic innovation (e.g., Chellaraj, Maskus, and Mattoo 2008; Stuen, Mobarak, and Maskus 2012).

Second, this paper contributes to the broader debate on the economic consequences of immigration by providing direct evidence on 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, through spending on non-tradable goods and services, immigrants could also stimulate local labor demand.[5] I document these demand-side effects by studying a large and growing group of foreign-born individuals in the US that cannot participate in the labor market in the short term due to visa restrictions. To the extent that these effects can compensate for an increase in local labor supply, the results presented in this paper

[5] Some exceptions exist. Bodvarsson, Van den Berg, and Lewer (2008) examine the 1980 "Mariel boatlift" and find strong increases in spending and labor demand in Miami's retail sector following the massive, sudden influx of Cuban immigrants. Dustmann, Schönberg, and Stuhler (2017) suggest that when the demand channel is suppressed, such as in the case of Czech workers who commuted across the Germany-Czech border to work and did not live and consume in affected areas, an immigration-induced increase local labor supply could lead to significant negative effects on natives' employment and wages in the short-run.

provide a short-run explanation as to why a large number of empirical studies have found relatively small overall effects of immigrants on natives' employment and wages. [6]

Third, my findings also contribute to current understanding of how demand shocks affect firm dynamics. Such inquires have been a major focus of the recent empirical literature in international trade, which seeks to incorporate heterogeneity in firm productivity and firm-level decisions. For example, Pavcnik (2002) shows that trade liberalization led to a 19% increase in aggregate manufacturing productivity in Chile, two thirds of which was the result of a reallocation of resources from less to more productive manufacturers. McCaig and Pavcnik (2018) document substantial movements of labor from informal household businesses to formal manufacturing firms in Vietnam after an increase in export exposure, which similarly raised aggregate manufacturing productivity. My results show that the theoretical predictions from this literature, interestingly, also apply to the non-tradable sector in the presence of immigration-induced local demand shocks.

2 Data

This paper draws on numerous sources of data to measure international student enrollment and characteristics, as well as individual and firm outcomes at the local labor market level. I use the concept of commuting zones developed by Tolbert and Sizer (1996) to approximate local labor markets. These geographic units represent clusters of U.S. counties that are characterized by strong commuting ties within each cluster and have been employed to study spatial differences in local labor market outcomes at both the individual and firm levels (e.g., Smith 2012; David, Dorn, and Hanson 2013; Autor et al. 2014; Asquith et al. 2019; Acemoglu and Restrepo 2020). My analysis focuses on 722 commuting zones that cover the entire U.S. continental territory. In this section, I discuss data sources

[6] For a recent, comprehensive review of this literature, see Blau and Kahn (2015), Dustmann, Schönberg, and Stuhler (2016), and Blau and Mackie (2017).

as well as features of each data set that are most relevant to my analysis.

2.1 International students

Data pertaining to international students come from administrative records and were provided by U.S. Department of Homeland Security (DHS) via a Freedom of Information Act (FOIA) request. These records cover the universe of students on F-1 visas who ever enrolled in a higher education institution in the U.S. between 2001 and 2015. Obtained data contain biographic information of students, including country and city of origin, as well as detailed information regarding their study program, such as school name and address, program level, and program start and end dates.[7]

I use these data to measure the size of the international student population in each commuting zone in each year. Specifically, based on program start and end dates, I construct international enrollment in a commuting zone-year to be the total number of international students enrolled in a postsecondary institution within that commuting zone for any portion of the year. Although the obtained administrative data cover the universe of the international student population of interest, there are some limitations that could lead to concerns about measurement error. For example, there's no information regarding students' residential addresses. To the extent that some students traveled long distance to schools and did not reside within the same commuting zones as their programs, my measure could understate the size of the international student population in some locations while overstate in some others. Some students may additionally have terminated their study before the reported program end dates, either to transfer to a new program or leave the US altogether. Thus, OLS estimates of the economic impacts of international students could be

[7] As part the Illegal Immigration Reform and Immigrant Responsibility Act of 1996, the DHS were mandated by U.S. Congress to collect and maintain current information on all international students throughout their courses of study. Schools have the legal responsibility to submit necessary documentation to a US government electronic database called SEVIS (Student and Exchange Visitor Information System) upon admitting a student and before he or she can apply for a visa and gain entry into the US.

biased due to measurement error.

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

2.2 Natives' employment, wages, and educational attainment

I use 2005-2015 American Community Survey (ACS) data extracted from the Integrated Public Use Microsamples (IPUMS) database to construct local labor market outcomes (Ruggles et al. 2021). In each survey year, I restrict my sample to non-institutionalized natives not living in group quarters. In some robustness checks, I also further restrict my sample to individuals living in their state of birth in order to minimize concerns about natives' migratory responses (Blanchard et al. 1992; Bound and Holzer 2000; Cadena and Kovak 2016; Monras 2020; Notowidigdo 2020). To construct outcomes, I assign individuals to commuting zones using information on county of residence, which exists for over half of the sample extracted from IPUMS. To assign commuting zones to the rest of the sample, for whom county identifiers are not available, I rely on Public Use Microdata Area (PUMA) information and a statistical procedure implemented by Smith (2012) and David and Dorn (2013). This procedure, which results in consistent estimates of outcomes, involves duplicating observations whose PUMAs are overlapped with multiple commuting zones and re-weighting each of these observations by the respective fraction of a PUMA population

that lives within each commuting zone.

I focus on the employment to population ratio and average hourly wages as the main labor market outcomes. Hourly wages are computed by dividing total wage and salary earnings in the previous year by the product of weeks worked and the usual number of hours per week. As in David and Dorn (2013), hourly wages are set not to exceed top-coded yearly earnings divided by 50 weeks times 35 hours, while hourly wages below the first percentile of the sample's distribution are set to the value of the first percentile. All wages are deflated to the year 2005 using the Bureau of Labor Statistics's 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.[8] I then divide these numbers by the size of the local 18-25 adult population in each year to get a measure of enrollment per capita.

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

2.3 Firm dynamics

I use annual establishment-level data from Your-Economy Time Series (YTS) database to construct measures of job flows. Maintained by the Business Dynamics Research Consortium (BDRC) at the University of Wisconsin, the database tracks all in-business establishments at their unique locations across the U.S. between 1997 and 2018. This sample in-

[8]Following the literature, I define four-year institutions to be any college or university that offers a four-year degree, while two-year institutions are those that offer two-year degrees but not higher.

cludes all establishments that are conducting or intent on conducting commercial activities, including for-profit, non-profits, and government establishments.[9] Detailed information, including an establishment's name, location (e.g., zipcode), industry affiliation, number of employees, and sales, is collected from each location in each year and linked longitudinally to assemble time series.

For the purpose of my analysis, I restrict my sample to all for-profit establishments that were in operation at some point between 2004 and 2016. Following Asquith et al. (2019), I further exclude all establishments that had less than two employees throughout this period to avoid nonemployer businesses. Based on this sample, I construct different job-flow components, i.e. changes in job creation due to firm entry and expansion and job destruction due to firm exit and contraction, at the commuting zone level. In addition, I also use information on industry affiliation and sales to conduct heterogeneity analysis by industry and establishment-level productivity. Further details behind variable construction are discussed in section 5.

Before moving on to the next section, I briefly discuss the reliability of YTS data. Appendix Figure A1 presents a scatter plot of the relationship between YTS and the ACS in terms of total commuting zone employment over the 2005-2016 period. The correlation coefficient between the two sources is 0.996, indicating a high level of reporting accuracy of the YTS data. As further discussed in section 5, both data sources yield almost identical estimates on the effects of international student enrollment on net changes in employment at the commuting zone as well as commuting zone-industry level. Nonetheless, my results on firm dynamics should be viewed as a first step towards dissecting the effects of international students on US local labor markets in the context of a general equilibrium model with heterogeneous firms, and would likely benefit from future validations using other sources of data, such as Census's Longitudinal Business Database.

[9] Entities that do not conduct commercial activities and therefore excluded from the YTS database include those created for tax purposes and holding companies. For more description of the database, see https://wisconsinbdrc.org/data/

3 Empirical Methodology

Although the number of international students in the US has been steadily rising, there is considerable variation in the distribution of students across commuting zones over the 2005-2015 period. Table 1 tabulates top ten commuting zones with the largest number of international in 2005 and 2015. Consistent with the findings of Ruiz (2014), these cross-sectional patterns indicate that international students tend to have a stronger presence in metropolitan areas with high concentrations of universities and colleges. Table 2 provides additional summary statistics on enrollment at various points along the distribution of international students across commuting zones. As shown, areas that were popular to students in 2005 were also more likely to experience strong growths in enrollment throughout the period. My empirical analysis exploits this spatial variation to examine the effects of international students on local labor markets and firms. In this section, I first describe the estimation equation and discuss challenges to identification. I then introduce an instrumental variable estimation approach that aims at addressing these issues and provide evidence that supports the validity of this approach before presenting results and discussing their implications in the next sections.

3.1 Estimation equation

To examine local labor market and firm responses to international student enrollment, I estimate specifications of the following stacked first-difference model:

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

where $t \in [2006, 2015]$, $\Delta z_t = z_t - z_{t-1}$, and γ_t denotes a vector of year fixed effects. The main explanatory variable of interest, $\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1}$, is the period change in the number

of international students enrolled in a postsecondary institution in commuting zone c normalized by the size of the commuting zone's population at the beginning of the period. This specification thus allows the effects of changes in international student enrollment to vary by the size of the local economy while avoids the potential pitfalls that arise when there are changes in the local population due to migratory responses by natives.[10] Furthermore, the lag structure of the independent variables accommodates a short delay before the effects of international students on workers and firms can be captured in survey data.

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.[11] To further account for potentially confounding changes in underlying local economic conditions, I include a large set of covariates, X_{ct}, that control for changes in the local population composition. These include changes in log population; the share of females; the shares of the population by age (16-34, 35-49, 50-64, and over 65), race (whites, blacks, Hispanics, and Asians), and education (no college, some college, college or professional degree, and advanced degrees); the share of employed adults that are foreign born; and the share of the population employed in manufacturing. 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

[10] In particular, an alternative specification that has been employed in the immigration literature is to regress changes in the outcome to changes in the *population share* of immigrants (or international students in this case), though results will be mechanically biased if there is in-migration or out-migration by natives in response to immigrant inflows (Card and Peri 2016).

[11] 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 that are robust to either structure.

potentially endogenous distribution of international students across commuting zones and time. For example, enrollment by international students could be driven by negative local economic shocks. Recent studies have identified economic recessions and the resultant declines in state support for higher education as strong drivers of international enrollment (Bound et al. 2020; Bound et al. 2021). Bound et al. (2020) finds 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 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 downward biased.

On the other hand, the arrivals of students from abroad can also be driven by positive local labor demand shocks. A primary concern that has often plagued the immigration literature is that areas that experience stronger growth in labor demand tend to also attract more foreign-born workers. If international students are aware of these positive shocks and account for the increases in local training and employment opportunities after graduation when making enrollment decisions, OLS estimates of their effects on local economies can also be upwardly biased.

In addition to the endogenous sorting of foreign 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 U.S., does not contain information on the actual termination date of a student's course of study. The estimated number of students that are present in a commuting zone in a year, which I construct using students' anticipated program end dates, might overstate the actual number if some students decide to leave their programs early and lead to a downward bias.

3.3 Instrumental variable approach

To address biases resulting from the endogenous distribution of international students, I employ a shift-share instrumental variable approach that isolates the plausibly exogenous, supply-driven variation in international student enrollment. Specifically, I predict enrollment in the U.S. by using the total number of students from each country of origin that enrolled in a higher education institution in three other leading English-speaking destinations—namely, Australia, Canada, and the United Kingdom—which collectively host an almost equal number of international students as does the U.S. The average pairwise correlation coefficient between the flows of students into the U.S. and in these three destinations over the 2005-2015 period across different countries of origin is about 0.7, which suggests the existence of a common set of factors that exert strong influences on the total supply of students who wanted to study abroad from each source country. These could be underlying changes in demographics, family income, and institutional background within each source country. Indeed, Khanna et al. (2020) shows that the rise in the number of international students from China, which accounted for much of the global increase in international student enrollment, 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 U.K are strong predictors of the realized changes in international student enrollment in the U.S. from each country of origin, but are arguably not related to pull factors that arise from changes in local economic conditions in the U.S. 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 U.S. 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 at the beginning of the

century with period changes in total enrollment from each country of origin in Australia, Canada, and the U.K. Let k denote a country of origin, the predicted change in enrollment in commuting zone c from $t-1$ to t is taken as

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

where $\Delta \mathrm{IS}_t^{\text{Australia, Canada, UK}}$ is the period change in enrollment of international students from country k in the three mentioned destinations. The share component, $\frac{\mathrm{IS}_{c,k,2001-2002}}{\mathrm{IS}_{k,2001-2002}}$, is the fraction of students from country k that ever enrolled in a US higher education institution in commuting zone c within the 2001-2002 period.[12] This instrumental variable estimation approach is thus very similar in spirit to a growing number of studies in the immigration and trade literature that utilize supply-push factors as shift components (Card 2001; Stuen, Mobarak, and Maskus 2012; David, Dorn, and Hanson 2013; Peri, Shih, and Sparber 2015; Shih 2017; and Monras 2020).

3.4 Validity of the instrument

Recent work by Borusyak, Hull, and Jaravel (2018) shows how identification can be achieved in this setting. In particular, with many periods as well as a large number of shocks per period, the shift-share IV estimates are shown to be numerically equivalent to those obtained by fitting transformed, shock-level regressions in which both outcomes and treatments are weighted by the shares while the shifts serve directly as instruments for the weighted treatment variable. Consequently, a shift-share strategy will result in consistent estimates if the shocks are idiosyncratic with regards to a share-weighted average of unobserved factors that determine the outcomes, a condition that would hold in this setting if shocks to enrollment of international students observed in Australia, Canada, and the

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

U.K. are indeed unrelated to changes in local economic conditions in the U.S., regardless of whether variation in the share component is endogenous.

To assess the validity of the identification assumption, I conduct a series of balancing tests that regress multiple indicators of changes in local economic conditions on the actual and predicted contemporaneous changes in international student enrollment. The results of these exercises are presented in Table 3. In columns 1 and 2, I look at commuting zone level changes in state appropriations per public full-time equivalent domestic student. As shown, there is a negative and strongly significant correlation between state support for higher education and enrollment of students from abroad. This is consistent with recent studies that documented strong increases in foreign student enrollment at public research institutions in response to declines in state funding after a recession (Bound et al. 2020; Bound et al. 2021). On the other hand, the obtained IV estimate is much smaller in magnitude and not statistically significant. Since declines in state funding for higher education are one of the major "pull factors" of international student enrollment, these results suggest that the supply-driven variation in international student enrollment being isolated by the instrument is indeed not correlated with changes in local economic conditions.

In columns 3 and 4, I look at changes in the share of employed adults that have a master or doctoral degree. This exercise stems from the concern that there could be unobserved shocks that affect the inflows of international students as well as the local share of highly-skilled workers, those that tend to be the most mobile. As before, OLS estimate is negative and statistically significant, indicating the presence of unobserved negative shocks that were driving foreign enrollment as well as natives' out-migration. The obtained IV estimate, however, is small and statistically insignificant.

Although international students are not allowed to work in the short-run, those who have graduated may try to stay and look for work in the same local areas as their colleges and universities, and thereby change the composition of the local workforce. Ruiz (2014) documents that about 45 percent of foreign students who engaged in temporary post-graduation

employment through Optional Practical Training (OPT) between 2008 and 2012 remained in the same metropolitan area as their study programs. To address this concern, I look at changes in the share of employed adults that are foreign-born and have some college education in columns 5 and 6. The obtained OLS estimate is positive and slightly significant, which suggests that areas that experienced strong increases in international student enrollment also tended to have a larger supply of college-educated foreign workers. On the other hand, IV estimate is close to zero and not statistically significant. These results thus reinforce the notion that my constructed instrument is isolating short-run supply-induced variation in enrollment of international students that is not correlated with changes in the underlying local economic conditions.

A final threat to this instrumental variable strategy is that there could be unobserved, confounding labor market adjustments to the rise in import competition from China. In particular, if export shocks lead to significant growth in family income in emerging economies and thereby simultaneously fuel the surge in the global supply of international students, particularly from China, and the erosion of economic opportunities for workers and firms in the US, the instrument can be contaminated. In practice, however, such dynamics do not appear to be a serious threat in this setting. One immediate reason is that areas in the US that experienced particularly severe declines labor market outcomes as a result of import competition tended to have a high concentration of manufacturing activities, whereas areas that received large inflows of international students tended to be "college town" economies that boasted a high concentration of universities and colleges. Hence, these two sources of economic shocks may not be spatially related. Furthermore, recent studies suggest that local labor market adjustments to increased import competition from China in the US took place largely before 2007 (Bloom et al. 2018; Abraham and Kearney 2020). Specifically, Bloom et al. (2019) shows that the local labor market effects of imports from China weakened over time and became negligible over the 2007-2015 period. Since this paper focuses on the local impacts of international student enrollment between 2005 and 2015, it's un-

likely that my results are biased by unobserved US local labor market adjustments to trade shocks. To corroborate these arguments, I regress changes in the population share in manufacturing on changes in international student enrollment. Both OLS and IV estimates are close to zero and statistically insignificant, suggesting labor market adjustments to trade shocks, particularly declines in manufacturing employment, are unlikely to be a source of bias.

Taken together, the results presented in this subsection suggest that OLS estimates of the economic effects of international students are confounded largely by local negative shocks, and are therefore likely to be biased downward. To the extent that my instrument is not correlated with changes in commuting zones' economic conditions, as has shown by a series of balancing tests in this section, one would expect IV estimates to be much closer to the true causal effects. I now turn to discussing my results and their implications.

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 industry and types of workers to shed light on the nature of labor demand shocks that may take place due to potential surges in local consumption generated by international students. To conserve space, I only report OLS and IV estimates on the main outcomes. While OLS estimates generally have the same signs as their IV counterparts, only the latter are economically and statistically significant across specifications. This is in line with recent studies as well as the evidence discussed in the previous section, which suggest that international enrollment tends to be countercyclical: declines in local economic conditions and particularly state funding for higher education increase local reliance on tuition revenue

from abroad and, consequently, enrollment of international students (Bound et al. 2020; Bound et al. 2021).

4.1 Overall employment and wage effects

Table 4 reports regressions of changes in the employment to population ratio and (log) average wages on changes in international student enrollment per capita. Panel A presents overall results, while panel B and C look at outcomes of men and women, respectively. Columns 1 and 2 show that increases in foreign enrollment have a positive and statistically significant impact on local employment. OLS estimates suggest that an increase in enrollment of one student per thousand residents would lead to a 1.1 percentage point increase in the overall employment to population ratio on average, with similar effects on both men and women (increases of 1.4 and 0.9 percentage points, respective). The corresponding IV estimates are 3.9, 4.3, and 3.4 percentage points, and are all significant at the 1 percent level. As a benchmark, the population share of international students increased by 0.16 percentage points between 2005 and 2015. Thus, the preferred IV estimate indicates that the overall increase in international student enrollment during this period led to a 0.62 (0.16×3.9) percentage point increase in the employment to population ratio, or about 1.9 million jobs, in total. This effect is equivalent in magnitude to more than 80% the displacement effect of the increase in import competition from China over the 1999-2018 period, and is economically substantial (Acemoglu et al. 2016; Abraham and Kearney 2020).

Columns 3 and 4 examine the local labor demand effects of international students in terms of changes in average wages. As before, both OLS and IV results are positive and strongly significant, though the IV estimates are much larger in magnitude. The preferred IV specifications suggest that one additional international student per thousand residents would increase average wages by 8.3 percent overall, and 7.9 and 9.1 percent for men and women, respectively.

Given the large effect of international students on local employment, some portion of the observed increase in average wages may reflect changes in the composition of local workers rather than the increased returns from working. To address this issue, I consider alternative measures of wages that have been used recently in the literature. These include wages adjusted by the probability of employment (Charles, Hurst, and Notowidigdo 2018; Notowidigdo 2020), residualized wages (Notowidigdo 2020), and wages computed at the commuting zone-demographic level (Acemoglu and Restrepo 2020). Column 5 and 6 present results using the changes in average wages adjusted by the probability of employment. Both OLS and IV estimates are economically large and statistically significant at the 1 percent level, suggesting that most of the observed effect on local wages due to increases in international enrollment does reflect increases in local labor market opportunities. Estimates using the rest of the alternative measures of wages also support this conclusion and are tabulated separately in the appendix.

4.2 Effects by industry

Which industries are most likely to benefit from the increases in local demand generated by international students? Construction is 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, on top of education and healthcare, should also contribute to labor demand in retail, transportation, and local services.

Figure 2 shows the effects of international students on local employment, both overall and separately for men and women, in different industries. I provide estimates and confidence intervals for IV specifications that are similar to column 2 of Table 4, with the outcomes in this case being changes in the industry-specific employment share of the population. Consistent with my hypotheses, construction accounts for a major portion of the

impact of international students on local employment. The IV estimate suggests that an increase of one additional international student per thousand residents leads to a 0.18 percentage point increase in the share of population employed in construction. The renaming portion of the employment effect can be attributed to retail and personal services (0.14 points), education, healthcare, professional and technical services (0.14 points) and transportation and warehousing (0.05 points). Note that the combined increase in employment share in these sectors exceeds the net overall effect of international students on local employment. This is because increases in international student enrollment appear to result in some inter-industry reallocation of labor, particularly from agriculture and manufacturing.[13] Overall, these results are consistent with the existence of positive local labor demand shocks, especially among non-tradable industries, induced by increases in international student enrollment and, consequently, local consumption.

4.3 Effects by education and age

Figure 3 summarizes the effects of international students on local employment by workers' education. The observed patterns of labor demand shocks across industries suggest that both college- and non-college-educated workers would experience increases in labor market conditions. In particular, positive labor demand shocks in education, healthcare, professional, and business services, which collectively employ almost half of workers with a college degree, should lead to substantial increases in employment and wages among college-educated workers. Likewise, changes in labor demand in construction, retail, and personal services should also result in improved opportunities for non-college workers, though the net increase in employment and wages among this group could be smaller due to the a slight contraction in agriculture and manufacturing.

Consistent with these expectations, IV estimates indicate positive and statistically sig-

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

nificant effects of international students on employment and wages of both non-college- and college-educated workers, with slightly larger effects among the latter group. In addition to some reallocation of labor across industries, particularly from agriculture, mining, and manufacturing to services, several mechanisms could explain the slightly smaller net effects of international students on employment and wages of non-college natives. In section 5, I show that increases in international student enrollment raise the rate of creative destruction in the service sector and lead to substantial within-industry labor reallocations towards the most productive firms. To the extent that these firms employ a relatively higher share of skilled workers (Engbom and Moser 2017) or that more educated workers face substantially lower adjustment costs (Dix-Carneiro 2014), such reallocations could contribute to the higher labor demand increase among college-educated natives. Furthermore, in a companion working paper, I show that increases in international student enrollment also result in labor supply adjustments among young natives, whereby improvements in local labor market opportunities reduce first-time, full-time enrollment of natives at public, two-year colleges. A summary of these results is provided in Appendix Table A1. Accordingly, the endogenous labor supply adjustments of natives towards labor force participation and away from college training could also offset the initial effects of international students on non-college workers' employment and earnings.

Figure 4 presents the employment and wages impacts across different age groups. I consider young (16-34), middle-age (35-49), and older workers (above 50). These results indicate that increases in international student enrollment have uniform effects on employment and wage outcomes across these three groups of workers.

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, but are substantial across different types of workers. Given these strong boosts in local jobs and income, one might be tempted to conclude that most workers and firms are "winners"

following a surge in local enrollment of students from overseas. Do international student inflows result in distributional consequences, if any? To answer this question, I analyze the impact of international students on local job flows in the context of a Melitz-type general equilibrium model with heterogeneous firms. Before moving on to the next section, I briefly discuss the robustness of the main results presented in this section to alternative samples and model specifications.

4.4 Robustness checks

Alternative wage outcomes. As mentioned, my baseline measure of average wages is constructed using a sample of full-year, full-time employed natives. In Appendix Table A2, I consider a less "restrictive" measure of wages based on both part-time and full-time employed workers. The corresponding IV estimate, presented in column 2, is strongly significant and slightly larger than the baseline estimate. This makes intuitive sense, as part of the labor demand shocks in construction as well as retail and personal services can be attributed to part-time workers. In addition, I also follow recent studies and consider two alternative measures of wages that are robust to compositional changes in the labor force (Acemoglu and Restrepo 2020; Notowidigdo 2020). These include average wages constructed at the commuting zone $\times$ demographic cell level, where demographic cells are defined by gender, education (non-college, college), and age (16-34, 35-49, and over 50), and average residualized wages obtained from regressing log wages on education, a quadratic in potential experience, gender, and race. Both IV estimates, presented in columns 3 and 4, are positive and statistically significant. Overall, these results suggest that the documented wage effect of international students are likely to reflect changes in the underlying returns to employment rather than changes in the composition of employed workers.

Alternative sample restrictions. In Appendix Table A3, I assess the robustness of my baseline estimates to several alternative sample restrictions. One concern with the main

results on the employment and wage effects of international students is that natives' migratory responses may counteract the initial effects of the labor demand shocks, in which case the baseline estimates may represent lower bounds of the true effects. Following Charles, Hurst, and Notowidigdo (2018), I address this concern by constructing employment and wage outcomes using a sample of natives living in their state of birth: those who are less likely to have moved across labor markets for employment reasons. Panel A presents IV estimates for this sample, which are quantitatively similar to the baseline estimates. This suggests that endogenous migration is not an overly important concern in this setting, consistent with the recently documented evidence on the low and declining mobility rates at the state as well as commuting zone level among US citizens (Basso and Peri 2020). In panels B and C, I repeat the baseline analysis but exclude either the top 10% of commuting zones with the highest number of international students or those without any international students in 2005. The corresponding IV estimates of the employment and wage effects of international students remain similarly positive and statistically significant, suggesting it's unlikely that any particular commuting zone is driving the observed results.

Alternative specifications. Lastly, in Appendix Table A4, I consider the robustness of my baseline results to alternative specifications. In panel B, I exclude international graduate students from my constructed measure of international enrollment. The obtained IV estimates are larger than the baseline, suggesting that it is local demand shocks instead of unobserved high-skilled migration that is driving the results. In panels C and D, I drop Chinese and Indian students, respectively. Corresponding point estimates are positive and statistically significant in each case, which indicate that my baseline results are not just capturing the local labor market effects of these two major groups of international students in the US.

5 Effects of International Students on Local Job Flows

In this section, I examine the effects of international students on local job flows and discuss their distributional implications. As mentioned, because of US student visa policy, international students are generally not permitted to engage in off-campus employment throughout their courses of study. An increase in enrollment would only directly affect the product market in local economies surrounding universities and colleges through demand shocks, much like an increase in "export" exposure. Following these enrollment-induced demand shocks, trade theory with heterogeneous firms predicts an increase in firm entry as well as expansion among the most efficient incumbents. These would raise competition in potentially both the product market and the labor market, which increase residual demand price elasticities and labor costs, respectively, and subsequently force the least efficient firms to shrink or exit altogether due to a reduction in profitability (Melitz 2003; Melitz and Ottaviano 2008). Hence, to the extent that an increase in enrollment mirrors a positive export shock, albeit in the non-tradable sector, international students could lead to within-industry resource reallocations and aggregate productivity gains, though these effects cannot be observed by looking at the overall changes in local employment and wages as discussed in the previous section.

To carry out this analysis, I rely on annual establishment-level time-series data between 2004 and 2017 from the Your-Economy Time Series (YTS) database, which is compiled by the Business Dynamics Research Consortium (BDRC) within the University of Wisconsin System. As discussed in section 2, YTS attempts to track all establishments in the US, including for-profit, non-profit, and government establishments, and provides annual establishment-level information on jobs, sales, industry affiliations, and geographic locations. Based on these data, I first calculate period net growth in employment, adjusted by the mid-point working age population, at the commuting zone level, then decompose net

growth into job-flow components along both the extensive and intensive margins as follows,

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

where $E^{\text{entry}}_{c,t}$ and $E^{\text{exit}}_{c,t}$ are gross job creation and destruction along the extensive margin due to establishment entry and exit, respectively, and $E^{\text{expansion}}_{c,t}$ and $E^{\text{contraction}}_{c,t}$ analogously defined along the intensive margin due to establishment expansion and contraction. Following Asquith et al. (2019), I define each of these four dynamics at the establishment level (e.g., the opening of a new branch by a national chain is counted towards entry) and exclude changes in commuting zone employment due to establishment relocation. Figure 5 shows the contribution of each job-flow component to gross job creation and destruction between 2005 and 2016. Consistent with findings from the literature, job flows along the extensive margin, i.e. due to firm establishment entry and exit, account for a major portion of the job creation and destruction processes.

Similar to my analysis in section 4, I first regress net employment growth and each of the four job-flow components in equation 3 on previous period change in international student enrollment. Later on in the section, I also explore heterogeneity by sector (tradable and non-tradable), industry, and a measure of establishment performance.

5.1 Overall effects on local job flows

Table 5 presents baseline estimates of the effects of international student enrollment on local job flows. Each reported coefficient comes from a regression where the outcome variable is either net employment growth or a job flow component. I present OLS and IV estimates, both overall and separately for the non-tradable and tradable sectors. By construction, job flow regression coefficients sum up to the net employment growth effect, while sector-specific coefficients sum up to the overall effect.

The first two coefficients of the first row of Table 5 reports the effects of international on overall net employment growth adjusted by the midpoint between the current period's and the previous period' size of a commuting zone population. While this outcome is different from changes in the employment to population ratio, which were examined in Table 4, both OLS and IV estimates are surprisingly similar in magnitude to the corresponding employment effects of international students obtained in the previous analysis using ACS data (Table 4, columns 1-2). The preferred IV estimate is significant at the 5 percent level and suggests that an increase of one additional international student per thousand residents increases employment by 0.36 percentage points. In columns 3-6, I examine employment effects by sector. As before, the local labor market response to an increase in international student enrollment is concentrated entirely in the non-tradable sector.

Moving beyond net employment changes, the job flow regressions show that an increase in international enrollment increases the rates of job creation and destruction across all margins. In particular, international students lead to not only greater job creation through firm entry and expansion, but also greater *job destruction* through firm exit and contraction. These effects are concentrated in the non-tradable sector, and are consistent with a theory of trade with heterogeneous firms that predicts substantial within-industry labor reallocation as a consequence of the opening up of the economy (Melitz 2003; Bernard, Redding, and Schott 2007; Melitz and Ottaviano 2008). To ascertain the existence of such reallocations, I next examine the effects of international students on local job flows within each industry.

5.2 Effects by industry

By what mechanism does a growth in international student enrollment lead to an increase in not only local job creation through firm entry and expansion but also job destruction through firm contraction and exit within a sector? As mentioned, a theory of

trade with heterogeneous firms predicts that an increase in demand in an industry would raise its profitability, which, in turn, stimulates firm entry as well as firm expansion among top performers at the expense of less productive firms. Accordingly, the extent of within-industry resource reallocation would likely depend on the magnitude of the demand shock as well as the cost of entry in each industry.

The results presented in section 4 using ACS data suggest that most of the effect of international students on local employment is concentrated in a small number of non-tradable industries such as services, retail, and construction. In Figure 5, I show that this pattern also holds for the YTS sample despite the fact that the outcome examined in this case, net employment growth, is slightly different from changes in industry employment to population ratio. As shown, both point estimates and the ordering of industries according to effect size closely match their counterparts in Figure 3. The robustness of these results suggests the demand shocks generated by international students indeed disproportionately benefit local retail and services. Due to their relatively low entry costs, one would expect most of the observed increase in within-sector labor reallocation to take place in these industries as well.

Results presented in Figure 6 confirm these expectations: an increase in international student enrollment leads to significant increases in the rate of job creation and destruction across all margins, particularly in industries that have relative low entry costs and are most impacted by the demand shocks such as services, retail, and finance, real estate, and insurance (FIRE). To the extent that the observed increases in firm entry and expansion raise the level of competition in either the labor or product market, and subsequently force the least productive firms to shrink or exit, enrollment of international students may also lead to an increase in aggregate productivity in the short run among industries that experience increased job turnover (Melitz 2003; Melitz and Ottaviano 2008). On the other hand, international students seem to increase net employment but not turnover in construction or transportation and warehousing, potentially due to the relatively higher entry costs in these

industries.

It's also interesting to note that an increase in international student enrollment seems to also lead to a slight decrease in net employment in manufacturing, as observed by both ACS (Figure 3) and YTS estimates (Figure 5). This reduction in manufacturing employment is consistent with an "industry switching" phenomenon whereby some manufacturing establishments change their industry code from manufacturing to service in response to the increase in demand in the service sector (Bloom et al. 2019). Furthermore, manufacturers facing increasing market pressure may also outsource a portion of their economic activities and thereby contribute to the reallocation of labor from manufacturing to the service sector (Berlingieri 2013). To the extent that service establishments, especially those with higher productivity, tend to employ a higher share of skilled workers, the observed labor reallocations from other parts of the economy to the service sector as well as reallocations from less productive to more productive establishments within the sector itself may explain the larger employment responses among college educated workers, as documented in section 4.3, as a result of an increase in international student enrollment. Overall, these results paint a much more nuanced picture of the local labor market impact of international student enrollment and highlight distributional consequences that cannot be readily discerned from examining net changes in local employment.

5.3 Effects by firm performance

What determines the differences in firms' responses to an a demand shock induced by international students? Product differentiation, in terms of location and quality, may decide how much an establishment can take advantage of increase in market size. In contrast, those with high marginal costs of production might be forced to shrink or exit as a result of increases in the number of competitors and labor costs. To the extent that such differences in firm characteristics can be summarized by a measure of performance, Melitz-type mod-

els suggest that an increase in international student enrollment would lead to expansions among the most efficient firms, and exits and contractions among the least productive. To shed light on this matter, I sort establishments within each industry in each commuting zone into four performance quartiles, then examine the short-run effects of an increase in international student enrollment on aggregate job flows in each quartile.

Earlier studies in the trade literature have shown that firms that self-select into the export market tend to outperform their non-exporting counterparts along many dimensions, including faster growth in sales and employment, years before they start exporting (e.g., Bernard and Jensen 1999). Accordingly, in the absence of data necessary to construct a measure of establishment-level 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 in each year it appears in the YTS data, to proxy for performance.[14] To allow comparability across establishments in each industry, I define performance of each establishment in a year to be the average annual growth rate in total sale volume, calculated using all the years in which an establishment exists in the database.[15] Specifically, the performance of establishment i in year t is constructed as

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

where $\underline{t}$ denotes the earliest year in which establishment i exists in the data. Using this measure of performance, I sort establishments within an industry in each commuting zone into four quartiles, and aggregate job flows in each quartile to the commuting zone level.

Table 6 reports IV estimates obtained from regressing job flows in each quartile of performance on changes in international student enrollment. Column 1 first presents the overall effects of international students on job flows in the private sector, which are only

[14] This analysis excludes establishments in the public sector for which a sale-based measure of performance is not applicable.

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

slightly different from those provided in Table 5. By construction, the sum of the four quartile coefficients from columns 2-5 is identical to the overall effect for each job flow outcome.

The effects of international students on job creation due to firm entry indicate no clear pattern across the four performance quartiles. In particular, job creation is driven by new entrants on both ends of the performance distribution. This is consistent with the notion that firms do not observe their productivity until after entry decisions have been made, which explains the disproportionately high likelihood of exit among young firms that has been observed in the firm dynamic literature (e.g., Haltiwanger, Jarmin, and Miranda 2013). On the other hand, job creation due to expansions is driven entirely by high-productivity incumbents. The obtained IV estimate suggests that one additional student per thousand residents results in a 0.51 percentage point increase in the rate of job creation due to expansion among the most productive establishments. This effect is strongly significant and explains 76% (0.51/0.67) of the overall effect.

In stark contrast, the impact of an increase in international student enrollment on job destruction is driven mostly by deaths and contractions among low-productivity establishments. The IV estimates for deaths and contractions in the first performance quartile are 0.067 and 0.017, which explain 81% (0.067/0.083) and 71% (0.017/0.024) of the overall effects, respectively.

Taken together, the various results discussed in this section demonstrate that the growing presence of international students in local US economies may also have led to Melitz-type local aggregate productivity gains in the non-tradable sector. In particular, only a selective set of potentially the most efficient firms seemed able to reap the benefits from the enrollment-induced positive demand shocks, whereas increases in competition in possibly both the product market and the labor market forced the least productive firms to shrink or exit altogether. The local labor market effects of an increase in international student enrollment are therefore *not* without distributional consequences. For example, to the extent that more educated, highly skilled workers are more likely to be employed at the most

productive firms (Engbom and Moser 2017) or face lower adjustment costs (Dix-Carneiro 2014) the overall positive impact of international students on local jobs and earnings may have accentuated the recent rise in wage inequality across workers.[16]

6 Concluding Remarks

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

Using large-scale administrative and survey data, this paper seeks to narrow this gap by investigating the short-run effects of international students on local labor markets and firms via increases in local consumption. I implement an instrumental variable estimation approach that takes advantage of the supply-push components of changes in US enrollment, proxied by fluctuations in the outflows of international students across countries of origin to other top English-speaking host countries. As shown by a series of balancing tests, this strategy allows me to purge US international enrollment of confounding changes in local economic conditions. My results suggest that an increase in international student enrollment leads to substantial increases in local employment and wages: one additional student per thousand residents raises the employment-to-population ratio by 0.39 percentage

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

points and average wages by 0.83%. These increases are concentrated in the non-tradable sector, most notably in construction, retail, and services. More importantly, surges in local demand stimulate firm entry and expansion, potentially increasing competition in both the product market and the labor market. Accordingly, international students also cause significant job destruction due to firm contractions and exits, particularly among less efficient firms. Hence, in addition to net positive effects on local jobs and earnings, an increase in enrollment of students from abroad also results in within-industry labor reallocations and, therefore, improvements in local aggregate productivity.

Overall, this paper suggests that future discussions and deliberation of US student visa policy should take into account these short-run local economic benefits of international students. A policy that restricts enrollment would hurt not only US universities and colleges, by curtailing tuition revenue and academic innovation, as prior research has shown, but also surrounding local economies through a reduction in employment, earnings, and business dynamism.

Given the overwhelming representation of international students in the fields of science, technology, engineering, and mathematics, what are the long-run effects of an increase in foreign enrollment and participation in the labor force after graduation on technological growth and innovation? Would both the short- and long-run effects differ if students were allowed to work while still enrolled in schools? Interestingly, the results discussed in this paper suggest that immigrants in general can also increase labor demand for natives through by affecting local consumption. How much does this channel counter the potentially negative effects of an immigration-induced labor supply shock? These are important topics that should be investigated by future research.

References

Abraham, K.G., and M.S. Kearney. 2020. "Explaining the decline in the US employment-to-population ratio: A review of the evidence." *Journal of Economic Literature* 58:585–643.

Acemoglu, D., D. Autor, D. Dorn, G.H. Hanson, and B. Price. 2016. "Import competition and the great US employment sag of the 2000s." *Journal of Labor Economics* 34:S141–S198.

Acemoglu, D., and P. Restrepo. 2020. "Robots and jobs: Evidence from US labor markets." *Journal of Political Economy* 128:2188–2244.

Asquith, B., S. Goswami, D. Neumark, and A. Rodriguez-Lopez. 2019. "Us job flows and the china shock." *Journal of International Economics* 118:123–137.

Autor, D.H., D. Dorn, G.H. Hanson, and J. Song. 2014. "Trade adjustment: Worker-level evidence." *The Quarterly Journal of Economics* 129:1799–1860.

Autor, D.H., L.F. Katz, and M.S. Kearney. 2008. "Trends in US wage inequality: Revising the revisionists." *The Review of economics and statistics* 90:300–323.

Basso, G., and G. Peri. 2020. "Internal mobility: The greater responsiveness of foreign-born to economic conditions." *Journal of Economic Perspectives* 34(3):77–98.

Beine, M., R. Noël, and L. Ragot. 2014. "Determinants of the international mobility of students." *Economics of Education review* 41:40–54.

Berlingieri, G. 2013. "Outsourcing and the Rise in Services.", pp. .

Bernard, A.B., and J.B. Jensen. 1999. "Exceptional exporter performance: cause, effect, or both?" *Journal of international economics* 47:1–25.

Bernard, A.B., J.B. Jensen, S.J. Redding, and P.K. Schott. 2007. "Firms in international trade." *Journal of Economic perspectives* 21:105–130.

Bernard, A.B., S.J. Redding, and P.K. Schott. 2007. "Comparative advantage and heterogeneous firms." *The Review of Economic Studies* 74:31–66.

Blanchard, O.J., L.F. Katz, R.E. Hall, and B. Eichengreen. 1992. "Regional Evolutions." *Brookings Papers on Economic Activity* 1992:1–75.

Blau, F.D., and L.M. Kahn. 2015. "Immigration and the Distribution of Incomes." In *Handbook of the economics of international migration*. Elsevier, vol. 1, pp. 793–843.

Blau, F.D., and C. Mackie. 2017. *The economic and fiscal consequences of immigration*. National Academies Press.

Bloom, N., K. Handley, A. Kumar, and P. Luck. 2018. "The Impact of Chinese Trade: The Good, the Bad, and the Apocryphal." *Unpublished manuscript*, pp. .

Bloom, N., K. Handley, A. Kurmann, and P. Luck. 2019. "The impact of chinese trade on us employment: The good, the bad, and the apocryphal." In *American economic association annual meetings*. vol. 2019.

Bodvarsson, Ö.B., H.F. Van den Berg, and J.J. Lewer. 2008. "Measuring immigration's effects on labor demand: A reexamination of the Mariel Boatlift." *Labour Economics* 15:560–574.

Borusyak, K., P. Hull, and X. Jaravel. 2018. "Quasi-experimental shift-share research designs." Working paper, National Bureau of Economic Research.

Bound, J., B. Braga, G. Khanna, and S. Turner. 2021. "The globalization of postsecondary education: The role of international students in the US higher education system." *Journal of Economic Perspectives* 35(1):163–84.

—. 2020. "A Passage to America: University Funding and International Students." *American Economic Journal: Economic Policy* 12:97–126.

Bound, J., and H.J. Holzer. 2000. "Demand shifts, population adjustments, and labor market outcomes during the 1980s." *Journal of labor Economics* 18:20–54.

Bureau of Economic Analysis. 2020. "International Transactions, International Services, and International Investment Position Tables." International Data. https://apps.bea.gov/iTable/iTable.cfm?ReqID=62&step=1#reqid=62&step=9&isuri=1&6210=4 (accessed November 10, 2021).

Cadena, B.C., and B.K. Kovak. 2016. "Immigrants equilibrate local labor markets: Evidence from the Great Recession." *American Economic Journal: Applied Economics* 8:257–90.

Card, D. 2001. "Immigrant inflows, native outflows, and the local labor market impacts of higher immigration." *Journal of Labor Economics* 19:22–64.

Card, D., A.R. Cardoso, J. Heining, and P. Kline. 2018. "Firms and labor market inequality: Evidence and some theory." *Journal of Labor Economics* 36:S13–S70.

Card, D., and G. Peri. 2016. "Immigration economics by George J. Borjas: a review essay." *Journal of Economic Literature* 54:1333–49.

Charles, K.K., E. Hurst, and M.J. Notowidigdo. 2018. "Housing Booms and Busts, Labor Market Opportunities, and College Attendance." *American Economic Review* 108:2947–94.

Chellaraj, G., K.E. Maskus, and A. Mattoo. 2008. "The contribution of international graduate students to US innovation." *Review of International Economics* 16:444–462.

David, H., and D. Dorn. 2013. "The growth of low-skill service jobs and the polarization of the US labor market." *American economic review* 103:1553–97.

David, H., D. Dorn, and G.H. Hanson. 2013. "The China syndrome: Local labor market effects of import competition in the United States." *American Economic Review* 103:2121–68.

Dix-Carneiro, R. 2014. "Trade liberalization and labor market dynamics." *Econometrica* 82:825–885.

Dustmann, C., U. Schönberg, and J. Stuhler. 2016. "The impact of immigration: Why do studies reach such different results?" *Journal of Economic Perspectives* 30(4):31–56.

—. 2017. "Labor supply shocks, native wages, and the adjustment of local employment." *The Quarterly Journal of Economics* 132:435–483.

Engbom, N., and C. Moser. 2017. "Returns to education through access to higher-paying firms: Evidence from US matched employer-employee data." *American Economic Review* 107:374–78.

Haltiwanger, J., R.S. Jarmin, and J. Miranda. 2013. "Who creates jobs? Small versus large versus young." *Review of Economics and Statistics* 95:347–361.

Katz, L.F., et al. 1999. "Changes in the wage structure and earnings inequality." In *Handbook of labor economics*. Elsevier, vol. 3, pp. 1463–1555.

Khanna, G., K. Shih, A. Weinberger, M. Xu, and M. Yu. 2020. "Trade Liberalization and Chinese Students in US Higher Education." *Available at SSRN 3590272*, pp. .

Lemieux, T. 2008. "The changing nature of wage inequality." *Journal of population Economics* 21:21–48.

McCaig, B., and N. Pavcnik. 2018. "Export markets and labor allocation in a low-income country." *American Economic Review* 108:1899–1941.

Melitz, M.J. 2003. "The impact of trade on intra-industry reallocations and aggregate industry productivity." *econometrica* 71:1695–1725.

Melitz, M.J., and G.I. Ottaviano. 2008. "Market size, trade, and productivity." *The review of economic studies* 75:295–316.

Monras, J. 2020. "Immigration and wage dynamics: Evidence from the mexican peso crisis." *Journal of Political Economy* 128:3017–3089.

Notowidigdo, M.J. 2020. "The incidence of local labor demand shocks." *Journal of Labor Economics* 38:000–000.

Pavcnik, N. 2002. "Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants." *The Review of economic studies* 69:245–276.

Peri, G., K. Shih, and C. Sparber. 2015. "STEM workers, H-1B visas, and productivity in US cities." *Journal of Labor Economics* 33:S225–S255.

Redding, S.J. 2011. "Theories of heterogeneous firms and trade." *Annu. Rev. Econ.* 3:77–105.

Ruiz, N.G. 2014. "The geography of foreign students in US higher education: Origins and destinations." *Report, Global Cities Initiative*, pp. .

Shih, K. 2017. "Do international students crowd-out or cross-subsidize Americans in higher education?" *Journal of Public Economics* 156:170–184.

Smith, C.L. 2012. "The impact of low-skilled immigration on the youth labor market." *Journal of Labor Economics* 30:55–89.

Stuen, E.T., A.M. Mobarak, and K.E. Maskus. 2012. "Skilled immigration and innovation: evidence from enrolment fluctuations in US doctoral programmes." *The Economic Journal* 122:1143–1176.

Tolbert, C.M., and M. Sizer. 1996. "US commuting zones and labor market areas: A 1990 update. ERS Staff Paper Number 9614. Washington, DC: Economic Research Service." *Rural Economy Division, US Department of Agriculture*, pp. .

UNESCO Institute for Statistics. 2021. "Education Data." http://data.uis.unesco.org. (accessed November 10, 2021).

Wooldridge, J.M. 2010. *Econometric analysis of cross section and panel data*. MIT press.

Zhu, L. 2021. "Comparative Immigration Policies and the Effect of International Students in U.S. Higher Education." Unpublished, Working Paper.

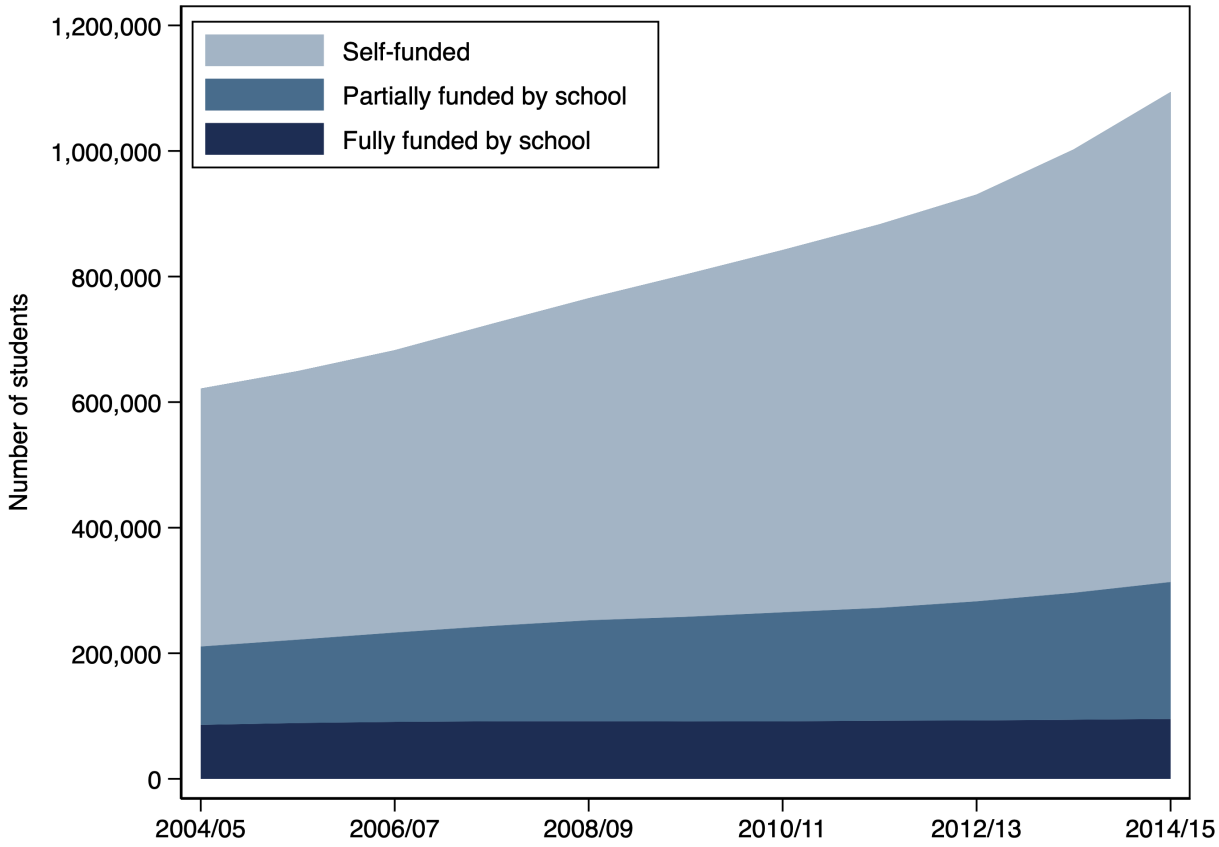


Figure 1. Trends in International Student Enrollment in US Higher Education by Funding Status.

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

Table 1—Top 10 Commuting Zones With Largest Number of International Students

2015		
Commuting zones	Largest counties (by 2010 Census population)	International students (% of pop)
38300	Los Angeles—Orange—Riverside (CA)	109,739 (0.59)
19400	Kings—Queens—New York (NY)	87,890 (0.71)
20500	Middlesex—Worcester—Essex (MA)	63,917 (1.19)
37800	Alameda—Contra Costa—San Francisco (CA)	46,595 (0.89)
39400	Pierce—Snohomish—Thurston (WA)	37,384 (0.81)
11304	Fairfax (VA)—Montgomery (MD)—D.C.	34,728 (0.60)
24300	Cook—DuPage—Lake (IL)	32,146 (0.37)
32000	Harris—Fort Bend—Montgomery (TX)	24,000 (0.38)
19600	Bergen—Middlesex—Essex (NJ)	23,983 (0.89)
37500	Santa Clara—Monterey—Santa Cruz (CA)	23,174 (0.38)

2005		
Commuting zones	Largest counties (by 2010 Census population)	International students (% of pop)
38300	Los Angeles—Orange—Riverside (CA)	53,528 (0.31)
19400	Kings—Queens—New York (NY)	48,218 (0.41)
20500	Middlesex—Worcester—Essex (MA)	29,960 (0.60)
11304	Fairfax (VA)—Montgomery (MD)—D.C.	19,722 (0.39)
37800	Alameda—Contra Costa—San Francisco (CA)	18,614 (0.40)
24300	Cook—DuPage—Lake (IL)	18,578 (0.22)
19600	Bergen—Middlesex—Essex (NJ)	15,790 (0.27)
32000	Harris—Fort Bend—Montgomery (TX)	14,942 (0.28)
11600	Wayne—Oakland—Macomb (MI)	14,590 (0.29)
39400	Pierce—Snohomish—Thurston (WA)	13,507 (0.34)

Table 2. Growth in International Student 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 higher education (undergraduate and graduate level) for any portion of the year in 2005 and 2015.

Table 3. Balancing Tests: Effects of International Students on Changes in Commuting Zone Characteristics, ACS Estimates, Stacked First Differences 2006-2015

	State Appropriations per Public FTE		Share of Employed Adults with an Advanced Degree		Share of Employed Adults that are College-Educated & Foreign Born		Share of Population in Manufacturing	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	-0.115***	0.022	-0.006***	0.004	0.003*	-0.001	0.001	-0.004
	(0.028)	(0.076)	(0.003)	(0.007)	(0.002)	(0.004)	(0.001)	(0.004)
First-stage *F*-statistic		44.1		50.2		50.2		50.2
Observations	5,160	5,160	7,220	7,220	7,220	7,220	7,220	7,220

Notes—Outcomes are period changes from *t-1 to t.* All specifications include time fixed effects, changes in (log) population, the share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), race (whites, blacks, Hispanics, and Asians), and education (no college, some college, college or professional degree, and advanced degrees), and the share of foreign born. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

* significant at the 10 percent level

** significant at the 5 percent level

*** significant at the 1 percent level

Table 4—Effects of International Students on Local Employment and Wages, ACS Estimates, Stacked First Differences 2006-2015

	Employment Rate		Average Wages		Emp. Rate x Average Wages	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. All workers						
$\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	0.011***	0.039***	0.038***	0.083***	0.059***	0.167***
	(0.004)	(0.010)	(0.011)	(0.025)	(0.016)	(0.039)
Panel B. Men						
$\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	0.014**	0.043***	0.042***	0.079**	0.073***	0.185***
	(0.005)	(0.013)	(0.013)	(0.032)	(0.022)	(0.051)
Panel C. Women						
$\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	0.009**	0.034***	0.029***	0.091***	0.044***	0.147***
	(0.004)	(0.011)	(0.011)	(0.028)	(0.014)	(0.038)
First-stage *F*-statistic		50.2		50.2		50.2
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 time fixed effects, changes in (log) population, the share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), race (whites, blacks, Hispanics, and Asians), and education (no college, some college, college or professional degree, and advanced degrees), the share of employed adults that are foreign born, and the share of the population employed in manufacturing. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

* significant at the 10 percent level

** significant at the 5 percent level

*** significant at the 1 percent level

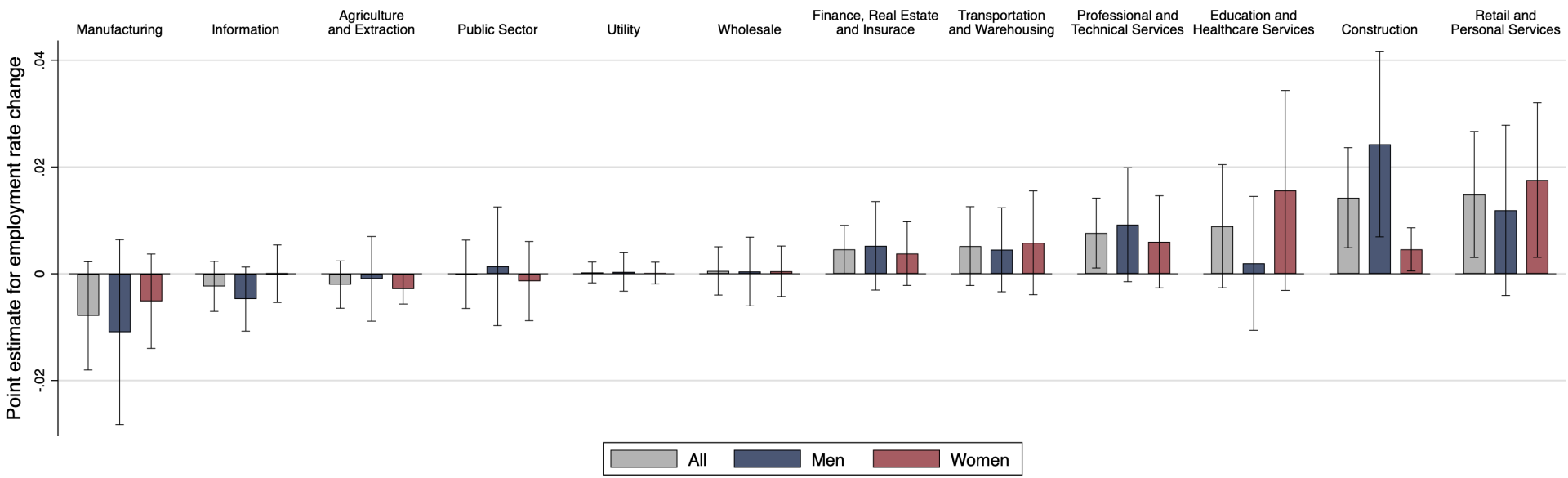


Figure 2. Effects of international students on industries, ACS estimates.

Notes—This figure presents estimates of the effects of a change in international student enrollment on changes in industry employment-to-population ratio. The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in column 2 of table 4.

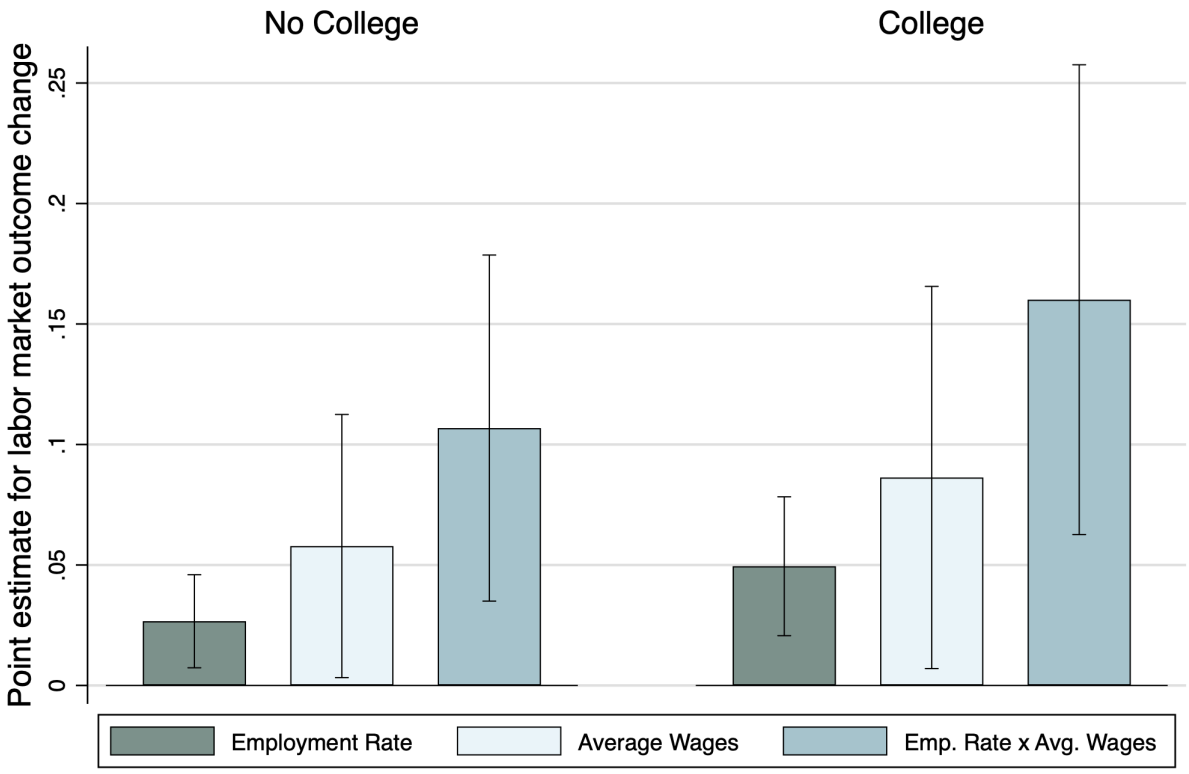


Figure 3. Effects of international students on employment and wages by education, ACS estimates.

Notes—This figure presents estimates of the effects of a change in international student enrollment 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 4.

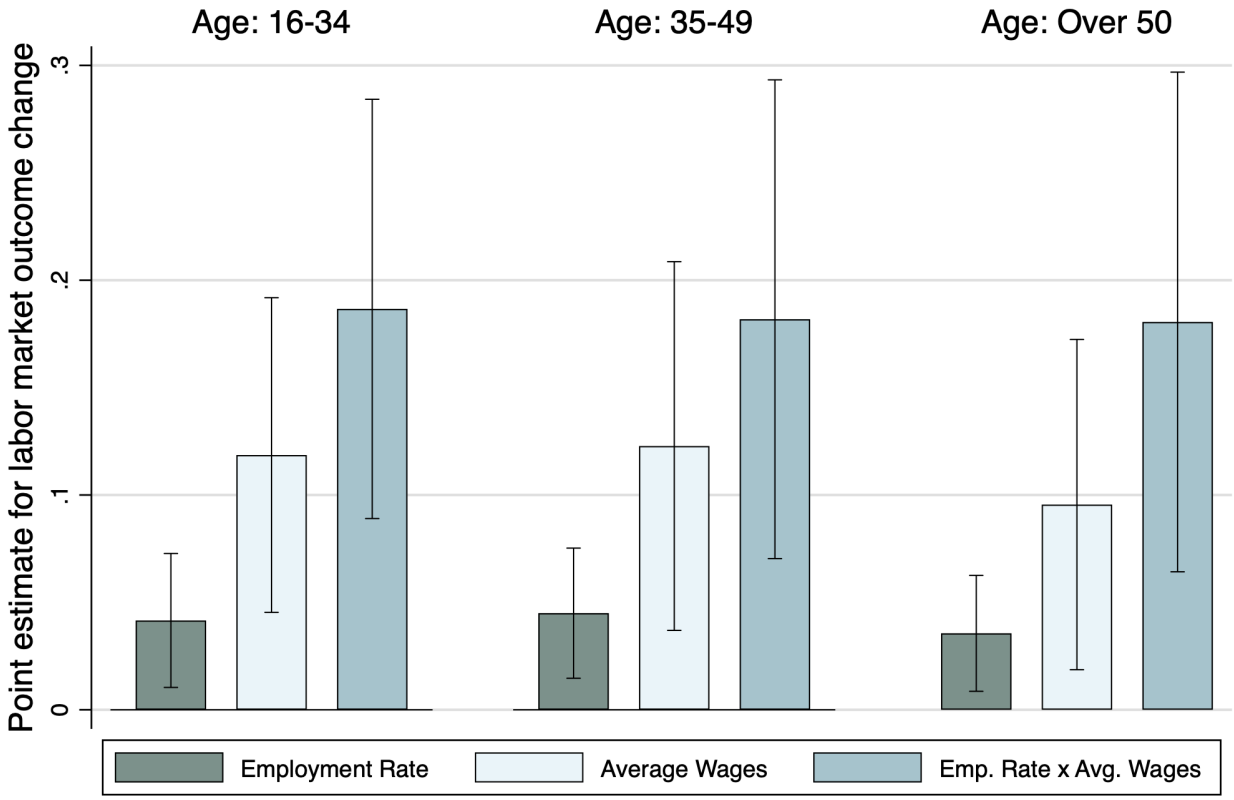
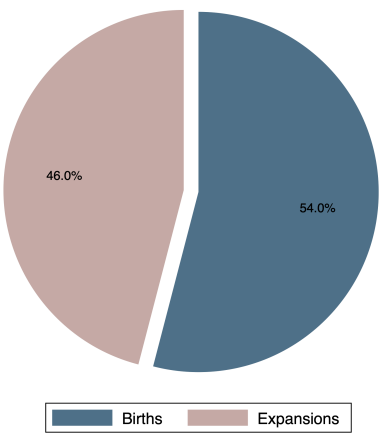
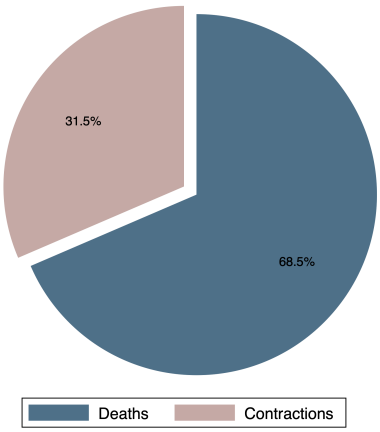


Figure 4. Effects of international students on employment and wages by age, ACS estimates.

Notes—This figure presents estimates of the effects of a change in international student enrollment on changes in employment and wage outcomes of natives in different age groups (16-34, 35-49, 50+). The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in columns 2, 4, and 6 of table 4.



(a) Job creation shares (average)



(b) Job destruction shares (average)

Figure 5. Employment creation and destruction between 2005 and 2016, YTS estimates

Table 5—Effects of International Students on Local Job Flows, YTS Estimates, Stacked First Differences 2006-2015

Independent variable: $\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	All		Nontradable Sector		Tradable Sector	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Net employment growth	0.005	0.036**	0.009*	0.029**	-0.004	0.007
	(0.008)	(0.016)	(0.005)	(0.011)	(0.004)	(0.008)
Job flows						
Births	0.022**	0.073**	0.014**	0.052**	0.008**	0.016
	(0.009)	(0.033)	(0.006)	(0.022)	(0.003)	(0.010)
Expansions	0.016**	0.079**	0.011***	0.048**	0.006**	0.026**
	(0.007)	(0.033)	(0.004)	(0.019)	(0.003)	(0.013)
Deaths	0.021**	0.091**	0.011***	0.057**	0.012***	0.030*
	(0.010)	(0.044)	(0.006)	(0.026)	(0.004)	(0.017)
Contractions	0.015***	0.037*	0.008***	0.019*	0.007***	0.010
	(0.004)	(0.020)	(0.003)	(0.010)	(0.002)	(0.008)
First-stage *F*-statistic		50.2		50.2		50.2
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 time fixed effects, changes in (log) population, the share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), race (whites, blacks, Hispanics, and Asians), and education (no college, some college, college or professional degree, and advanced degrees), and the share of foreign born. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

* significant at the 10 percent level

** significant at the 5 percent level

*** significant at the 1 percent level

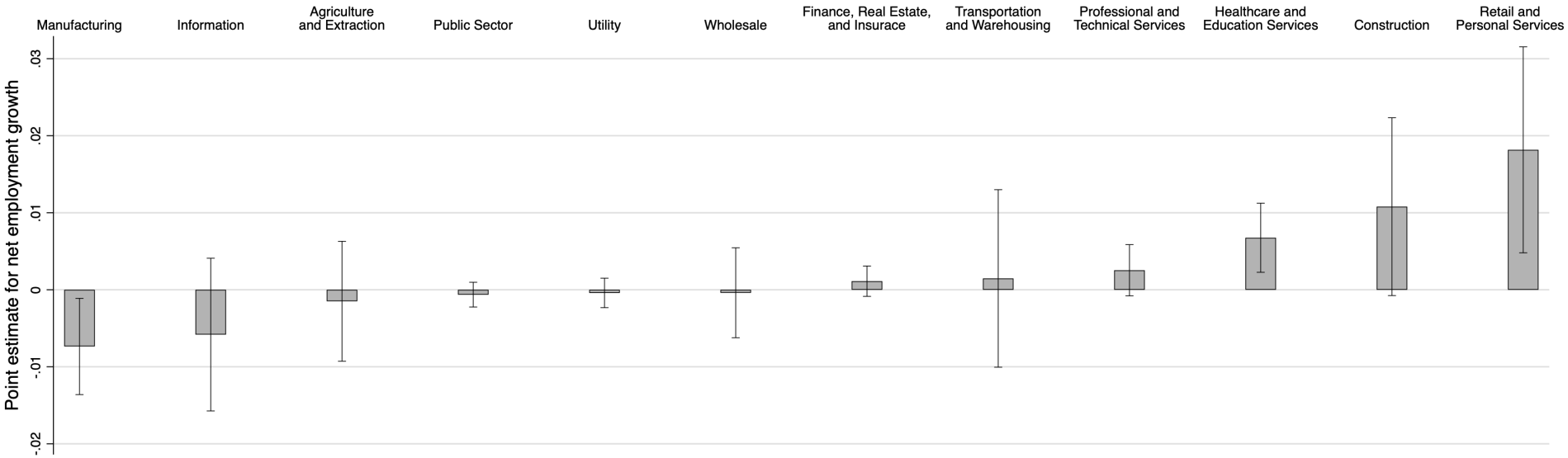


Figure 6. Effects of international students on industries, YTS estimates.

Notes—This figure presents estimates of the effects of a change in international student enrollment on changes in industry net employment growth adjusted by commuting zone population (see equation 3 in the main text). The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in column 2 of table 5.

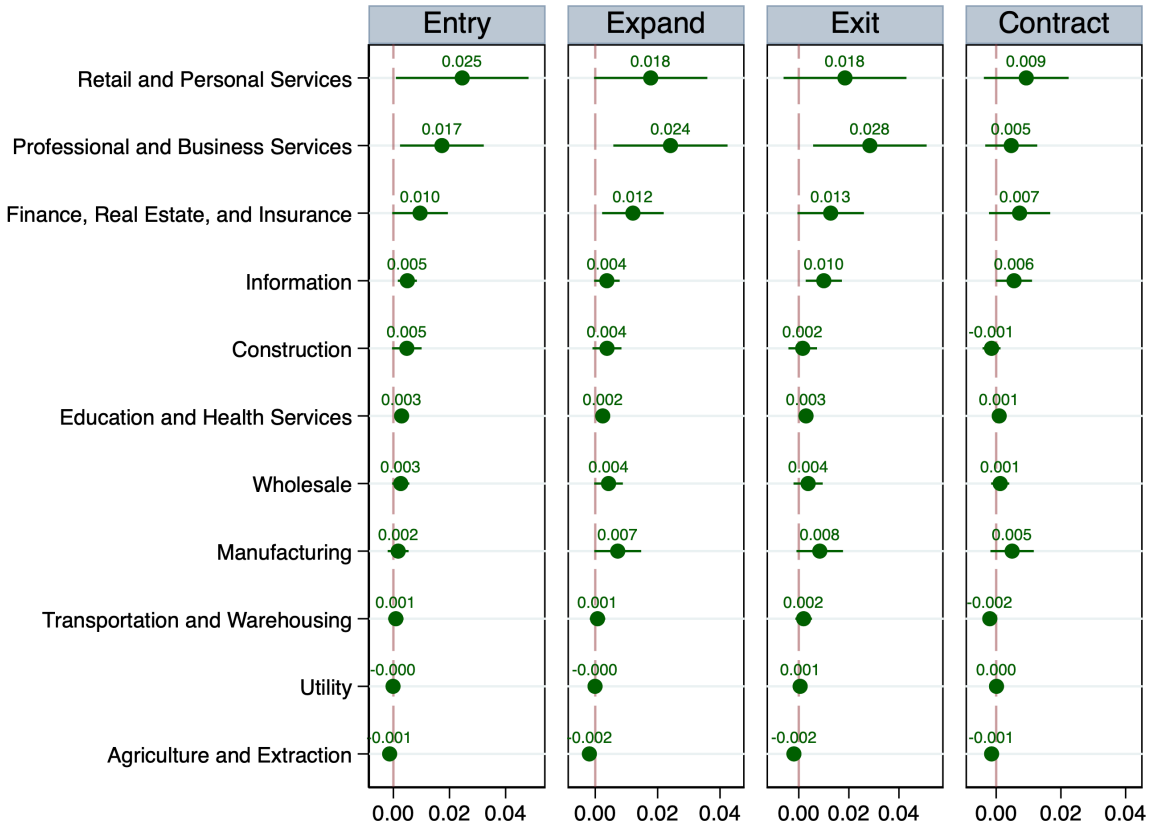


Figure 7. Effects of international students on job flows by industry, YTS estimates.

Notes—This figure presents estimates of the effects of a change in international student enrollment on changes in commuting zone job-flow components in each industry. The capped lines provide 95% confidence intervals. Estimates are obtained from stacked-differences IV specifications as in columns 2 of table 5.

Table 6—Effects of International Students on Local Job Flows by Establishment Performance Quartile, YTS Estimates, Stacked First Differences 2006-2015

Independent Variable: $\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	Overall	First Quartile	Second Quartile	Third Quartile	Fourth Quartile
	(1)	(2)	(3)	(4)	(5)
Births	0.068**	0.041***	0.000	0.010***	0.017***
	(0.028)	(0.015)	(0.006)	(0.004)	(0.006)
Expansions	0.067**	0.005***	0.003	0.008**	0.051**
	(0.028)	(0.002)	(0.002)	(0.003)	(0.022)
Deaths	0.083**	0.067***	0.021**	-0.004	-0.001
	(0.040)	(0.022)	(0.010)	(0.004)	(0.009)
Contractions	0.024*	0.017**	0.001	0.002	0.003
	(0.015)	(0.007)	(0.002)	(0.002)	(0.007)
First-stage *F*-statistic	50.2	50.2	50.2	50.2	50.2
Observations	7,220	7,220	7,220	7,220	7,220

Notes—Outcomes are period changes from *t* to *t+1*. All specifications include time fixed effects, changes in (log) population, the share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), race (whites, blacks, Hispanics, and Asians), and education (no college, some college, college or professional degree, and advanced degrees), the share of employed adults that are foreign born, and the share of the population employed in manufacturing. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

* significant at the 10 percent level
** significant at the 5 percent level
*** significant at the 1 percent level

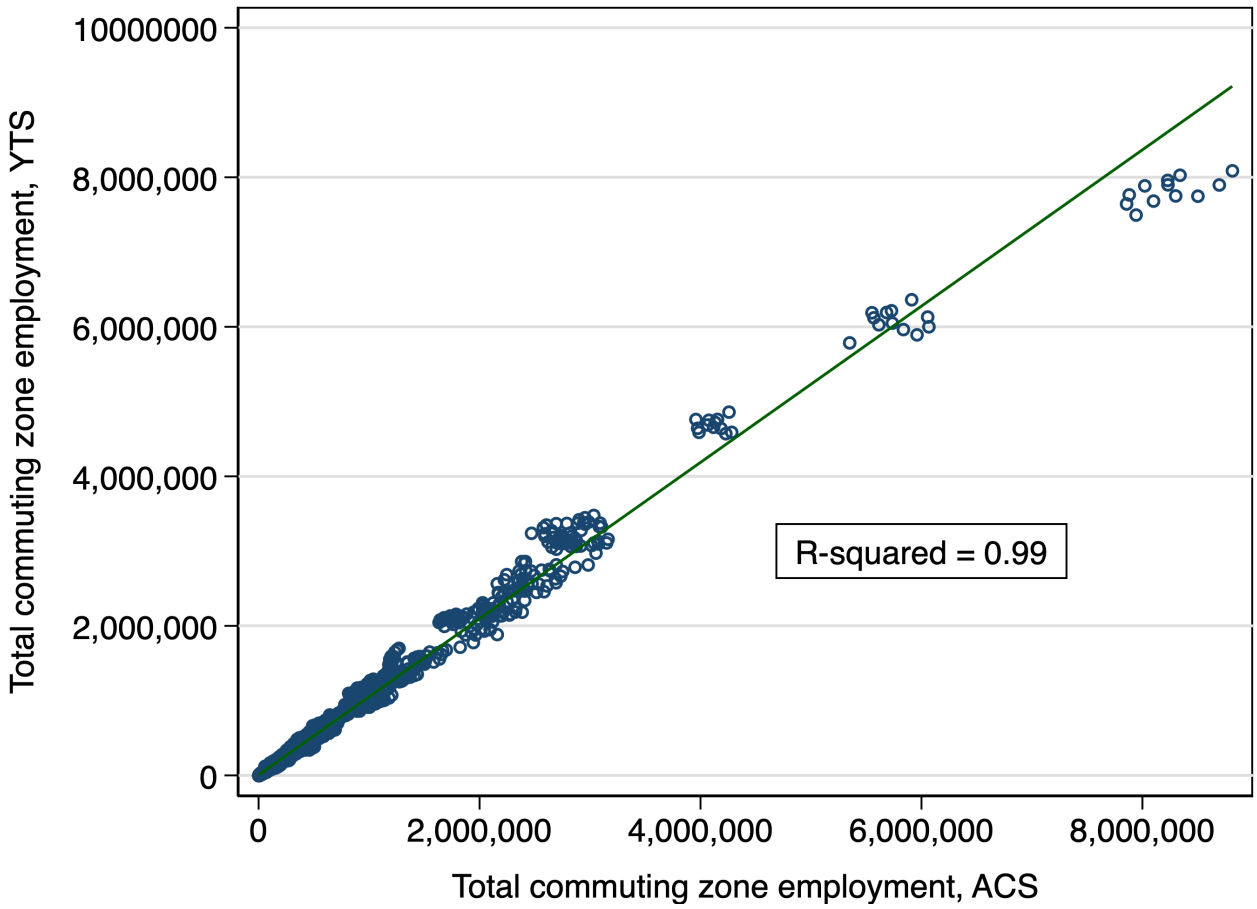


Figure A1. Correlation between ACS and YTS total commuting zone employment

Notes—Tabulations on 722 commuting zones between 2005 and 2016.

Table A1—Effects of International Students on Natives' College Attendance, IV Estimates, Stacked First Differences 2006-2015

	Public		Private, Non-Profit		Private, For-Profit	
	2-year	4-year	2-year	4-year	2-year	4-year
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Men and Women						
$\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	-0.023**	0.014	-0.002	-0.002**	0.002	-0.001
	(0.011)	(0.010)	(0.001)	(0.001)	(0.006)	(0.001)
Panel B. Men						
$\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	-0.023**	0.012	-0.001	-0.002**	-0.002	-0.000
	(0.010)	(0.009)	(0.001)	(0.001)	(0.004)	(0.000)
Panel C. Women						
$\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	-0.024*	0.015	-0.003*	-0.002*	0.006	-0.001
	(0.012)	(0.011)	(0.001)	(0.001)	(0.010)	(0.001)
First-stage *F*-statistic		43.3		43.3		43.3
Observations	5,700	5,700	5,700	5,700	5,700	5,700

Notes—Observations = 570CZ x 10. Outcomes are period changes in per capita first-time, first-year college enrollment by natives from *t* to *t+1*. All specifications include time fixed effects, changes in (log) population, the share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), race (whites, blacks, Hispanics, and Asians), the share of employed adults over 25 with a college degree, the share of employed adults that are foreign born, and the share of the population employed in manufacturing. Regressions are weighted by commuting zone 18-25 population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

* significant at the 10 percent level

** significant at the 5 percent level

*** significant at the 1 percent level

Table A2—Robustness Checks: Baseline IV Estimates with Alternative Wage Outcomes, ACS

	Baseline: Average Wages (full-time workers only)	Average Wages (full- and part-time workers)	Average Wages at CZ x Demographic Cell Level (full-time workers only)	Average Residualized Log Wages (full-time workers only)
	(1)	(2)	(3)	(4)
$\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	0.083***	0.093***	0.077**	0.44**
	(0.025)	(0.030)	(0.031)	(0.021)
First-stage *F*-statistic	50.2	50.2	42.4	50.2
Observations	7,220	7,220	114,986	7,220

Notes—Outcomes are period changes from *t* to *t+1*. All specifications include time fixed effects, changes in (log) population, the share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), race (whites, blacks, Hispanics, and Asians), and education (no college, some college, college or professional degree, and advanced degrees), the share of employed adults that are foreign born, and the share of the population employed in manufacturing. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

* significant at the 10 percent level
** significant at the 5 percent level
*** significant at the 1 percent level

Table A3—Robustness Checks: Baseline IV Estimates with Alternative Sample Restrictions, ACS

Independent Variable: $\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	Employment Rate	Average Wages	Emp. Rate x Average Wages
	(1)	(2)	(3)
Panel A			
Baseline estimates (all workers)	0.039***	0.083***	0.167***
	(0.010)	(0.025)	(0.039)
Panel B			
Same state of birth workers	0.042***	0.082***	0.173***
	(0.013)	(0.029)	(0.046)
Panel C			
Exclude CZ with the highest numbers of international students in 2005 (top 10%)	0.066***	0.134***	0.274***
	(0.020)	(0.045)	(0.074)
Panel D			
Exclude CZ with no international students in 2005	0.039***	0.092***	0.172***
	(0.010)	(0.026)	(0.040)

Notes—Outcomes are period changes from *t* to *t+1*. All specifications include time fixed effects, changes in (log) population, the share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), race (whites, blacks, Hispanics, and Asians), and education (no college, some college, college or professional degree, and advanced degrees), the share of employed adults that are foreign born, and the share of the population employed in manufacturing. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

* significant at the 10 percent level
** significant at the 5 percent level
*** significant at the 1 percent level

Table A4—Robustness Checks: Baseline IV Estimates with Alternative Specifications, ACS

Independent Variable: $\Delta \text{IS}_{c,t}/\text{Pop}_{c,t-1} \times 100$	Employment Rate	Average Wages	Emp. Rate x Average Wages
	(1)	(2)	(3)
Panel A			
Baseline estimates (all workers)	0.039***	0.083***	0.167***
	(0.010)	(0.025)	(0.039)
Panel B			
Exclude international graduate students	0.076***	0.193***	0.345***
	(0.025)	(0.068)	(0.102)
Panel C			
Exclude Chinese students	0.143***	0.362***	0.647***
	(0.049)	(0.123)	(0.196)
Panel D			
Exclude Indian students	0.040***	0.084***	0.169***
	(0.010)	(0.025)	(0.038)

Notes—Outcomes are period changes from *t* to *t+1*. All specifications include time fixed effects, changes in (log) population, the share of females, the shares of the population by age (16-34, 35-49, 50-64, and over 65), race (whites, blacks, Hispanics, and Asians), and education (no college, some college, college or professional degree, and advanced degrees), the share of employed adults that are foreign born, and the share of the population employed in manufacturing. Regressions are weighted by commuting zone population in 2005. Robust standard errors in parentheses are clustered at the commuting zone level.

* significant at the 10 percent level
** significant at the 5 percent level
*** significant at the 1 percent level