The Local Economic Impacts of Foreign Students*

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Abstract

Do foreign students affect the economic outcomes of the natives in places with post-secondary institutions? I address this question by examining the impacts of demand shocks induced by expansions in foreign post-secondary student enrollment in the US between 2004 and 2016. Using an instrumental variables strategy that exploits spatial variation in foreign student enrollment expansion over this period, I estimate the causal effects on a vector of local economic outcomes. On average, the demand shocks substantially increased local employment and wages while having no significant effect on housing rent. At the same time, I find no evidence of adverse spillover effects on neighboring areas without post-secondary institutions. Further, the effect on employment increases with population density. However, the effect on housing rent also increases, likely due to limited supply in densely populated areas. The results suggest welfare gains for natives, especially in less densely populated areas that depend heavily on the education sector. While the effect of changes in foreign student enrollment on the local economy is sizable, the effect of changes in domestic student enrollment is small during the same period.

Keywords: Local Demand Shocks, Foreign Students, Higher Education, Immigration

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I. Introduction

Recent decades have seen a massive increase in the number of foreign students in post-secondary education (henceforth, foreign students) in the US. Following an almost two-fold increase since the beginning of the twenty-first century, the total foreign student enrollment stood at 1 million in 2016, which accounted for roughly 5% of total post-secondary enrollment in the US.[1] The foreign students bring billions of dollars in revenue to the US post-secondary institutions and the economy, in addition to global talent and diverse cultural values; however, a rapid increase in their population may adversely affect the economic outcomes of the natives at places with host post-secondary institutions. This paper investigates this concern by examining the impacts of the expansion of foreign student enrollment on the local economic outcomes of the natives.

An influx of foreign students creates positive local demand shocks at places with host institutions. As the local economic activities are interconnected, demand shocks evolve, creating a multiplying effect and affecting different aspects of the local economy. Because of this externality, many policies that aim to promote local demand are implemented.[2] However, the impact on the local economy could eventually dissipate as labor and firms move across locations to arbitrage the benefits of the increased local demand, putting upward pressure on the land rents. Economists have long debated the distortions in economic behavior and eventual effects of local demand shocks (Glaeser and Gottlieb, 2008; Kline and Moretti, 2014*b*). Overall, the incidence and efficiency of these shocks are both empirical questions, depending on the mobility of workers and firms, housing supply elasticity, and changes in the factor prices. The effect of local demand shocks created by foreign students could be particularly important for local economies that depend heavily on the education sector and lack growth opportunities in other sectors. A positive effect may foster economic growth in such areas.

While there has been a long-standing debate on the impact of immigrants on the native outcomes and the host economy (Abramitzky and Boustan, 2017; Kerr and Kerr, 2011), for-

[1] The number of newly enrolled foreign students on the most commonly issued student visa for the US, F1 visa, has dramatically increased from 138,500 in 2004 to 364,000 in 2016 (Ruiz and Budiman, 2018). There is no official yearly limit on the number of F1 visas that can be issued, unlike most other visa types issued by the government of the United States.

[2] See Kline and Moretti (2014*b*), Neumark and Simpson (2015), Bartik (2020)

eign students are notably different. Usually, the immigrant population live, consume, and work in the host area, thereby affecting both the demand and supply in the labor market. Dustmann, Schönberg and Stuhler (2017) study an unusual case where the immigrants were only allowed to work in the host area, but were denied residency rights, which led to a labor supply shock only.[3] In contrast, a distinctive and key feature of foreign students in the US is that they cannot work on a student visa until they have finished their education;[4] hence the shock is arguably a "pure" demand shock. In addition to contributing to the debate of whether foreign students are good for the local economy, this paper fills a gap in the literature by exploring the effects of a unique case of "pure" demand shock.

In this paper, I study the local economic impacts of foreign student enrollment expansions between 2004 and 2016, when foreign student enrollment doubled in the US. Focusing on counties with post-secondary institutions where students were a large share of the county population in the base year (henceforth, sample counties[5]), I estimate the causal effects on the local economic outcomes. I also look at the local economic effects of domestic post-secondary student (henceforth, domestic student) enrollment and discuss the potential welfare impacts on different agents in the local economy.

My primary data sources are publicly available Integrated Postsecondary Education Data System (IPEDS), Bureau of Economic Analysis (BEA), County Business Pattern (CBP) series, and National Historical Geographical Information System(NHGIS). I use a long difference specification and exploit the cross-county variation in the change in enrollment of foreign and domestic students. However, a major challenge in estimating the causal impact is that the student enrollment could be correlated with the unobserved county-specific secular trend or the unobserved contemporaneous shocks affecting the local economic outcomes of the county. For instance, a worsening state economy could reduce state appropriations to public universities and increase universities' reliance on foreign students leading to a problem of

[3] Dustmann, Schönberg and Stuhler (2017) evaluate a policy implemented 14 months after the fall of the Berlin wall. The policy allowed Czech workers to seek employment in German border municipalities, but denied residency rights, leading to an exogenous labor supply shock.

[4] An exception to this is working part-time on-campus or full time on Curricular Practical Training (CPT). CPT is temporary employment authorization for students on F-1 visa while enrolled in a college-level degree program. Also, the work on CPT must be related to the student's degree program and necessary to complete the degree.

[5] To be precise, I set the student-to-population ratio cutoff to be 5% in the year 2004.

reverse causality and downward bias in the OLS estimates.

First, to address the potential endogeneity issue between the enrollment and the secular trend, I control for a county-specific pre-trend in the outcome. Second, to address the potential endogeneity concern between foreign student enrollment and the unobserved contemporaneous shock, I construct a shift-share instrument (henceforth, the foreign IV) based on the historical share of the foreign students in a county in the US. Counties with higher initial shares of foreign students are more likely to substantially increase foreign student enrollment during a period when foreign enrollment increases at the national level. One of the potential reasons for this is the network effect — foreign students provide information and assistance to a compatriot planning to study abroad. In particular, the foreign IV, which is the predicted change in the actual foreign enrollment, is the interaction of the historical presence of foreign students in a county ("share") and the contemporaneous national level expansion in foreign student enrollment ("shift"). While the instrument is uncorrelated with contemporaneous shocks as long as the "shift" part of the instrument is not driven by idiosyncratic local shocks, the "share" part of the instrument could be correlated with the secular trend. Therefore, it is crucial to credibly partial out the secular trend of the local economic outcomes, without which the instrument can be invalid.

Third, I construct a shift-share instrument (henceforth, the domestic IV) to address the endogeneity concern with domestic student enrollment as well. However, unlike the foreign IV, the domestic IV uses the variation in the historical share of the domestic students in a county from different states in the US, rather than from total domestic students in the US as it better explains the variation in actual domestic enrollment. In particular, the instrument is constructed by summing the interaction terms between the historical presence of domestic students in a county ("share") from a particular state and the contemporaneous change in the number of post-secondary students who are residents of the corresponding state ("shift"). Since a large share of domestic students attends post-secondary institutions within their state of residence, the domestic IV could be reflecting the overall state economy; however, including state fixed effects addresses the concern. Using similar arguments as for foreign IV, the domestic IV is plausibly exogenous to the local economy. I examine the plausibility of identifying assumptions, including the validity of exclusion restrictions in the case of shift-share

instruments. I conduct a test recently suggested by Goldsmith-Pinkham, Sorkin and Swift (2020) and show that the instruments are unlikely to be correlated with the unobservables.

I find sizable effects of the increase in foreign student enrollment on the level of local economic activities between 2004 and 2016. The estimates imply that one additional foreign student created 2.73 jobs in the same county over the 12 years. Demographic-adjusted wages also increased steeply by 3.32% for one percentage point increase in the foreign student enrollment-to-population ratio. A potential reason that the effects are stronger than in other immigration contexts is that foreign students have very restricted work opportunities, thereby reducing possible supply-side effects. Further, foreign student enrollment led to a large positive increase in the county population, which is reasonable as the creation of new employment opportunities might attract more workers from other places. In the housing market, I do not find a significant effect on gross housing rent. The rapid increase in housing units might have eased upward pressure on the housing rent as I find that the housing units increased by 1.1 for every additional foreign student. While the marginal effect of foreign student enrollment is sizable, domestic student enrollment led to little or no effect on the levels of local outcomes over the 12 years.

Overall, the results suggest potential welfare gains for native workers as employment opportunities and wages improved but there is no significant effect on the housing rent. In theory, the movement of firms and workers into a particular geographical area puts upward pressure on rent. And if the housing supply is inelastic, it leads to welfare gains capitalized in land rents that would otherwise accrue to resident workers. However, in this paper, I find no significant effect on housing rent.

While foreign student enrollment increased rapidly between 2004 and 2016, domestic student enrollment increased significantly until 2010 and declined rapidly after that. A 12-year long difference specification masks this sharp change in trend and could lead to conflated effects. However, a split period analysis addresses this concern and validates the main results. Several robustness tests further strengthen the results presented in this paper. The findings are robust to the additional controls that partial out secular trends more flexibly and alternate sample analysis. Moreover, I do not find any adverse impacts on the counties without post-secondary institutions that neighbor sample counties. As workers and firms are mobile,

the overall impact of the expansion of foreign student enrollment could be misrepresented without looking at the effect on neighboring counties.

The findings suggest that foreign student enrollment expansions lead to welfare gains, on average, for the natives; however, the extent to which there are heterogeneous effects could be large, as the adjustment of the local economy depends on various local characteristics. To further unfold how local demand shocks evolve and affect the local economy, I look at the heterogeneity by county's population density. While I find that employment increases with increasing population density, housing rent also increases. Although the welfare impacts on the resident workers would depend on the relative magnitude of the increase in wages and housing rent, the results provide suggestive evidence of greater benefits for natives in sparsely populated counties than in densely populated counties in the longer run.

This paper makes three broad contributions to the literature. First, it contributes to the literature on the effects of local demand shocks on the local economy. To the best of my knowledge, my paper is the first to look at the effects of local demand shocks created by foreign students on the local economy. While the literature on local demand shocks includes papers that focus on place-based policies (Busso, Gregory and Kline, 2013; Chaurey, 2017; Chodorow-Reich et al., 2012; Kline and Moretti, 2014*a*; Neumark and Kolko, 2010), shocks to amenities and infrastructure (Chirakijja, 2022), or other specific shocks (Black, McKinnish and Sanders, 2005; Zou, 2018), the expansion of foreign students provides a suitable and unique setup to study the effects of "pure" demand shocks. Many studies in this literature focus on the local labor markets and look at the local job multiplier, which is the number of additional jobs created by exogenously generating one more job (Black, McKinnish and Sanders, 2005; Chodorow-Reich et al., 2012; Moretti, 2010). However, looking at only the job multiplier may misrepresent the true welfare impacts since the various aspects of the economy are connected, and factors move across locations (Zou, 2018).[6] So, I look at a vector of outcomes and provide a more complete picture of the local economic impacts. My paper further examines the heterogeneous effects by county's population density, a relatively understudied area within this

[6] Zou (2018) looks at the local economic impact of the US military contractions between 1988 and 2000. It shows that even though the local job multiplier was sizable, the welfare costs to workers were small as the local population adjusted quickly to the shock, mainly through reduced in-migration, which led to small changes in wages but large declines in the rental prices.

literature. This aspect is essential as the potential welfare gains or losses to native workers would depend on how prices adjust in different markets in the local economy, which may vary substantially by the local characteristics.

Second, this paper contributes to the extensive literature on the impact of immigration on the host economy. Most papers in this literature look at the immigrant population that can provide labor (Altonji and Card, 1991; Card, 1990, 2001; Doran, Gelber and Isen, 2014; Ottaviano and Peri, 2012). While it is still an unresolved debate whether immigration negatively affects the local economic outcomes, my paper finds sizable positive effects of foreign students on the natives and the local economy (Abramitzky and Boustan, 2017), potentially due to their distinctive feature of not being able to supply labor.

Finally, this paper contributes to relatively new and growing economics literature on foreign post-secondary students, an immigrant type that is expanding rapidly around the world and is expected to grow further in the future with the globalization of education. The existing literature on foreign students focuses on domestic students' educational outcomes (Anelli, Shih and Williams, 2020; Borjas, 2007; Shih, 2017), universities' reliance on foreign students to generate revenue (Bound et al., 2020) or future labor market effects on natives (Demirci, 2020). Another study looks at the impact of the international student boom between 2005 and 2015 on the housing markets at the college-town level (Mocanu and Tremacoldi-Rossi, 2019). My paper, in contrast, looks at the local economic effects of foreign students at the county level, which arguably constitutes a local economy.[7]

II. Foreign Students in US Post-Secondary Institutions

The number of foreign students enrolled in degree programs in post-secondary institutions in the United States increased dramatically between 2004 and 2016. Figure 1a shows that for-

[7] A concurrent working paper, Dang (2022), also studies the effects of foreign students' increase on the labor market but with a different empirical specification and shift-share instrument. The author shows that foreign students' increase in period t is associated with an increase in local employment and wages in period $t+1$. Unlike them, I use a long-difference equation that estimates the adjustment of the local economy in the "long run" that takes into account the macro trends over a large period. Looking at the labor market, housing market, and population, I comment on welfare implications for different agents in the local economy to provide a broad picture. Further, I include the domestic student enrollment in the main specification, without which the shift-share-style foreign instrument could violate the exclusion restriction, as both are likely to be correlated.

eign student degree enrollment increased by 70% in this period from around 565,000 students to 950,000 students. This includes total degree enrollment at post-secondary institutions of all level[8] and control[9] types that are eligible for the federal financial aid program. The increase in undergraduate enrollment accounts for 60% of this increase, and the number of new foreign students enrolled grew faster at public institutions than at private institutions (Ruiz and Budiman, 2017). The average increase in foreign student degree enrollment was 517 per county over the 12 years among the sample counties. Over the same period, the share of foreign students in total post-secondary degree enrollment increased from 3.5% to over 5%. Not only has foreign student enrollment increased in absolute numbers, but also as a share of the population. The average foreign student-to-population ratio almost doubled in counties with post-secondary institution (Figure 1b).

The foreign students come to the US from around the world but the countries that send the most students are China, India, South Korea, and Saudi Arabia. In fact, China, India, and South Korea accounted for 54% of all the new foreign students in the US in 2016 (Ruiz and Budiman, 2017). Various push and pull factors may have contributed to the significant increase in foreign students in the US. First, due to the rapid economic growth of the sending countries, the number of families who can afford their child's post-secondary education in a foreign country increased in the last two decades.[10] Second, to generate higher revenue, universities are admitting more foreign students who pay higher out-of-state tuition. Many new programs have also sprung up, particularly in the STEM fields, where foreign students are heavily represented. The increase in foreign student enrollment is closely related to the decrease in state appropriations to public universities. Bound et al. (2020) estimate a 16% increase in foreign enrollment at the public research universities, which partially compensate for lost funding, with a 10% reduction in the state appropriations. Third, the Optional Practical Training (OPT) period was extended from one year to 29 months in 2008 for the

[8] A classification of whether an institution's programs are 4-year or higher (4-year), 2-but-less-than 4-year (2-year), or less than 2-year.

[9] A classification of whether an institution is operated by publicly elected or appointed officials or by privately elected or appointed officials and derives its major source of funds from private sources.

[10] Bound et al. (2020) document that with the fourfold increase in China's GDP per capita between 1996 and 2012 and appreciation of yuan since 2005, the percentage of Chinese families with average income greater than the average out-of-state tuition plus boarding expense increased exponentially from 0.005% in 2000 to over 2% in 2013.

STEM graduates to retain foreign STEM students as workers.[11] OPT is a program that allows full-time foreign students to temporarily work on their student visas after completing their post-secondary education. The extension addressed concerns of losing students due to a limit on H-1B visas, a primary work visa for the US. Unlike H-1B work visa, which has an annual cap of 85,000 visas, the number of approvals under OPT has no cap. So, an increased OPT period meant that the foreign students in the US would have two additional chances (once every year) of getting approved for the H-1B work visa and entering the US labor market, which encouraged more foreign students to enroll for a post-secondary STEM course in the US (Amuedo-Dorantes, Furtado and Xu, 2019).[12] Finally, the number of students completing high school or an undergraduate degree increased in the sending countries (UNESCO, Institute for Statistics, 2017).

During the same period, the number of domestic students enrolled in degree programs increased from around 15 million to around 17.5 million but not monotonically. Figure 1c shows domestic student enrollment increased to 19.3 million by 2010 and decreased after that. Most of this decrease since 2010 is due to a decrease in enrollment at 2-year and less than 2-year post-secondary institutions.

The students contribute to the host economy by paying for their education and expenditure to support themselves while enrolled in post-secondary institutions. An increase in the student population would lead to additional demand for goods and services, creating additional local labor demand. Foreign student influx likely created strong local demand shocks, primarily because of their strong financial background. They usually pay higher out-of-state tuition than domestic students. So, families abroad who can afford out-of-state tuition, boarding expense, and travel costs can only send their child for post-secondary education, suggesting foreign students have higher resources.[13] Compared to domestic students, foreign students from different countries are also likely to create demand for diverse goods

[11] This period was further extended to 36 months in 2016.

[12] Also, 20,000 visas of the total H-1B visas are set aside for those who hold advanced degrees (master's, professional, or doctorate) in any subject from a US higher educational institution. This provides an added advantage to foreign students enrolled in a US post-secondary institution.

[13] As mentioned previously, there has been rapid improvement in the financial conditions of the families from the primary sending countries. Further, using the administrative data on the F-1 student visa, Bound et al. (2020) documented that for the 2010-15 period, only 6% of undergraduate students from China at research universities received funding from the universities they attended, which again suggests strong financial background of the foreign students in the US.

and services, creating opportunities for a wide variety of new businesses. Moreover, the market for goods and services "traditionally" demanded by domestic students might already exist to a large extent. This suggests that foreign students are likely to induce stronger demand shocks than domestic students. Foreign students contributed nearly $41 billion to the US economy in the academic year 2018-19 (NAFSA, 2020).[14] To put that in perspective, the financial incentives provided by all tiers of the US government under place-based job policies was around $60 billion in 2015 (Bartik, 2020).[15]

The labor demand shocks may evolve through various channels and create a multiplier effect, affecting different aspects of the local economy. First, existing businesses may expand, and new businesses may open up, generating more employment, which in turn creates additional jobs mainly through increased demand for goods and services (Moretti, 2010). Increased demand for labor with supply fixed increases wages in the short term. Second, new employment opportunities may lead to population adjustments, mainly through increased in-migration of workers and their families, which may partially offset the wage increase over time. Third, the population adjustment may affect the demand for housing units, with an increase in population putting upward pressure on housing rent. Finally, the housing market may respond with the supply of new housing units. Depending on the housing supply elasticity of the area, it might partially offset the housing rent over time. Because the local economic activities are so interconnected, we must look at various outcomes in the local economy to get a broad picture of the effects, which depend on the mobility of workers and firms, the local housing market conditions, and other local characteristics.

III. Econometric Framework

I estimate the impact of a change in the number of foreign and domestic student enrollment on the local economic outcomes during the phase of the dramatic increase in foreign post-secondary student enrollment in the US over the period 2004-16 using the following long-

[14] NAFSA (2020) estimate of economic value contribution by foreign students is the overall imported dollars from foreign students without any multiplier effect.

[15] Some other estimates of incentives are provided by Thomas (2011) and Story (2012). Thomas (2011) calculates $73 billion, and Story (2012) calculates $101 billion (in 2019 dollars) in incentives.

difference specification:

$$\Delta y_c^k = \alpha^k + \beta_1^k \Delta foreign_c + \beta_2^k \Delta domestic_c + X_c \cdot \Theta^k + \lambda_s + \Delta \epsilon_c^k \quad (1)$$

The unit of observation is the county and is denoted by the c subscript in the regression. Δ denotes the 12-year difference between the years 2004 and 2016. y^k denotes a local outcome, which include (a) employment, (b) log average demographic-adjusted wage, (c) the number of business establishments, (d) non-student population, (e) housing units, and (f) log median gross housing rent. Wages and rents are in constant 2010 dollars and are used in the logarithmic form as local outcomes. Outcome variables Δy_c^k are changes in local outcomes y^k of county c, which are scaled by the county's 2004 population for non-logarithmic local outcomes (a), (c), (d), and (e). $\Delta foreign_c = (Foreign_{c,2016} - Foreign_{c,2004})/Pop_{c,2004}$ is the change in number of foreign students in county c scaled by the county's 2004 population. Similarily, $\Delta domestic_c = (Domestic_{c,2016} - Domestic_{c,2004})/Pop_{c,2004}$ is the change in number of domestic students in county c scaled by the county's 2004 population. X_c is a vector of observable county characteristics. λ_s is the state fixed effects. The primary coefficients of interest are β_1^k and β_2^k, which are the changes in the local outcome associated with a net increase of one foreign student and one domestic student, respectively, for non-logarithmic local outcomes. For logarithmic local outcomes, the coefficients of interest are the percentage changes in the local outcome associated with a percentage point increase in the foreign student enrollment-to-population ratio and the domestic student enrollment-to-population ratio, respectively. Lastly, $\Delta \epsilon_c^k$ is the error term that includes the unobserved factors that might influence the outcome variables.

There are a few challenges to causally estimating the impact of change in foreign and domestic enrollment on the local economy using an ordinary least squares regression. First, foreign and domestic student enrollment changes could be endogenous to county-specific secular trend. For instance, a fast-growing county economy could lead to higher housing rent and discourage students from enrolling in an institution in that county. This could bias the OLS estimates downward. Second, foreign and domestic student enrollment changes could be endogenous to unobserved contemporaneous shocks. For instance, a negative shock to

the state economy between 2004 and 2016 could reduce state appropriations to universities, inducing universities to admit more full-tuition-paying foreign students to cushion the lost revenue. This could bias the OLS estimates downward.

To address the endogeneity issues, it is important to control for the secular trend of the county. Following the conventional approach, I control for the secular trend in outcome y^k driven by the observable characteristics X_c. Specifically, I control for the growth rate of all the outcomes from the year 1996 to 2001.[16] For wages and rents, the control is the change in the log of the outcome in the pre-period. Moreover, I include state fixed effects to control for the state-specific secular trend in the outcomes.

To address the potential endogeneity issue of correlation between foreign student enrollment and the unobserved contemporaneous shocks, I construct a shift-share instrument using the initial distribution of number of foreign students by county. Network effect is one of the primary determinant of location choice of foreign students (Beine, Noel and Ragot, 2014).[17] A foreign student is likely to provide information and assistance to a compatriot planning to study abroad. So, counties with higher initial share of foreign students are more likely to substantially increase foreign student enrollment during a period when foreign student enrollment increases at the national level. Figure 2 presents the fitted line of the county level regression of the change in the ratio of foreign student-to-population between 2004 and 2016 on the ratio in the year 2001.[18] The slope of the fitted line is 0.57, and it is significant at the 1% level. It shows that foreign student enrollment increased more in counties with a higher initial foreign student enrollment-to-population ratio. Based on this idea, I construct the foreign IV, which can be interpreted as the predicted change in the number of foreign student enrollment in a county. Specifically, I construct it as follows:[19]

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[16] Housing market outcomes require decennial census data so the change is between 1990 and 2000.

[17] Beine, Noel and Ragot (2014) study the location choice determinants of foreign students and finds network effect to be a primary determinant. They define network to include stock of all migrants from the origin country living at the destination. Although they look at the determinants of the location choices at the country level, similar factors should determine the location choices at the city or county level within a particular destination country.

[18] I use 2001 as the base year because the US government imposed restrictive immigration policies in the immediate aftermath of 9/11 due to security concerns, which could have affected the natural distribution of foreign students across locations in the US in a couple of years following 2001.

[19] This is similar to the one used in Altonji and Card (1991).

$$\Delta foreign_c^{IV} = \frac{1}{Pop_{c,2004}} \cdot \frac{Foreign_{c,2001}}{Foreign_{US,2001}} \cdot (Foreign_{US,2016} - Foreign_{US,2004}) \tag{2}$$

In equation (2), $Foreign_{US,t}$ denotes the total foreign student enrollment in the US in year t. The second term is the "share" part of the instrument, which is the ratio of foreign students in county c to foreign students in the US in the year 2001. The third term is the "shift" part of the instrument, which is the change in the number of foreign students in the US between 2004 and 2016. Similar to the main explanatory variables, the product of terms is scaled by the county's 2004 population. As long as the "shift" part of the instrument is not driven by idiosyncratic local shocks, the instrument is uncorrelated with contemporaneous shocks. The variation in the foreign IV across the sample counties is presented in Figure A.2.

I again use a shift-share instrument to address the potential endogeneity issue of correlation between domestic student enrollment and unobserved contemporaneous shocks. The instrument uses the same idea of calculating the predicted change in enrollment, which in this case would be of the domestic students. For this, I use the information on the total number of first-time degree-seeking domestic students in an institution by the state of residence.[20] The instrument I construct for the change in the number of domestic students enrolled in a county is the weighted average of the change in the number of domestic students by the state of residences, with weights being the county-specific domestic student enrollment share in those resident states in the year 2004. Specifically, I construct the domestic IV using the following equation:

$$\Delta domestic_c^{IV} = \frac{1}{Pop_{c,2004}} \cdot \sum_{s \in S} \frac{Domestic_{c,s,2004}}{Domestic_{s,2004}} \cdot (Domestic_{s,2016} - Domestic_{s,2004}) \tag{3}$$

In equation (3), $Domestic_{s,t}$ denotes the total first-time degree-seeking domestic students com-

[20] The state of residence information is only available for first-year freshmen students. Since most undergraduate programs are four-year-long, I multiply it by four to calculate the total number of students attending an institution from a particular state of residence. A couple of other factors could affect this ratio of domestic enrollment to domestic freshmen enrollment. First, first-year students dropping out of college would decrease this ratio. Second, considering the domestic graduate enrollment would increase this ratio. So, on average, it is reasonable to argue that the domestic enrollment would be approximately four times the domestic freshmen enrollment.

ing from a resident state s in the year t. S is the set of all states in the US. The second term is the share of first-time degree-seeking domestic students from the resident state s in county c in the year 2004. The third term is the total change in the number of first-time degree-seeking domestic students from the resident state s between 2004 and 2016. Finally, the summation of the product of two terms over all the resident states $s \in S$ is scaled by the baseline population of the county. Consider, for example, two counties where the total domestic enrollment is the same, but the share of domestic enrollment from different states is different. If the total number of post-secondary students from a state increases (decreases), the county with a higher share of students from that state receives more (less) domestic students from that resident state. The variation in the domestic IV across the sample counties is presented in Figure A.3. A potential concern with the domestic IV is that it could be correlated with the state-level contemporaneous shocks. Since a large share of domestic students attends a post-secondary institution within their state of residence, the domestic IV could be reflecting the overall state economy. However, including state fixed effects in the main specification addresses this concern.

Note that the "shift" part of the foreign IV is the same for all counties. The variation comes from the "share" part of the instrument, which might be correlated with the secular trend of the county. For instance, a county that experienced an economic downturn in the 1990s could lead to both a large share of foreign student enrollment in the base year and lower economic growth between 2004 and 2016. So, it is imperative to control for the secular trend of the county, without which the instruments could violate the exclusion restriction. A similar argument goes for the domestic IV as well. As mentioned previously, I partial out the secular trend by controlling for the pre-period growth rate of the outcome variable, but there could still be concerns about the term adequately capturing the secular trend. So, as a robustness exercise, I control for a long list of non-linear functions of controls to capture the secular trend more flexibly, and the results are similar. In an additional exercise recently suggested by Goldsmith-Pinkham, Sorkin and Swift (2020), I show that the instruments are unlikely to be correlated with the secular trend.

IV. Data

Annual institution-level enrollment numbers of domestic and foreign students and institutional characteristics, including county address, are available from the Integrated Postsecondary Education Data System (IPEDS). The IPEDS universe includes institutions of all levels, sectors, and degree-granting and non-degree-granting status. IPEDS also includes institution-level state of residence data for first-time degree-seeking first-year students (this includes students who enrolled in the fall term and the last summer term), collected in even-numbered years. It gathers information for every institution participating in the federal student financial aid program (henceforth, Title IV institution). The Higher Education Act of 1965 requires all the Title IV institutions to report to IPEDS annually.[21] For the analysis, I consider those institutions that were Title IV eligible in at least one of the years from 1996 to 2017.

I use the Fall Enrollment component[22] of IPEDS to calculate the annual enrollment in an institution, among degree/certificate-seeking students. Non-degree/certificate-seeking students are more likely to be enrolled in an online or distant program and not directly influence the county's local economy. However, these students might affect the local economy indirectly as they are paying tuition to the institution. Next, I aggregate the institution-level annual enrollment to get county-level annual enrollment. For some institutions, the county address was entered manually,[23] particularly for those that did not operate pre-2000 and post-2008, as IPEDS does not provide county information from 2000 to 2008.

Annual county-level population, employment, and earnings by industry come from the Regional Economic Accounts (REA) available on the Bureau of Economic Analysis (BEA) website. The County Business Pattern (CBP) series provides annual county-level business establishment numbers. Data on housing units and rents come from county-level tabulations of Census and American Community Survey (ACS) data on National Historical Geographical Information System (NHGIS). I use the county level tabulations of 5% ACS 2009 as a proxy

[21] A non-Title IV institution must request to be part of IPEDS, but IPEDS does not identify what percentage of those institutions are represented in its universe. Aggregate annual enrollment in non-Title IV institutions accounts for less than 0.05% of aggregate annual enrollment in all institutions in the IPEDS universe in 2004 and 2016.

[22] It collects data on the number of foreign and domestic students enrolled in an institution in the fall.

[23] The county address come from the official websites of the institutions.

for the year 2004 as no dataset provides data on these variables for all the counties for the year 2004. I construct a county density variable using the area information from county shapefiles available from NHGIS. Lastly, the county adjacency files come from NBER public use data archive.

There are 1534 counties with at least one Title IV institution and 1591 counties without any Title IV institution. I restrict the sample to counties with a high student-to-population ratio in 2004, where it is more likely that shocks to student composition would create substantial demand shocks and subsequent adjustments of the local economy. I set the student-to-population ratio threshold to be 5% in 2004, leaving a sample of 655 counties — these counties hosted over 80% of foreign students in the US in 2004. Further, I remove three counties due to missing values of one or the other variables, leaving a final sample of 652 counties (Figure A.1). Table A.1 presents the summary statistics of the variables for the sample counties. Appendix B provides more details on the construction of key variables.

V. Empirical Results

V.A Effects of Foreign and Domestic Enrollment on Employment

I first look at the first stage results of the 2SLS estimator for both the foreign and domestic student enrollment with employment as an outcome in Table 1. Column 1 reports results for foreign student enrollment, and column 2 reports results for domestic student enrollment. The coefficient for the foreign IV in column 1 is 0.963, and the coefficient for the domestic IV in column 2 is 1.396, which means the instruments quite accurately predict the actual change in student enrollment between 2004 and 2016. Next, the positive and significant coefficient for foreign IV in the second column suggests a cross-subsidization of domestic enrollment fees by high tuition payments from foreign students leading to an increase in domestic enrollment (Shih, 2017). Moreover, the positive correlation implies the need to control for domestic student enrollment, without which the foreign IV will violate the exclusion restriction.[24] The

[24] Further, it is essential to instrument for domestic student enrollment, without which there may be an induced "spillover bias" on the estimate of coefficient for foreign student enrollment.

last row reports the Angrist-Pischke (AP) first-stage F-statistic of 53.10 and 17.59 for foreign and domestic student enrollment, respectively, which suggests the strong predictive power of the instruments.

Table 2 reports the estimation results from various versions of equation 1 using OLS and 2SLS estimators with employment as an outcome. The coefficients can be interpreted as local job multiplier, which would be the increase in the number of jobs due to an additional student enrollment. Column 1 is the OLS estimation using just foreign student enrollment, and the estimated coefficient is 1.280, which is statistically significant at the 1% level. Column 2 controls for domestic student enrollment, and the coefficient drops to 0.825. This is expected as domestic student enrollment is likely to be positively correlated with both employment and foreign student enrollment. Column 3 further controls for secular trend and state fixed effects, and the coefficient increases to 1.081.

Columns 4 to 7 report the estimation results using the 2SLS estimation method. The AP first-stage F-statistics are reported in the last two rows of the table depending on the version of the specification 1 used in that column. Column 4 instruments for foreign student enrollment but does not control for domestic student enrollment, secular trend and state fixed effects. Column 5 adds domestic student enrollment as a control and column 6 instruments for both the enrollment variables. The estimated coefficient in column 6 is 2.748, which is statistically significant at the 1% level. Column 7 further controls for the secular trend and the state fixed effects, and the estimate is 2.725. The estimates in Columns 6 and 7 are virtually similar, somewhat addressing the concern that the "share" part of the foreign IV might be correlated to the secular trend. Moving from columns 1 to 7, the movement in the estimated coefficient for foreign student enrollment shows how the estimates could be biased if the endogeneity issues are not addressed.

From column 7, which is the preferred specification, the local job multiplier of foreign enrollment over the 12 years is 2.73, and the estimate is significant at the 1% level. At the same time, a net increase of one domestic student enrollment in a county created 0.24 jobs in the same county, although the estimate is not significant at any conventional level. Given that the average initial employment-to-population ratio is 0.574 and the average increase in the foreign student enrollment-to-population ratio in the sample is 0.26 percentage points,

the employment in the sample counties increased by 1.24% due to the foreign student boom over the 12 years.[25]

Comparing the estimates with other local job multiplier estimates in the literature suggests that the effect of foreign student enrollment is sizable. Moretti (2010) finds that an additional job in the tradable sector[26] in a given city creates 1.6 jobs in the nontradable sector in the same city over a decade, whereas an additional skilled job in the tradable sector generates 2.5 jobs in the nontradable sector. The effect is significantly larger for skilled jobs because they command higher earnings, leading to stronger local demand shocks. The estimate associated with foreign student enrollment is similar to the one for the skilled job in the tradable sector, as foreign students are also likely to have strong local demand shocks due to their strong financial background.

V.B Effects of Foreign and Domestic Enrollment on Other Outcomes

Table 3 reports estimates for other outcomes in local labor markets and local businesses. All columns in this table present results for the specification in Table 2, column 7. Column 1 repeats the result for employment. Next, I look at the effect on employment in tradable and nontradable sectors (Black, McKinnish and Sanders, 2005; Zou, 2018).[27] Columns 2 and 3 report that a net increase of one foreign student enrollment did not affect employment in the tradable sector but created 2.3 jobs in the nontradable sector. At the same time, a net increase of one domestic enrollment created 0.08 jobs in the tradable sector and did not affect the nontradable sector. Consistent with the literature, the effects are primarily concentrated in the nontradable sector. As one would expect, the production of goods and services sold locally is likely to be impacted more.

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[25] $\Delta employment = \frac{employment_{2016} - employment_{2004}}{population_{2004}} = \frac{employment_{2016} - employment_{2004}}{employment_{2004}} \times \frac{employment_{2004}}{population_{2004}}$. So, the percentage change in employment due to foreign student enrollment expansions is $\frac{employment_{2016} - employment_{2004}}{employment_{2004}} 100 = \beta \Delta foreign \frac{population_{2004}}{employment_{2004}} 100 = \frac{2.73 \times 0.0026}{0.574} 100 = 1.24$. Similarly, I calculate the percentage change in other non-logarithmic local outcomes.

[26] The tradable sector includes industries whose products could be primarily traded nationally or internationally. Whereas the nontradable sector includes industries whose products are primarily traded locally.

[27] Following Black, McKinnish and Sanders (2005), the tradable sectors here includes manufacturing. The nontradable sector includes all private nonfarm employment sectors excluding manufacturing, mining, forestry, fishing, and related activities.

Column 4 reports the effect on the log demographic-adjusted average wage[28] in the county. The adjusted wage increased by 3.32% for a percentage point increase in the foreign student enrollment-to-population ratio. Column 5 reports that a net increase of 13 foreign students led to an increase in one business establishment.[29] There was no impact of the change in domestic student enrollment on wages or business establishments. As expected, the effect of foreign students on local labor market outcomes and business establishments is much stronger than domestic students, as foreign students are likely to induce stronger demand shocks. Moreover, the effects differ from other immigration contexts, possibly due to foreign students' restricted access to work, thus reducing possible supply side effects.

Table 4 reports effects on county population and outcomes in the housing market. Column 1 shows that with a net increase of one foreign student enrollment, the non-student population in the county increased by 3.17, which is significant at the 1% level. A sizable increase in the non-student population is consistent with the large positive effect on employment, as the creation of new job opportunities may have attracted more workers and their dependents to the host counties. If the dependents of new workers are accounted for among the migrating population, the difference in the number of new jobs and new workers is large, suggesting increased employment among the residents. Further, an increase in the employed population may partially offset the wage increase; still, there was a substantial wage increase. Thus, the results strongly suggest that the resident and newly migrated workers benefited in the labor market due to an increase in foreign student enrollment. At the same time, an increase in domestic student enrollment led to a decrease in the non-student population. One potential explanation is that the increase in domestic student enrollment did not create more job opportunities but might have led to the development of amenities geared to the student demographic, which the resident population might not like, resulting in out-migration.

Column 2 reports that the total housing units[30] increased by 1.1 with additional foreign student enrollment, and the coefficient is statistically significant at the 1% level. The num-

[28] Appendix B provides details on the construction of this variable.

[29] Given that the initial average ratio of business establishments-to-population is 0.025, the number of business establishments expanded by 0.8% due to foreign student enrollment expansions.

[30] A housing unit is a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters.

ber of housing units increased by 0.6% due to foreign student enrollment expansions over 12 years. In column 3, the estimated coefficient shows that median gross housing rent[31] increased by 0.6% with a percentage point increase in the foreign student enrollment-to-population ratio, but the effect is not statistically significant. The rapid increase in the supply of housing units may have eased upward pressure on housing rent due to the increasing student and non-student population. On average, the wages increased more than the housing rent, suggesting increased welfare for the natives. Lastly, the coefficient associated with domestic student enrollment for housing market outcomes in Table 4 is small and not statistically significant at any conventional level, suggesting no effect on the housing market due to the change in domestic student enrollment over the 12 years.

I find sizable effects of the local demand shocks created by the increase in foreign student enrollment on the level of local economic activities. The results suggest potential welfare gains for native workers of the county as the employment opportunities and wages improved, but there was no significant effect on housing rent. In theory, the movement of firms and workers into a particular geographical area puts upward pressure on rent. And if the housing supply is inelastic, it leads to welfare gains capitalized in land rents that would otherwise accrue to resident workers. However, I find no significant effect on housing rent. A potential reason could be the rapid increase in the housing supply. During the same time, the change in domestic enrollment had little to no effect on the levels of local economic outcomes over the 12 years.

V.C Effects of Foreign and Domestic Enrollment on Local Outcomes using Split Long Difference

While there was a net increase in domestic student enrollment between 2004 and 2016, the long difference masks the substantial increase in domestic enrollment between 2004 and 2010 and equally rapid decline between 2010 and 2016 (Figure 1c). This may lead to conflated effects in the 12-year long difference estimation. In this subsection, I address this concern by splitting one long period (2004-16) into two periods and using them to estimate the effect on

[31] Gross housing rent is the monthly contract rent plus the estimated average monthly cost of utilities and fuels.

the local outcomes. The two split periods are 2004-10 (henceforth, first period) and 2010-16 (henceforth, second period). Specifically, I estimate the following equation:

$$\Delta y^k_{ct} = \alpha^k + \beta^k_1 \Delta foreign_{ct} + \beta^k_2 \Delta domestic_{ct} + X_c \cdot \Theta^k + \lambda_s + \tau_t + \Delta \epsilon^k_{ct} \tag{4}$$

This equation is a modified version of equation 1 where I introduce subscript t with the outcome and the enrollment variables to denote the two time periods. Here the unit of observation is county cross time period and is denoted by the subscript ct in the equation. Δy^k_{ct} either denotes $y^k_{c,2010} - y^k_{c,2004}$ or $y^k_{c,2016} - y^k_{c,2010}$, depending on the time period t, scaled by the county's 2004 population, where y^k is a local outcome of the county c. The outcomes include employment, business establishments and non-student population. Housing market variables are not included in this analysis due to non availability of the data for the two split periods. $\Delta foreign_{ct} = (Foreign_{c,t2} - Foreign_{c,t1})/Pop_{c,2004}$ is the change in number of foreign students in county c scaled by the county's 2004 population, where t2 = 2010, t1 = 2004 for the first period and t2 = 2016, t1 = 2010 for the second period. The construction of domestic student enrollment variable is analogous to this. I also introduce the time period dummy τ_t to absorb the time period effect which takes value 0 and 1 for the first and second period, respectively. As before, $X_c \cdot \Theta^k$ controls for the secular trend, and λ_s is the state fixed effects. $\Delta \epsilon^k_{ct}$ is the error term.

The instruments are modified accordingly as well. The "share" part of the foreign and domestic IVs is the same as before for both periods, but the "shift" part depends on the time period. Specifically, the modified foreign and domestic IV are as follows:

$$\Delta foreign^{IV}_{ct} = \frac{1}{Pop_{c,2004}} \cdot \frac{Foreign_{c,2001}}{Foreign_{US,2001}} \cdot (Foreign_{US,t1} - Foreign_{US,t2}) \tag{5}$$

$$\Delta domestic^{IV}_{ct} = \frac{1}{Pop_{c,2004}} \cdot \sum_{s \in S} \frac{Domestic_{c,s,2004}}{Domestic_{s,2004}} \cdot (Domestic_{s,t1} - Domestic_{s,t2}) \tag{6}$$

where t1 = 2010, t2 = 2004 for the first period and t1 = 2016, t2 = 2010 for the second period. The 2SLS estimates using specification (4) are reported in the Table 5. The standard errors are clustered at the county level. The last two rows in the table showing the AP F-statistics

indicate strong first stage relevance.

The point estimate of the local job multiplier of foreign student enrollment is slightly higher than the earlier estimate, but they fall within the range of one standard error from each other. Note that the results in this analysis is the adjustment of the local economy over the 6 years period. The effects on the employment, business establishments and non-student population tell a similar story as the main results. Overall, they address the concerns associated with a sharp change in domestic student enrollment trend.

V.D Heterogeneity with Population Density

The results so far suggest that an increase in foreign student enrollment leads to potential welfare gains, on average, for the natives. However, the adjustment of the local economy to shocks may depend on various local characteristics, and it is interesting to explore the extent to which there are heterogeneous effects. So, to further unfold these adjustments, I investigate the heterogeneous effects across the area's population density.

Densely populated areas are likely to have better urban amenities, lower transportation costs of goods between different stages of production, or other agglomeration benefits, which could contribute to a stronger effect on the local labor market (Ciccone and Hall, 1993). For instance, having better road facilities improves the accessibility to businesses, leading to a stronger demand shock. At the same time, these areas are likely to have congestion effects or other agglomeration costs. For instance, the housing market could be tight due to lower vacancy rates, or the housing supply could be inelastic due to scarcity of land, which could put upward pressure on the rent when firms and workers move into the area to arbitrage the benefits of local demand shocks. The eventual effects of the same population shock in different local economies could vary substantially depending on these local factors.

To study the heterogeneous effects, I include an interaction term of the foreign student explanatory variable and the population density of the county in the main equation (1). In particular, I estimate the following equation:

$$\Delta y_c^k = \alpha^k + \beta_1^k \Delta foreign_c + \beta_2^k \Delta domestic_c + \beta_3^k (\Delta foreign_c \times D_c) + \gamma^k D_c + X_c \cdot \Theta^k + \lambda_s + \Delta \epsilon_c^k, \quad (7)$$

where D_c is the demeaned log of population density of the county c. All the other terms are the same as before. In addition to the earlier two instruments, I construct a third one similarly as the interaction term, by interacting $\Delta foreign_c^{IV}$ and D_c.[32] Table 6 reports the 2SLS estimates using specification (7). The AP F-statistics show that all endogenous variables have a strong first stage. Finally, I cluster the standard errors at the county level.

Column 1 in Table 6 shows that the local job multiplier increases with population density. The estimated coefficient on the interaction term is 2.2, which is statistically significant at the 1% level. This means that with every 10% increase in population density, the job multiplier increases by 0.22. The effects on wages, business establishments, and the non-student population exhibit similar patterns, although the estimates are not statistically significant. I do not find the effects on housing units differ by the area's population density; the estimated coefficient on the interaction term in column 5 is small and not significant at any conventional level. In light of a larger positive effect on employment but no effect on housing units in more densely populated areas, it is not surprising that I find a large positive effect (statistically significant at the 1% level) on housing rent with increasing population density of the area.

There could be a stronger positive effect on the housing rent in the future because of the possible housing supply saturation in more densely populated areas due to the relative scarcity of land. In contrast, sparsely populated areas could have more slack in the local housing market to absorb the increasing population without upward pressure on rent. Although the welfare impacts of a resident worker would depend on the relative magnitude of the increase in wages and housing rent, the results provide suggestive evidence that the welfare benefits might get smaller in more densely populated areas, due to increasing housing rent, compared to sparsely populated areas.

[32] There is no correlation between foreign student enrollment and population density of the county in the sample.

VI. Robustness

VI.A Alternative Specifications

Several alternative specifications confirm the tenor of the results in previous sections and, in the interest of space, are presented in the Appendix A. First, I include the quadratic and cubic terms of the pre-period growth rate of all the local economic outcomes. While the AP F-statistic is low for domestic student enrollment after inclusion of a long list of controls, the results are consistent with our main specification (Table A.2). Second, I expand the sample by sequentially including counties with a lower student-to-population ratio in the base year as a check on how I define a "high" student-to-population ratio and restrict the sample. For the main sample, the ratio threshold was set to be 5%. Table A.3 reports the results when I estimate the main specification on samples of varying sizes. Results tell a similar story.

Finally, I look at the impact on the local outcomes of the neighboring counties without post-secondary institutions. As workers and firms are mobile, the demand shocks could affect the local outcomes of the neighboring counties, so without looking at them, the true overall effects of the foreign student enrollment boom might be misrepresented. In particular, one would be interested to know if the positive impact in counties with host post-secondary institutions comes at the expense of a negative impact on the neighboring counties without host post-secondary institutions. I use a sample of the counties without post-secondary institutions that neighbor a county with post-secondary institutions (henceforth, neighboring counties) for this analysis. I use the 12-year long difference in the local outcome of the neighboring county as the outcome variable, where all non-logarithmic outcomes are scaled by the neighboring county's 2004 population. The two main explanatory variables for each neighboring county are the 12-year enrollment changes in domestic and foreign students summed over all the adjacent counties with post-secondary institutions. Further, I control for the secular trend and the state fixed effects. I construct the instruments as before, where they are the predicted change in enrollment in a county; however, now they are summed over all the adjacent counties with post-secondary institutions for each neighboring county. I further scale the enrollment variables and the instruments by the neighboring county's 2004 population. I find that there is no effect of foreign student enrollment increase on the local outcomes of

the neighboring counties except a very small positive effect on wages (Table 7). The results address the concerns related to adverse spillover effects on the neighboring counties.

VI.B Plausibility of Identifying Assumptions

The first identifying assumption is that the instrument is not correlated with the unobserved part of the secular trend (exclusion restriction). As mentioned previously, the "shift" part of the foreign IV is the national level change in foreign enrollment over the years; the variation comes from the "share" part of the instrument, which could be correlated to the unobserved part of the secular trend. In other words, the initial share of the foreign student in a county could be correlated to the unobserved county-specific factors that affect the outcome variable. A similar argument goes for domestic IV as well. Looking at the robustness of the results when I control for a long list of controls in the previous subsection somewhat addresses this concern. In addition, I conduct a standard test suggested by Goldsmith-Pinkham, Sorkin and Swift (2020) to look at how balanced instruments are across observable potential confounders, which suggests the importance of the unobservable confounders. So, I regress the foreign IV and domestic IV on the list of covariates used in the regressions previously and report the results in Table 8. I use the logarithmic transformation of the non-logarithmic variables so that the coefficient interpretation is straightforward.[33] In Columns 1 and 3 of Table 8, the instrument is regressed on all the pre-period growth rates of the outcome variables. I find that the R^2 is very low in both the regressions; the covariates only explain 3% and 7% variation in the foreign IV and domestic IV, respectively. Even after adding the quadratic and cubic terms of the covariates in columns 2 and 4, the R^2 increases to 9% and 13%, respectively. As a point of reference, the R^2 is low compared to the R^2 of 43% in the canonical model in Goldsmith-Pinkham, Sorkin and Swift (2020). Moreover, the magnitude of all the coefficients, including the statistically significant ones, is very small. This test, along with the robustness of estimates to a long list of controls, suggests that the instruments are unlikely to be correlated with the unobserved part of the secular trend, and it is reasonable to assume that the instruments satisfy the exclusion restrictions.

[33] Because the non-logarithmic variables can take the least value of -1, I add 1.1 to all the variables and then take the logarithm of it.

Finally, one assumption is that the instrument is not correlated with the unobserved contemporaneous factors (exclusion restriction). By construction, the shift-share IV should not be correlated with the contemporaneous factors. However, one concern in the literature is that if a local economy is particularly big in a particular "industry" (foreign enrollment in this case), the national shock could be correlated with the local shock. In other words, it means that the national level shocks and the main effects are driven by only a few influential counties, which might violate the exclusion restriction. To check that, I remove counties with the highest absolute number of foreign student enrollment in 2004 and run the main results. In particular, I remove counties in the top 1 percentile of total foreign student enrollment in 2004. Results tell a similar story (Table A.4).

VII. Conclusion

This paper looks at the local economic impacts of the rapid increase in foreign student enrollment in the US between 2004 and 2016. Focusing on counties with post-secondary institutions where students were a large share of the county population, I look at several outcomes and provide a broad picture of the effects on these local economies. On average, expansions in foreign student enrollment led to a substantial increase in local employment, business establishments, and wages. A potential reason why the labor market effects are different from other immigration contexts is that the foreign students are notably different — they have a strong financial background and cannot work on a student visa until they finish their education. In the housing market, the housing supply increased rapidly, and there was no significant effect on the gross housing rent. Overall, the results suggest potential welfare gains for the native workers. Further, I find that the native workers may benefit more in sparsely populated counties in the long run than in densely populated counties, where the housing rent could rise steeply, leading to a shift of welfare gains from the native workers to the landlords. Finally, while foreign students have a sizable marginal effect, domestic students have little to no marginal effect on the local economy over the 12 years.

An influx of foreign students creates local demand shocks similar to various place-based policies that are usually implemented in underperforming locations to reduce economic dis-

parity. Many argue that place-based policies are inefficient and that they simply reallocate economic activity across locations. Often, the equity argument is made in support of these policies. Whether the policy leads to welfare gains for intended recipients is largely an empirical question. In this paper, I find potential welfare gains for natives due to foreign student enrollment expansions in the host counties. At the same time, there is no evidence of the adverse effects on the neighboring counties without post-secondary institutions. Further, unlike the place-based policies usually funded by diverting resources from other regions, which might not be cost-effective, the local demand shocks created by foreign students are funded primarily by money from abroad. While informing about the overall effects of foreign student enrollment on the local economy, the results in this paper highlight the potential advantages of policies that promote foreign student enrollment — they can lead to economic growth in targeted locations. In the long run, they might especially be beneficial for less densely populated locations that depend heavily on the education sector and lack growth opportunities in other sectors. ■

References

Abramitzky, Ran, and Leah Boustan. 2017. "Immigration in American Economic History." *Journal of Economic Literature*, 55(4): 1311–1345.

Altonji, Joseph G., and David Card. 1991. "The Effects of Immigration on the Labor Market Outcomes of Less-Skilled Natives." In *Immigration, Trade, and the Labor Market*. , ed. John M. Abowd and Richard B. Freeman, 201–234. Chicago and London:University of Chicago Press.

Amuedo-Dorantes, Catalina, Delia Furtado, and Huanan Xu. 2019. "OPT Policy Changes and Foreign Born STEM Talent in the US." *Labour Economics*, 61.

Anelli, Massimo, Kevin Shih, and Kevin Williams. 2020. "Foreign Students in College and STEM Graduates."

Bartik, Timothy J. 2020. "Using Place-Based Jobs Policies to Help Distressed Communities." *The Journal of Economic Perspectives*, 34(3 (Summer)): 99–127.

Beine, Michel, Romain Noel, and Lionel Ragot. 2014. "Determinants of the International Mobility of Students." *Economics of Education Review*, 41: 40–54.

Black, Dan, Terra McKinnish, and Seth Sanders. 2005. "The Economic Impact of the Coal Boom and Bust." *Economic Journal*, 115(503): 449–76.

Borjas, George J. 2007. "Do Foreign Students Crowd Out Native Students from Graduate Programs?" In *Science and the University*. , ed. Ronald G. Ehrenberg and Paula E. Stephan.

Bound, John, Breno Braga, Gaurav Khanna, and Sarah Turner. 2020. "A Passage to America: University Funding and International Students." *American Economic Journal: Economic Policy*, 12(1): 97–126.

Busso, Matias, Jesse Gregory, and Patrick Kline. 2013. "Assessing the Incidence and Efficiency of a Prominent Place Based Policy." *American Economic Review*, 103(2): 897–947.

Card, David. 1990. "The Impact of the Mariel Boatlift on the Miami Labor Market." *Industrial and Labor Relations Review*, 43(2): 245–257.

Card, David. 2001. "Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration." *Journal of Labor Economics*, 19(1): 22–64.

Chaurey, Ritam. 2017. "Location-Based Tax Incentives: Evidence from India." *Journal of Public Economics*, 156: 101–120.

Chirakijja, Janjala. 2022. "The Local Economic Impacts of Prisons." Working Paper.

Chodorow-Reich, Gabriel, Laura Fieveson, Zachary Liscow, and William Gui Woolston. 2012. "Does State Fiscal Relief During Recessions Increase Employment? Evidence From the American Recovery and Reinvestment Act." *American Economic Journal: Economic Policy*, 4(3): 118–45.

Ciccone, Antonio, and Robert E. Hall. 1993. "Productivity and the Density of Economic Activity." NBER Working Paper 4313.

Dang, Tung. 2022. "The Local Economic Impact of International Students: Evidence from US Commuting Zones." Working Paper.

Demirci, Murat. 2020. "International Students and Labour Market Outcomes of US-born Workers." *Canadian Journal of Economics*, 53(4): 1495–1522.

Doran, Kirk, Alexander Gelber, and Adam Isen. 2014. "The Effects of High-Skilled Immigrantion Policy on Firms: Evidence from H-1B Visa Lotteries." NBER Working Paper 20668.

Dustmann, Christian, Uta Schönberg, and Jan Stuhler. 2017. "Labor Supply Shocks, Native Wages, and the Adjustment of Local Employment." *The Quarterly Journal of Economics*, 132(1): 435–483.

Glaeser, Edward L., and Joseph D. Gottlieb. 2008. "The economics of place-making policies." *Brookings Paper on Economic Activity*, 39(1): 155–253.

Goldsmith-Pinkham, Paul, Isaac Sorkin, and Henry Swift. 2020. "Bartik Instruments: What, When, Why, and How." *American Economic Review*, 110(8): 2586–2624.

Kerr, Sari Pekkala, and William R. Kerr. 2011. "Economic Impacts of Immigration: A Survey." NBER Working Paper 16736.

Kline, Patrick, and Enrico Moretti. 2014*a*. "Local Economic Development, Agglomeration Economies, and the Big Push: 100 Years of Evidence from the Tennessee Valley Authority." *The Quarterly Journal of Economics*, 129(1): 275–331.

Kline, Patrick, and Enrico Moretti. 2014*b*. "People, places, and public policy: Some simple welfare economics of local economic development programs." *Annual Review of Economics*, 110(8): 629–662.

Mocanu, Tatiana, and Pedro Tremacoldi-Rossi. 2019. "International Student Migration and Local Housing Markets." Mimeo.

Moretti, Enrico. 2010. "Local Multipliers." *American Economic Review: Papers and Proceedings*, 100(2): 373–77.

NAFSA. 2020. "Losing Talent 2020: An Economic and Foreign Policy Risk America Can't Ignore." *Policy Resources*.

Neumark, David, and Helen Simpson. 2015. "Chapter 18 - Place-Based Policies." In *Handbook of Regional and Urban Economics*. Vol. 5, , ed. Gilles Duranton, J. Vernon Henderson and William C. Strange, 1197–1287. Elsevier.

Neumark, David, and Jed Kolko. 2010. "Do enterprise zones create jobs? Evidence from California's enterprise zone program." *Journal of Urban Economics*, 68(1): 1–19.

Ottaviano, Gianmarco I. P., and Giovanni Peri. 2012. "Rethinking the Effect of Immigration on Wages." *Journal of the European Economic Association*, 10(1): 152–97.

Ruiz, Neil G., and Abby Budiman. 2017. "New Foreign Enrollment at U.S. Colleges and Universities doubled since Great Depression." *Pew Research Center*.

Ruiz, Neil G., and Abby Budiman. 2018. "Number of Foreign College Students Staying and Working in U.S. After Graduation Surges." *Pew Research Center*.

Shih, Kevin. 2017. "Do International Students Crowd-Out or Cross-Subsidize Americans in Higher Education." *Journal of Public Economics*, 156: 170–84.

Story, Louise. 2012. "As Companies Seek Tax Deals, Governments Pay High Price." *The New York Times*.

Thomas, Kenneth. 2011. "The Effects of Immigration on the Labor Market Outcomes of Less-Skilled Natives." In *Investment Incentives and the Global Competition for Capital*. London and New York:Palgrave Macmillan.

UNESCO, Institute for Statistics. 2017. "Enrollment by Level of Education."

Zou, Ben. 2018. "The Local Economic Impacts of Military Personnel." *Journal of Labor Economics*, 36(3): 589–621.

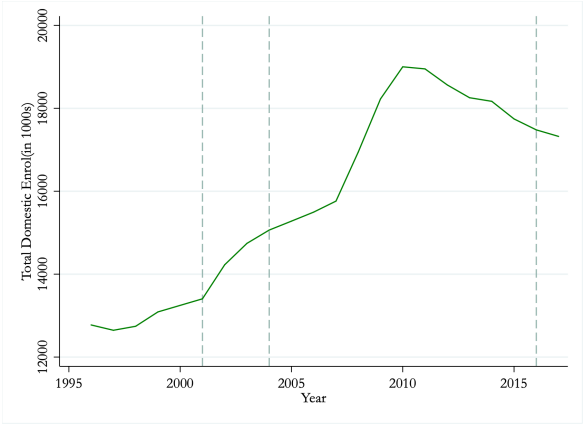
Main Tables and Figures

Figure 1: DEGREE ENROLLMENT IN US POST-SECONDARY INSTITUTIONS OVER TIME

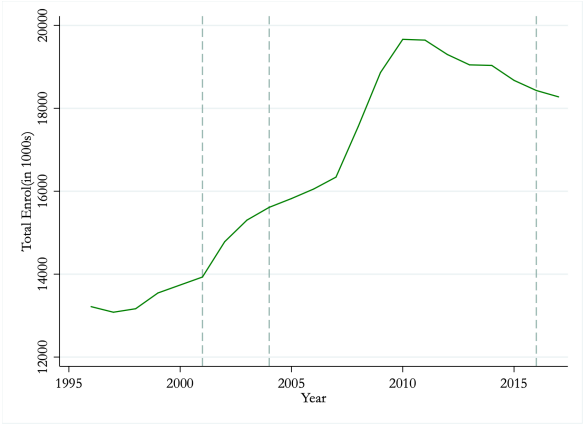
(a) FOREIGN STUDENT ENROLLMENT

(b) FOREIGN STUDENT BY POPULATION

(c) DOMESTIC STUDENT ENROLLMENT

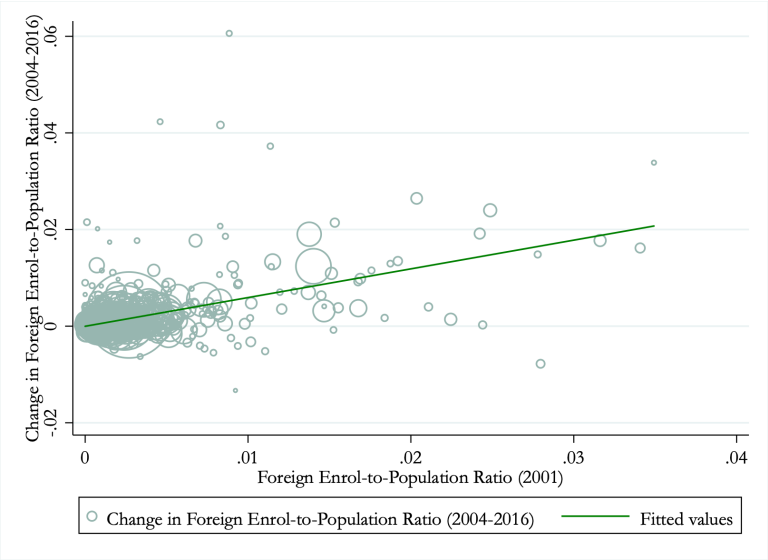


(d) TOTAL STUDENT ENROLLMENT



Notes: The figures show the student enrollment numbers in degree programs over the years in the US starting from 1996. Three vertical light green lines indicate the years 2001, 2004, and 2016 in all the panels. Only post-secondary institutions eligible for federal financial aid program are included in calculating the enrollment numbers. Source: Author's calculation using IPEDS and BEA data.

Figure 2: INITIAL FOREIGN STUDENT SHARE AND FUTURE INCREASE



Notes: This figure shows the fitted line of the regression of future change in foreign student enrollment-to-population ratio on the initial ratio at the county level. The regression is weighted by the initial population of the county. Each bubble is a county, and the size of the bubble is proportional to the initial population of the county. The slope of the fitted line is 0.57, and the robust standard error is 0.07. An outlier is dropped here, which does not affect the overall takeaway from the graph. Source: Author's calculation using IPEDS and BEA Data.

Table 1: EMPLOYMENT: FIRST STAGE REGRESSION FOR BOTH ENDOGENOUS EXPLANATORY VARIABLE

	Δ foreign	Δ domestic
	(1)	(2)
Δ foreign IV	0.963***	2.460***
	(0.160)	(0.862)
Δ domestic IV	-0.004	1.396***
	(0.028)	(0.344)
Secular Trend	×	×
State Fixed Effects	×	×
N	652	652
AP Fstat	53.10	17.59

Notes: This table reports the first stage results for employment as an outcome. Column 1 reports the results for Δ foreign IV and column 2 reports the results Δ domestic IV. In both the columns, the endogenous explanatory variable is regressed on both the excluded instruments, secular trend controls, and the State FEs. "AP Fstat" row reports the Angrist Pischke first stage F statistics. N denotes the number of observations. Robust standard errors clustered at county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data. *** p<0.01, ** p<0.05, * p<0.1.

Table 2: EFFECT OF CHANGE IN STUDENT ENROLLMENT ON EMPLOYMENT

	Dependent Variable: Δ employment						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ foreign	1.280***	0.825**	1.081***	4.168***	3.859***	2.748***	2.725***
	(0.343)	(0.327)	(0.295)	(1.082)	(1.094)	(1.019)	(0.961)
Δ domestic		0.221***	0.074*		0.135*	0.621***	0.237
		(0.075)	(0.045)		(0.075)	(0.193)	(0.209)
Secular Trend			×				×
State Fixed Effects			×				×
Instrument				Foreign	Foreign	Both	Both
Estimation Method	OLS	OLS	OLS	2SLS	2SLS	2SLS	2SLS
N	652	652	652	652	652	652	652
AP Fstat Foreign				39.53	39.84	51.15	53.10
AP Fstat Domestic						23.85	17.59

Notes: This table reports results of regression for employment as an outcome using various versions of the empirical specification. The dependent variable is the change in the employment of the county between 2004 and 2016 scaled by the population of the county in 2004. The main explanatory variables are changes in enrollment between 2004 and 2016 scaled by the population of the county in 2004. "Secular Trend" row denotes if the secular trend control has been included. Secular trend control includes the growth rate of the outcome between 1996 and 2001. "State Fixed Effects" row denotes if the state fixed effects has been included. "Instrument" row denotes what instruments have been used. Foreign is for $\Delta\ foreign^{IV}$ and Both is for both $\Delta\ foreign^{IV}$ and $\Delta\ domestic^{IV}$. "Estimation Method" row denotes whether we use OLS or 2SLS method for estimation. "AP Fstat Foreign" row reports the Angrist Pischke first stage F statistics for the Δ foreign. "AP Fstat Domestic" row reports the Angrist Pischke first stage F statistics for the Δ domestic. N denotes number of observations. Robust standard errors clustered at county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: EFFECT OF CHANGE IN STUDENT ENROLLMENT ON LOCAL LABOR MARKET AND LOCAL BUSINESS OUTCOMES

	Δ employment	Δ tradable employment	Δ nontradable employment	Δ log adjusted wage	Δ business establishment
	(1)	(2)	(3)	(4)	(5)
Δ foreign	2.725***	0.043	2.314**	3.319***	0.077**
	(0.961)	(0.216)	(0.908)	(1.137)	(0.032)
Δ domestic	0.237	0.079*	-0.035	-0.122	0.009
	(0.209)	(0.046)	(0.203)	(0.367)	(0.008)
N	652	652	652	652	652
AP Fstat Foreign	53.10	53.10	53.10	53.10	53.10
AP Fstat Domestic	17.59	17.59	17.59	17.59	17.59

Notes: This table reports results of regression for various outcomes. The outcome variable is depicted in the column head. All the columns are estimated using the specification in column 7 of Table 2. Outcome variables in column 1,2,3 and 5 are scaled by 2004 population. Wages are denominated in 2010 dollars. "AP Fstat Foreign" row reports the Angrist Pischke first stage F statistics for the Δ foreign. "AP Fstat Domestic" row reports the Angrist Pischke first stage F statistics for the Δ domestic. N denotes number of observations. Robust standard errors clustered at county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4: EFFECT OF CHANGE IN STUDENT ENROLLMENT ON POPULATION AND HOUSING MARKET OUTCOMES

	Δ non-student population	Δ house units	Δ log median rent
	(1)	(2)	(3)
Δ foreign	3.170***	1.136***	0.618
	(1.082)	(0.345)	(0.877)
Δ domestic	-1.012***	0.029	0.034
	(0.268)	(0.099)	(0.251)
N	652	652	652
AP Fstat Foreign	53.10	53.10	53.10
AP Fstat Domestic	17.59	17.59	17.59

Notes: This table reports results of regression for various outcomes. The outcome variable is depicted in the column head. All the columns are estimated using the specification in column 7 of Table 2. Outcome variables in column 1 and 2 are scaled by 2004 population. Rents are denominated in 2010 dollars. "AP Fstat Foreign" row reports the Angrist Pischke first stage F statistics for the Δ foreign. "AP Fstat Domestic" row reports the Angrist Pischke first stage F statistics for the Δ domestic. N denotes number of observations. Robust standard errors clustered at county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5: EFFECT OF CHANGE IN STUDENT ENROLLMENT ON COUNTY OUTCOMES USING SPLIT PERIODS

	Δ employment	Δ business establishment	Δ non-student population
	(1)	(2)	(3)
Δ foreign	3.217***	0.067**	2.110**
	(0.937)	(0.027)	(1.073)
Δ domestic	0.045	0.010**	-0.463**
	(0.133)	(0.005)	(0.193)
Secular Trend	×	×	×
State Fixed Effects	×	×	×
Time Period Dummy	×	×	×
N	1304	1304	1304
AP Fstat Foreign	46.65	46.65	46.65
AP Fstat Domestic	25.73	25.73	25.73

Notes: This table reports results of regression for various outcomes. The outcome variable is depicted in the column head. All the columns are estimated using specification 4. All outcome variables are scaled by 2004 population. "Secular Trend" row denotes if the secular trend control has been included. "State Fixed Effects" row denotes if the state fixed effects has been included. "Time Period Dummy" row denotes if the time period dummy has been included. "AP Fstat Foreign" row reports the Angrist Pischke first stage F statistics for the Δ foreign. "AP Fstat Domestic" row reports the Angrist Pischke first stage F statistics for the Δ domestic. N denotes number of observations. Robust standard errors clustered at county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 6: HETEROGENEITY WITH POPULATION DENSITY

	Δ employment	Δ log adjusted wage	Δ business establishment	Δ non-student population	Δ house units	Δ log median rent
	(1)	(2)	(3)	(4)	(5)	(6)
Δ foreign	1.609**	3.337***	0.048*	2.055**	1.052***	0.272
	(0.797)	(1.133)	(0.028)	(0.874)	(0.328)	(0.884)
Δ domestic	0.168	-0.149	0.008	-1.023***	0.026	-0.010
	(0.203)	(0.359)	(0.008)	(0.210)	(0.096)	(0.247)
Δ foreign × PD	2.212***	0.782	0.030	0.515	0.112	1.348***
	(0.528)	(0.730)	(0.028)	(0.741)	(0.213)	(0.515)
N	652	652	652	652	652	652
AP Fstat Foreign	63.81	63.81	63.81	63.81	63.81	63.81
AP Fstat Domestic	19.32	19.32	19.32	19.32	19.32	19.32
AP Fstat Interaction	82.30	82.30	82.30	82.30	82.30	82.30

Notes: This table reports results of regression for various outcomes. The outcome variable is depicted in the column head. All the columns are estimated using specification 7. Outcome variables in column 1,3,4 and 5 are scaled by 2004 population. Wages and rents are denominated in 2010 dollars. "D" is demeaned log of population density of the county. "AP Fstat Foreign" row reports the Angrist Pischke first stage F statistics for the Δ foreign. "AP Fstat Domestic" row reports the Angrist Pischke first stage F statistics for the Δ domestic. "AP Fstat Interaction" row reports the Angrist Pischke first stage F statistics for the interaction term. N denotes number of observations. Robust standard errors clustered at county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: NEIGHBORING COUNTY OUTCOMES

	Δ employment	Δ log adjusted wage	Δ business establishment	Δ non-student population	Δ house units	Δ log median rent
	(1)	(2)	(3)	(4)	(5)	(6)
Δ foreign	-0.046	0.135*	-0.000	-0.044	0.036	-0.026
	(0.087)	(0.070)	(0.005)	(0.068)	(0.043)	(0.129)
Δ domestic	0.036	0.009	0.002	0.014	-0.003	0.019
	(0.022)	(0.015)	(0.001)	(0.012)	(0.008)	(0.021)
N	1429	1429	1429	1429	1429	1429
AP Fstat Foreign	100.14	100.14	100.14	100.14	100.14	100.14
AP Fstat Domestic	13.03	13.03	13.03	13.03	13.03	13.03

Notes: This table reports the results of effects of foreign and domestic student enrollment on the various outcomes of neighboring counties without institutions. The outcome variable is depicted in the column head. The sample includes all counties without institutions that neighbor a county with an institution (neighboring counties). The dependent variable is the change in the outcome of the neighboring county between 2004 and 2016. Dependent variables in columns 1,3,4 and 5 are scaled by the 2004 population. Wages and rents are denominated in 2010 dollars. The two main explanatory variables ((Δ foreign and Δ domestic)) are the 12-year enrollment changes of domestic and foreign students summed over all the adjacent counties with institutions. All the explanatory variables except wages and rents are further scaled by the population of the neighboring county in 2004. All regressions have secular trend control, i.e., the growth rate of the outcome between 1996 and 2001. Also, state fixed effects are included in every regression. The estimation method used is 2SLS. "AP Fstat Foreign" row reports the Angrist Pischke first-stage F statistics for the Δ foreign. "AP Fstat Domestic" row reports the Angrist Pischke first-stage F statistics for the Δ domestic. N denotes the number of observations. Robust standard errors clustered at the county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, CBP, and NBER Public Use Data. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 8: CORRELATION BETWEEN STUDENT ENROLLMENT IV AND CONTROLS

	log(f(Δ foreign IV)		log(f(Δ domestic IV)	
	(1)	(2)	(3)	(4)
Log(f(Employment Growth (1996-01)))	0.009***	0.015***	-0.004	-0.007
	(0.002)	(0.003)	(0.016)	(0.019)
Log(f(Nontradable Employment Growth(1996-01)))	-0.001	-0.001	0.011	0.005
	(0.002)	(0.003)	(0.011)	(0.013)
Log(f(Tradable Employment Growth(1996-01)))	0.000	-0.001	-0.002	-0.006
	(0.000)	(0.001)	(0.003)	(0.005)
Δ Log Wage(1996-01)	-0.007**	-0.008**	0.009	0.011
	(0.003)	(0.004)	(0.014)	(0.018)
Log(f(Business Establishment Growth(1996-01)))	-0.002	-0.000	-0.013	-0.022
	(0.003)	(0.003)	(0.014)	(0.015)
Log(f(Non Student Population Growth(1996-01)))	-0.002	-0.002	-0.004	0.028
	(0.003)	(0.003)	(0.021)	(0.017)
Log(f(Houseunits Growth (1990-00)))	0.001	0.004	0.044***	-0.003
	(0.002)	(0.004)	(0.010)	(0.023)
Δ Log Median Rent(1990-00)	-0.000	-0.002	-0.010	-0.004
	(0.001)	(0.002)	(0.007)	(0.010)
More Controls		×		×
N	652	652	652	652
R^2	0.03	0.09	0.07	0.13

Notes: This table reports results of regression of the instrument variables on the variables controlling for secular trend in the earlier regressions. Logarithmic transformation of the variables has been used for straighforward interpretation. Before applying logarithmic transformation to non-logarithmic variables, I add 1.1 to the variables which is denoted by function f in the table. Columns 2 and 4 include the quadratic and cubic terms of the controls as well, which is indicated in the "More Controls" row. N denotes number of observations. Robust standard errors clustered at county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data. *** p<0.01, ** p<0.05, * p<0.1.

APPENDIX

“The Local Economic Impacts of Foreign Students”

A Appendix: Tables and Figures

Table A.1: SUMMARY STATISTICS

	Mean	SD
Δ foreign	0.00263	0.00770
Δ domestic	0.00592	0.0658
Foreign Enrollment in 1000s (2004)	0.641	1.822
Foreign Enrollment in 1000s (2016)	1.158	3.514
Domestic Enrollment in 1000s (2004)	16.77	31.68
Domestic Enrollment in 1000s (2016)	19.01	39.85
County Population in 1000s (2004)	200.3	529.0
County Population in 1000s (2016)	220.4	562.0
Non-student Population in 1000s (2004)	182.9	497.8
Non-student Population in 1000s (2016)	200.2	521.6
Employment in 1000s (2004)	127.7	330.3
Employment in 1000s (2016)	146.3	387.6
Tradable Employment in 1000s (2004)	10.26	27.52
Tradable Employment in 1000s (2016)	8.891	22.50
Nontradable Employment in 1000s (2004)	97.33	265.1
Nontradable Employment in 1000s (2016)	116.5	327.3
Average Wage in 1000s (in 2010 dollars, 2004)	35.83	7.628
Average Wage in 1000s (in 2010 dollars, 2016)	38.36	8.382
Business Establishments in 1000s (2004)	5.338	14.11
Business Establishments in 1000s (2016)	5.604	15.44
Housing Units in 1000s (2004)	85.63	201.3
Housing Units in 1000s (2016)	89.65	208.6
Median Monthly Gross Rent (in 2010 dollars, 2004)	660.6	158.1
Median Monthly Gross Rent (in 2010 dollars, 2016)	686.8	166.0
Employment-to-Population Ratio (2004)	0.574	0.130
Tradable Employment-to-Population Ratio (2004)	0.0567	0.0359
Nontradable Employment-to-Population Ratio (2004)	0.392	0.125
Business Establishments-to-Population Ratio (2004)	0.0252	0.00687
Housing Units-to-Population Ratio (2004)	0.451	0.0539
Population Density in 1000s (2000)	0.189	1.097
Observations	652	

Notes: This table shows the summary statistics of the variables for the sample counties. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data.

Table A.2: COUNTY OUTCOMES: SENSITIVITY TO ADDITIONAL CONTROLS

	Δ employment	Δ log adjusted wage	Δ business establishment	Δ non-student population	Δ house units	Δ log median rent
	(1)	(2)	(3)	(4)	(5)	(6)
Δ foreign	2.519**	3.568***	0.079**	2.849***	0.971***	0.400
	(1.052)	(1.246)	(0.038)	(1.100)	(0.372)	(0.975)
Δ domestic	0.382*	-0.061	0.016	-0.817***	0.066	0.141
	(0.226)	(0.340)	(0.010)	(0.295)	(0.119)	(0.279)
N	652	652	652	652	652	652
AP Fstat Foreign	61.05	61.05	61.05	61.05	61.05	61.05
AP Fstat Domestic	11.40	11.40	11.40	11.40	11.40	11.40

Notes: This table reports results of regression for various outcomes. The outcome variable is depicted in the column head. All the columns are estimated using the specification in column 7 of Table 2. Outcome variables in column 1,3,4 and 5 are scaled by 2004 population. Wages and rents are denominated in 2010 dollars. Secular trend control includes the growth rate of all the outcomes between 1996 and 2001 as well as their quadratic and cubic terms ."AP Fstat Foreign" row reports the Angrist Pischke first stage F statistics for the Δ foreign. "AP Fstat Domestic" row reports the Angrist Pischke first stage F statistics for the Δ domestic. N denotes number of observations. Robust standard errors clustered at county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data. *** p<0.01, ** p<0.05, * p<0.1.

Table A.3: COUNTY OUTCOMES: ALTERNATE SAMPLE ANALYSIS

	Δ employment	Δ log adjusted wage	Δ business establishment	Δ non-student population	Δ house units	Δ log median rent
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: ATLEAST 1% STUDENT POPULATION						
Δ foreign	2.878***	2.970***	0.068**	3.649***	0.964***	-0.047
	(0.928)	(1.098)	(0.032)	(1.071)	(0.328)	(0.815)
Δ domestic	0.287	-0.163	0.014	-0.837***	0.025	0.221
	(0.229)	(0.354)	(0.009)	(0.279)	(0.097)	(0.249)
N	1235	1235	1235	1235	1235	1235
AP Fstat Foreign	73.69	73.69	73.69	73.69	73.69	73.69
AP Fstat Domestic	16.24	16.24	16.24	16.24	16.24	16.24
PANEL B: ATLEAST 2% STUDENT POPULATION						
Δ foreign	2.551***	2.821**	0.061*	3.216***	0.826**	-0.131
	(0.909)	(1.105)	(0.032)	(1.065)	(0.335)	(0.821)
Δ domestic	0.319	-0.170	0.014	-0.754**	0.068	0.236
	(0.227)	(0.366)	(0.009)	(0.304)	(0.105)	(0.252)
N	1121	1121	1121	1121	1121	1121
AP Fstat Foreign	73.95	73.95	73.95	73.95	73.95	73.95
AP Fstat Domestic	15.58	15.58	15.58	15.58	15.58	15.58
PANEL C: ATLEAST 3% STUDENT POPULATION						
Δ foreign	2.575***	2.759**	0.057*	3.129***	0.827**	0.081
	(0.920)	(1.098)	(0.032)	(1.059)	(0.344)	(0.810)
Δ domestic	0.286	-0.090	0.014	-0.817***	0.066	0.136
	(0.233)	(0.359)	(0.010)	(0.307)	(0.110)	(0.247)
N	973	973	973	973	973	973
AP Fstat Foreign	70.11	70.11	70.11	70.11	70.11	70.11
AP Fstat Domestic	14.95	14.95	14.95	14.95	14.95	14.95
PANEL D: ATLEAST 4% STUDENT POPULATION						
Δ foreign	2.594***	2.662**	0.070**	3.154***	0.957***	0.397
	(0.847)	(1.101)	(0.028)	(0.982)	(0.314)	(0.807)
Δ domestic	0.183	-0.144	0.009	-0.980***	0.034	-0.001
	(0.207)	(0.361)	(0.008)	(0.273)	(0.098)	(0.247)
N	802	802	802	802	802	802
AP Fstat Foreign	65.79	65.79	65.79	65.79	65.79	65.79
AP Fstat Domestic	16.02	16.02	16.02	16.02	16.02	16.02

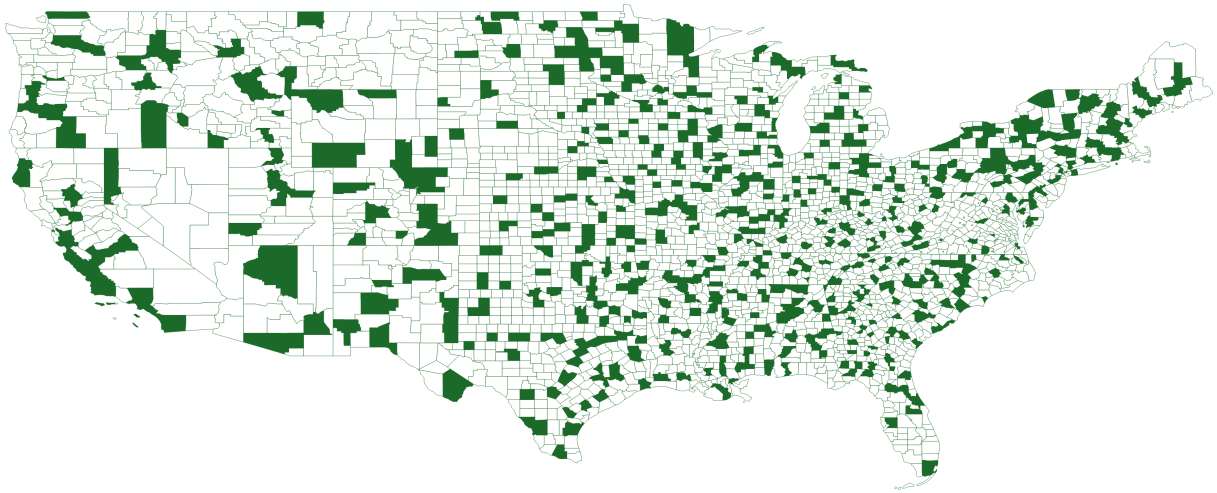
Notes: This table reports results of regression for various outcomes. The outcome variable is depicted in the column head. All the columns are estimated using the specification in column 7 of Table 2. Outcome variables in column 1,3,4 and 5 are scaled by 2004 population. Wages and rents are denominated in 2010 dollars. Different panels report results of regressions run on a sample of counties having different share of student population in the base year, which is depicted in the panel head. "AP Fstat Foreign" row reports the Angrist Pischke first stage F statistics for the Δ foreign. "AP Fstat Domestic" row reports the Angrist Pischke first stage F statistics for the Δ domestic. N denotes number of observations. Robust standard errors clustered at county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A.4: COUNTY OUTCOMES: EXCLUDING INFLUENTIAL COUNTIES

	Δ employment	Δ log adjusted wage	Δ business establishment	Δ non-student population	Δ house units	Δ log median rent
	(1)	(2)	(3)	(4)	(5)	(6)
Δ foreign	2.187**	3.372***	0.076**	3.075***	1.148***	0.341
	(0.859)	(1.173)	(0.033)	(1.111)	(0.359)	(0.890)
Δ domestic	0.212	-0.108	0.009	-1.020***	0.030	0.032
	(0.208)	(0.363)	(0.008)	(0.267)	(0.099)	(0.249)
N	645	645	645	645	645	645
AP Fstat Foreign	50.83	50.83	50.83	50.83	50.83	50.83
AP Fstat Domestic	17.86	17.86	17.86	17.86	17.86	17.86

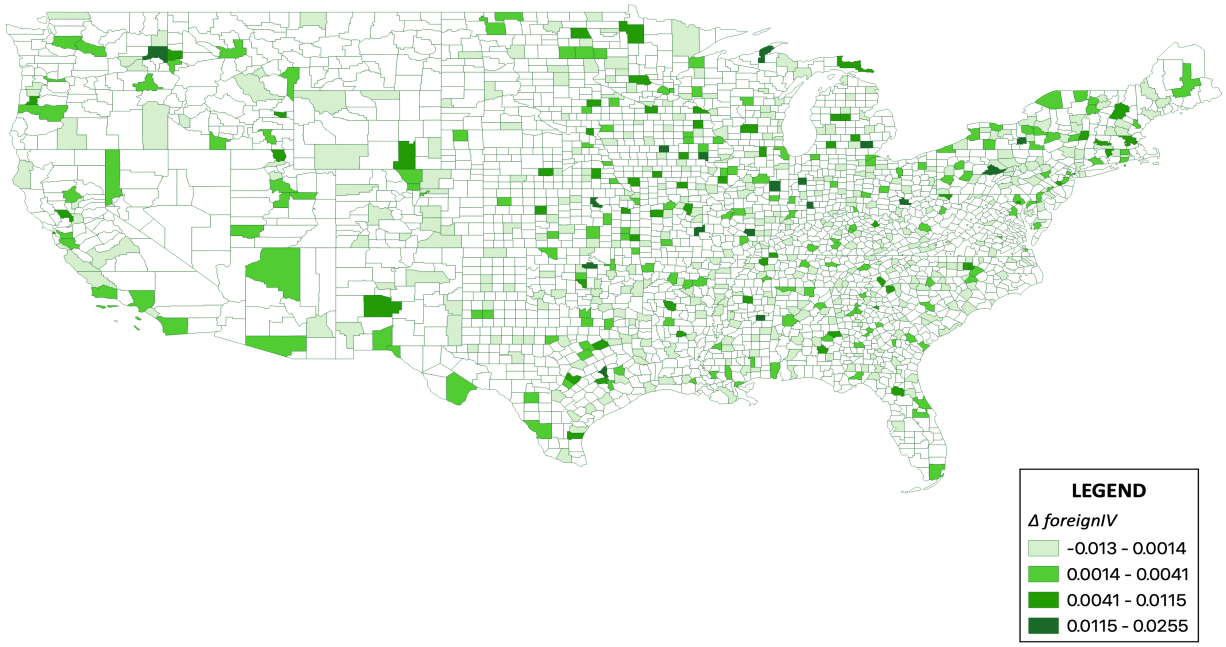
Notes: This table reports results of regression for various outcomes. The outcome variable is depicted in the column head. All the columns are estimated using the specification in column 7 of Table 2. Outcome variables in column 1,3,4 and 5 are scaled by 2004 population. Wages and rents are denominated in 2010 dollars. Sample includes all main sample counties except those in top 1 percentile of total foreign student enrollment in 2004. "AP Fstat Foreign" row reports the Angrist Pischke first stage F statistics for the Δ foreign. "AP Fstat Domestic" row reports the Angrist Pischke first stage F statistics for the Δ domestic. N denotes number of observations. Robust standard errors clustered at county level in parentheses. Source: Author's calculation using IPEDS, BEA, NHGIS, and CBP Data. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Figure A.1: MAIN SAMPLE COUNTIES



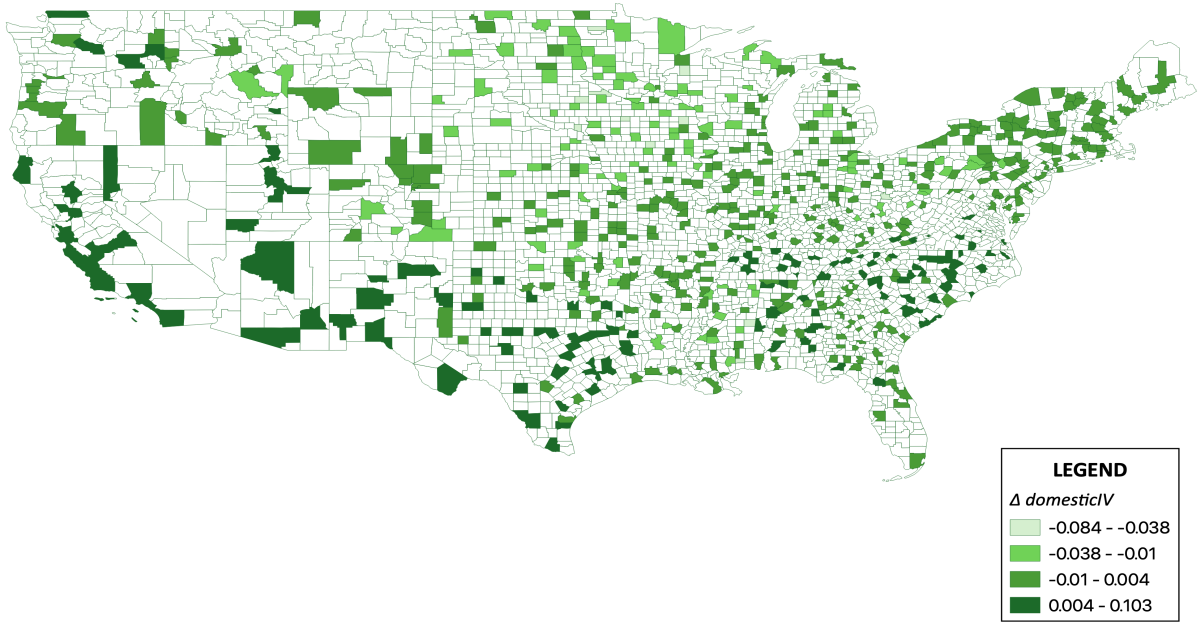
Notes: This figure shows main sample counties highlighted on the US map. Source: Author's calculation using IPEDS, BEA, and NHGIS Data.

Figure A.2: VARIATION IN Δ *foreignIV* ACROSS SAMPLE COUNTIES



Notes: This figure shows the variation in the Δ *foreignIV* across the main sample counties on the US map. Source: Author's calculation using IPEDS, BEA, and NHGIS Data.

Figure A.3: VARIATION IN Δ *domesticIV* ACROSS SAMPLE COUNTIES



Notes: This figure shows the variation in the Δ *domesticIV* across the main sample counties on the US map. Source: Author's calculation using IPEDS, BEA and NHGIS Data.

B Appendix: Variables

B.1 Explanatory Variables

$Foreign_{ct}$ is the number of foreign post-secondary students in county c in year t. $Domestic_{ct}$ is the number of domestic post-secondary students in county c in year t. Pop_{ct} is the population of county c in year t.

$\Delta foreign_c = (Foreign_{c,2016} - Foreign_{c,2004})/Pop_{c,2004}$ is the change in number of foreign students in county c between 2004 and 2016, scaled by county's 2004 population. $\Delta domestic_c = (Domestic_{c,2016} - Domestic_{c,2004})/Pop_{c,2004}$ is the change in number of domestic students in county c between 2004 and 2016, scaled by county's 2004 population.

For Split Period Analysis (Table 5): $\Delta foreign_{ct} = (Foreign_{c,t2} - Foreign_{c,t1})/Pop_{c,2004}$ and $\Delta domestic_{ct} = (Domestic_{c,t2} - Domestic_{c,t1})/Pop_{c,2004}$, where t2 = 2010, t1 = 2004 for the first period and t2 = 2016, t1 = 2010 for the second period.

For Neighboring County Sample Analysis (Table 7): $\Delta foreign_c = \sum_{s \in AdjC}(Foreign_{s,2016} - Foreign_{s,2004})/Pop_{c,2004}$ and $\Delta domestic_c = \sum_{s \in AdjC}(Domestic_{s,2016} - Domestic_{s,2004})/Pop_{c,2004}$, where AdjC is the set of counties with post-secondary institutions that share border with county c without any post-secondary institutions.

B.2 Outcome Variables

y^k is a local outcome. y^k_{ct} is the measure of local outcome y^k of county c in year t. Pop_{ct} is the population of county c in year t. Δy^k_c are changes in local outcomes y^k of county c, which are scaled by the county's 2004 population for non-logarithmic local outcomes.

$\Delta employment_c = (employment_{c,2016} - employment_{c,2004})/pop_{c,2004}$, where $employment_{ct}$ is the total employment in county c in year t.

$\Delta tradable\ employment_c = (trade\ employment_{c,2016} - trade\ employment_{c,2004})/pop_{c,2004}$, $\Delta nontradable\ employment_c = (nontrade\ employment_{c,2016} - nontrade\ employment_{c,2004})/pop_{c,2004}$, where $trade\ employment_{ct}$ is the total employment in tradable sector in county c in year t and $nontrade\ employment_{ct}$ is the total employment in nontradable sector in county c in year t.

The tradable sector includes industries whose products could be primarily traded nationally or internationally. Whereas the nontradable sector includes industries whose products are primarily traded locally. Following Black, McKinnish and Sanders (2005), the tradable sectors here includes manufacturing. The nontradable sector includes all private nonfarm employment sectors excluding manufacturing, mining, forestry, fishing, and related activities.

$\Delta log\ adjusted\ wage_c = log\ adjusted\ wage_{c,2016} - log\ adjusted\ wage_{c,2004}$, where $log\ adjusted\ wage_{ct}$ is the log demographic adjusted average wage of county c in year t. Following Zou (2018), I calculate it as follows: First, I calculate the average wage for each county by dividing total county wages and salary earnings by total county wages and salary employment. Second, I regress log average wages on county demographic characteristics, which includes racial composition (white, black), share of population with a college degree, and the quadratic terms of these variables. The log demographic adjusted average wage is the residual from this regression.

$\Delta business\ establishment_c = (bus\ estab_{c,2016} - bus\ estab_{c,2004})/pop_{c,2004}$, where $bus\ estab_{ct}$ is the total number of business establishments in county c in year t.

$\Delta non\,student\ population_c = (non\,stu\ pop_{c,2016} - non\,stu\ pop_{c,2004})/pop_{c,2004}$, where $non\,stu\ pop_{ct}$ is the non-student population of county c in year t.

$\Delta house\ units_c = (house\ units_{c,2016} - house\ units_{c,2004})/pop_{c,2004}$, where $house\ units_{ct}$ is the total number of housing units in county c in year t. A housing unit is a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters. Separate living quarters are those in which the occupants live and eat separately from any other persons in the building and which have direct access from the outside of the building or through a common hall.

$\Delta log\ median\ rent_c = log\ median\ rent_{c,2016} - log\ median\ rent_{c,2004}$, where $log\ median\ rent_{ct}$ is the log median gross rent of county c in year t. Gross rent is the monthly housing cost expenses for renters. It is the contract rent plus the estimated average monthly cost of utilities (electricity, gas, and water and sewer) and fuels (oil, coal, kerosene, wood, etc.) if these are paid by the renter (or paid for the renter by someone else).