International student migration and local housing markets*

Tatiana Mocanu[†‡] Pedro Tremacoldi-Rossi[†]

June 28, 2019

Abstract

We study the impact of the 2005-2015 international student boom on local housing markets. By constructing a sample of American college towns characterizing rarely studied local markets, we show that international students exogenously sustained demand for rentals and residential investment even during the housing bust. Using an instrument based on the historical distribution of foreign students across college towns, we find that international students increased rents by 1% and home prices by 1.6% relative to the housing boom peak. An analysis exploiting within-city dynamics reveals that neighborhoods near campus absorbed international inflows by replacing single-family homes with apartment rentals.

Keywords: migration, international students, housing markets
JEL Classification: F22; R31; R23; I23.

*We are grateful in particular to David Albouy for his invaluable advice and guidance. We also thank Alex Bartik, Marianne Bertrand, Thomas Dohmen, Philip Garcia, Marieke Kleemans, Gabriel Kreindler, Daniel McMillen, Alexei Tchistyi, Patrick Testa, Russell Weinstein, Dean Yang, and participants of the 13th Meeting of the Urban Economics Association and seminars at the University of Illinois for helpful comments. All errors are our own.

[†]University of Illinois at Urbana-Champaign.

[‡]Corresponding author: mocanu2@illinois.edu.

1 Introduction

As the global market for tertiary education continues to expand, the United States alone witnessed an increase of 67% in the share of foreign students in total postsecondary enrollment from 2005 to 2015.[1] In spite of making up only 4% of total enrollment in 2005, international students accounted for a *quarter* of all new college students in the last decade. For each 10 American students in 2005, only 2 additional domestic students were enrolled ten years later, which roughly aligns with the historical annual growth rate of 1% of domestic enrollment in 4-year institutions. In the same period, international enrollment almost doubled (Figure (I)).[2] Many of these students attended colleges in relatively small and isolated locations, where local economies largely depend on student demand.

In this paper, we study how sizable international student inflows during the most critical moment of the last housing cycle drove housing market behavior. Employing a national shift-share instrument, we find the causal effect of international student inflows on prices, rents, and densification. Our estimates indicate that an influx of foreign students equal to 1% of preexisting total enrollment increased prices and rents by approximately 0.1% during the housing bubble collapse and subsequent recovery periods. This translates into average nominal price gains of $2,500 relative to the housing boom peak, caused by an average annual international inflow of 1.5% of total enrollment.

We capture the spatial heterogeneity of international students' college choices by constructing for the first time a comprehensive sample of American college towns. College towns combine less than 4% of the country's population, albeit concentrate one third of all international and total college enrollment. The universities in our sample closely match the national distribution of four-year institutions by sector, type, and enrollment patterns. We focus on college towns instead of all locations with universities because these are the places where students can affect local consumption to a meaningful extent. Our sample selection requires the demand for housing to be sufficiently influenced by shocks

[1]See Figure (A.3). With an influx of over 300 thousand foreign-born students in 2015 alone, the contingent of international students entering the U.S. that year was twice as large as other skill-based immigration groups: 80,000 permanent immigrants with an employment visa and 65,000 temporary immigrants admitted as foreign workers.

[2]Domestic enrollment grew about 1% per year from 1995 until 2004 and again by 1% annually from 2005 to 2015. The annual growth rate of international enrollment had a twofold increase from 1995-2004 to 2005-2015. These enrollment figures correspond to degree-seeking students in 4-year universities in our sample and are similar to annual growth rates of students enrolled in all 4-year institutions nationwide.

to the composition of student enrollment without being heavily affected by extraneous factors.[3]

By using the historical distribution of international students across college towns, our instrument leverages the fact that the top destinations for international students in 1996 remain the most internationalized universities decades later. Without a national-level policy to recruit students from abroad, American universities need to compete for international applicants by investing in initiatives that reduce search frictions. Thus, universities first able to establish international outreach networks and popularize their "brand" abroad gained competitive advantage in recruitment over institutions that entered the global market for students more recently.

A series of robustness checks indicate that our results are unlikely to be driven by local secular trends, domestic enrollment growth, or other confounding effects. We show that over longer time horizons, housing markets in college towns experience mean reversion, and that places with the largest and lowest price increases during 2005-2016 were similar along observable characteristics before the international student boom. Instruments exploiting temporal persistence of state-of-origin and major choices also indicate that domestic enrollment failed to account for housing cost increases in college towns.

In order to rationalize our findings, we begin by documenting three stylized regularities of college towns housing markets. First, students, particularly foreign-born, rent much more often than nonstudents, with over 95% of internationals renting. Second, because students disproportionately live in multi-family rental units, these dwellings represent over 40% of the local housing stock. Third, students locate near the university campus, which implies that the stock of multi-family rentals is unevenly distributed within a college town. 60% of all multi-family rentals and 70% of all students live within 2 miles from campus.

These three structural factors unique to our sample allow us to explore the consequences of student residential choices *within* college towns. We show that the university campus generates a convex gradient of rents, rent growth, student population, and supply of multi-family rentals, and that nonstudents and owned dwellings locate farther out. Akin to well-established patterns of residential segregation based on attributes such as race and income (e.g. Cutler and Glaeser (1997) and Bayer et al. (2004)), students and nonstudents live in distinct college town areas, creating a segmented student housing market where international and native students compete for rental units in the student "ghetto".

[3]Our cities sharply contrast to the usual location choices of permanent immigrants. More than half of the immigrants in the 1983-1997 period moved to only *ten* Metropolitan Statistical Areas (MSAs), which contained 20% of the U.S. population (Saiz (2007), Card (2009)).

Taking into account the intra-city dynamics displayed by college towns, we then propose two mechanisms to explain the impact of the international enrollment boom on house prices. First, a shift in the demand for multi-family rentals induced by international students leads to the replacement of owned single-family homes with rental units near campus. Hence, the rise in demand for homes pushes up prices in the areas where student housing construction pressures local homeowners. Second, as a consequence, homeowners substitute away from housing nearby campus, thereby increasing demand for houses farther out. This centrifugal movement leads to price spillovers, which is reflected in our city-level price regressions.[4]

We substantiate the plausibility of our mechanisms with a variety of empirical tests. These rely on data from various sources, including student housing investment by large developers and detailed land cover satellite-imagery. Taken together, these tests indicate that the supply of multi-unit rentals grew disproportionately near campus, partially driven by luxury developments with increased quality, and by converting land sparsely occupied by single family homes into construction types consistent with multi-unit housing. We find that international student inflows caused land conversion near campus and that the upward price pressure extended to nonstudent areas.

This paper has three main contributions. First, it expands on numerous studies analyzing immigration effects on local housing (Saiz (2003), Saiz (2007), Saiz and Wachter (2011), Sá (2014)) and labor markets (Borjas (2005), Dustmann et al. (2005), Basso and Peri (2016)), and provides new evidence on the importance of migration inflows during economic downturns. With respect to housing markets, the literature tends to find a positive effect on housing costs from immigration at the city or MSA levels, but home value decreases in neighborhoods where immigrants settle because of native flight. International students did not drive domestic students out of campus surroundings, where both rents and prices increased faster because of concentrated demand and income effects, even amid the Great Recession.

International student migration differs from permanent migration along two major dimensions. First, individuals holding temporary student visas are virtually disallowed to work. This enables us to analyze the housing market without having to consider short-run first-order effects of these students on the labor supply.[5] Second, students' local consump-

[4]This dynamics is somewhat similar to the out-of-town investment model of Favilukis and Van Nieuwerburgh (2016). In our framework, exogenous demand shocks in college towns are much more concentrated, since international students face "prohibitive" commuting costs and pressure rental units only in the city center.

[5]There are three categories of student visas in the U.S.: F, J, and M types. F and J are of particular interest, since M visas cover vocational and not academic studying. F-1 visas require full enrollment and only allow students to work on campus, while J visas are issued for visitors, such as research scholars and exchange students, and *may* include the possibility of work travel. It is important to stress that J visas demand a U.S. sponsor, so that work mobility, when working is allowed, is halted by visa compliance.

tion is financed with home country savings instead of host country earnings. Under the assumption that (home country) wealth is orthogonal to local earnings, an inflow of students from abroad represents a stochastic demand push likely to be countercyclical.[6] One interpretation of our estimates is that college towns receiving larger international student inflows relative to total enrollment better insulated their housing markets during the housing collapse, as international students exogenously sustained demand for rentals and residential investment.

This paper also contributes to a growing literature on international students. Most of this previous research has focused on consequences of foreign enrollment to education outcomes. Although Borjas (2004) suggests that native graduates are displaced by international students, Shih (2017) and Bound et al. (2016) find that these students affect natives positively due to cross-subsidization and direct financing in public research universities, respectively. Our first contribution is to show how international inflows impact students and *nonstudents* through local markets. Our findings imply that, while homeowners benefit from increased home equity, students face higher living expenses in college towns.

These effects for students have direct implications to the current college affordability debate (e.g. Rothstein and Rouse (2011) and Avery and Turner (2012)). While most attention is given to rising tuition values, expenditure on housing comprises the second most substantial part of the cost of attending college. Published room and board expenses are on average 50% of out-of-state tuition in a 4-year university. Since many college towns are usually less costly than large MSAs, the rise in housing costs induced by international students we document affects particularly those locations at the lower end of the cost of living associated with attending college. This cost-of-living channel represents a novel dimension that aggravates college unaffordability.

Our third contribution is to assemble a dataset that combines housing costs, local amenities, economic and demographic information on college towns. The data enables us to analyze the characteristics of local economies responsible for a substantial share of human capital formation in the U.S. Using fine geographic scale, we uncover spatial features of college towns making them housing markets distinct from large and other small urban areas. In addition to displaying a much larger fraction of housing made up by rentals than the national average, residential investment in college towns largely comprises multi-family housing and occurs in student neighborhoods, increasing density faster than the amount of developed land.

The rest of the paper is organized as follows. Section 2 outlines the construction of the college town sample. Section 3 details the international student inflow variable,

[6] Administrative records on international students living in college towns indicate that declared personal funds increased by 5% during 2007-2009, while local nominal income remained unchanged.

prices, rents, and other data. Section 4 introduces the methodology and discusses the results of the paper. Section 5 shows additional empirical tests to assess the robustness of our results and Section 6 describes the stylized facts of housing markets in college towns. Section 7 analyzes the effects of international inflows on rental demand and Section 8 presents the mechanisms behind our main estimates. Section 9 concludes.

2 American college towns

We begin by defining the relevant local housing markets to our analysis. Since our main goal is to understand how the rapid increase of international enrollment in the last decade impacted local housing markets, the relevant demand for housing must be sufficiently influenced by shocks to the composition of student enrollment, without being heavily affected by extraneous factors. With these desirable characteristics as guidance, we select college towns out of all U.S. cities with at least one 4-year university based on two criteria: student demand relevance and geographic isolation. Accordingly, we define a college town as a place whose population consists of at least 10% of students, and that is situated no less than 30 miles away from the nearest MSA with more than 1 million people.[7]

To motivate our sample construction process, consider first the implications if we were to select college towns based on certain institution types, such as land-grant universities, or by tracking where all students live. The historical influence of a land-grant campus in shaping its city's economy provides good candidates of places that should have large student populations.[8] Yet, even though Cambridge, MA hosts a land-grant institution (MIT), one may question whether its proximity to Boston still allows the city to display a housing market structure comparable to Bozeman, MT, located 300 miles away from the nearest large MSA.

Further, by simply considering all local markets where students live, we would include housing markets highly associated with local economic trends independent from student demand, or that are too large to be affected by enrollment growth. Think of Berkeley, CA or Evanston, IL: both cities host prestigious universities, but are also part of large urban networks, which makes it difficult to disentangle students' effects on local markets from other factors. A similar argument can be made if we were to include all

[7]Outside the economics literature, Gumprecht (2003) emphasizes the difference between a "*college town and a city that is merely home to a college*". Using "introspective" requirements in addition to at least 20% of the local population made up by students as an initial selection condition, Gumprecht then chooses places where the "*collegiate culture is more concentrated and conspicuous*".

[8]Recent studies have used land-grant institutions in a variety of settings (Moretti (2004), Liu (2015), and Andrews (2018)).

locations where large contingents of international students live. NYU concentrates the largest number of international students in any American institution. At the heart of one of the most densely populated areas in the country, even relatively sizable changes in the student population are unlikely to exert any observable pressure on Manhattan's housing market.

Relevance. We measure our first requirement, the *student housing demand relevance*, similar to Gumprecht (2003). To satisfy this condition, a college town must have its local population composed of at least 10% of students. The importance of having a significant population fraction made up by students is two-fold. First, shocks to the student population are more likely to affect local housing demand. Second, the greater the number of students relative to the non-student population, the more likely students' preferences for housing will shape the local supply of dwellings, making housing markets more similar. If student preferences for housing and residential location differ from non-students, housing markets local to universities might develop distinctive features over time. After accounting for local characteristics, cities with large student populations will have housing markets sharing common structural features. Imagine that students demand more multi-family rentals than single-family homes. College towns will then have disproportionately higher shares of renter-occupied units compared to non-college towns.

Distance from large urban area. The second requirement for a college town, *geographic isolation*, is to be located no less than 30 miles from the nearest MSA with 1 million people. Almost 90% of American workers commute no more than 30 miles one way, so we consider that students are even less likely to cover large distances daily.[9] As we document in Section (8), the vast majority of students live very close to campus, which implies that considering broader geographic areas as "local" housing markets, such as counties or MSAs, would make housing costs more susceptible to capture extraneous factors.

We assemble the college towns sample with student and overall population data. The main source of student enrollment and university-related data used in this paper is the Integrated Postsecondary Education Data System (IPEDS) of the U.S. Department of Education. We initially include all 4-year public, private not-for-profit and private for-profit, higher education institutions in the contiguous U.S. We focus on these institutions since 90% of international students in the U.S. attend 4-year universities. The selection returns 3,097 universities with 2016 as the base year. For each one of these universities, we gather data on Fall enrollment of full-time degree seeking undergraduate, part-time degree seeking undergraduate, full time graduate and part-time graduate (graduate programs are degree-granting), both nonresident and total (domestic and international) students.

[9]From the Bureau of Transportation Statistics (https://www.bts.gov/bts/sites/rita.dot.gov.bts/files/publications/omnistats/volume_03_issue_04/pdf/entire.pdf).

We also retrieve the number of degrees awarded to international and total students, and institutional characteristics from IPEDS. To reduce potential measurement error, we drop institutions with less than 500 students enrolled during Fall 2011 and without at least one international student in any year from 2001-2015. Student enrollment from the resulting 1,370 universities are aggregated to the city level using the place identifier provided by IPEDS. These city identifiers may not map onto Census nomenclatures, which requires that we homogenize IPEDS and Census names by hand to match data from the two different sources.

We then obtain population for 19,506 incorporated places from 2011 to 2015 with data from the U.S. Census Bureau. We combine the student and population datasets and match city-level population to city-level student data. There are 953 matched cities, of which 523 locations have at least 10% of local population made up by students, according to 2011-2015 population and total enrollment averages. Finally, we drop places with less than 100 international students enrolled during Fall 2015, again to avoid measurement error. This further reduces the sample to 351 places. Finally, we calculate the orthodromic distance using the Haversine formula between each city and the nearest MSA with more than 1 million residents. Only the locations no less than 30 miles away from the nearest large metropolitan area are selected to compose the final sample of 241 college towns.

Sample description. The assembled sample includes almost 3 million students (as of 2000) distributed across nearly 325 universities in 241 college towns, representing almost a third of the national degree-seeking enrollment in four-year higher education institutions. Our representative university had 700 international and 11,000 total students enrolled in 2015, which is similar to the average 4-year university in the U.S. (570 international and 8,000 total students). The college towns sample also matches closely the national distribution of universities by sector and type, as shown in Table (A.2).

With respect to spatial distribution and local characteristics, Figure (II) shows how college towns are scattered across the country, with clusters along the East Coast and including very small places, with an overall average population of 51,000 people. To get a better sense of the variation in college town characteristics, consider first one of the largest college towns, Lubbock, TX. The city is home to over 40,000 students and almost 250,000 people. Lubbock is located in one of the largest cotton producing regions in the country, with a population density of about 2,000 people per square mile, household median income of $48,000, over 30% of its population made up by Hispanics, and 10% of jobs come from retail.

In Middletown, PA, one of the smallest college towns, over 4,000 students account for nearly half of the city's population. Twice as dense as Lubbock, Middletown has only 3% of Hispanics and a household median income of $42,000. Over 10% of employment is concentrated in manufacturing. In spite of their differences, Lubbock and Middletown share two significant features related to student population. First, these places have housing markets with very similar characteristics, shaped by students' preferences, as we discuss in Section (8). Second, both cities saw international enrollment surge in ten years: in Lubbock from 1,089 international students in 2005 to 3,115 in 2015, and in Middletown from 69 to 486.

A complete list of American college towns with selected demographic, economic, and geographic characteristics is contained in Table (A.3) in the Appendix.

3 Data and sample construction

A. International students

With the relevant local markets to our analysis determined, we now focus on the international enrollment accounting. Due to the shortcomings involving measurement and sampling error discussed in detail in Appendix (B), we refrain from using individual or household Census data for local international student populations. The IPEDS database is the best option to track international students with precise annual variation. The data is compiled with information on all institutions included under Title IV of the Higher Education Act of 1965 have to provide to the National Center for Education Statistics (NCES). Student enrollment is available as of the beginning of each Fall semester. Given that most changes in the student population composition tend to occur at that point, the IPEDS Fall enrollment provides a static student headcount that reflects the student population spanning at most August of a given year until May.

The Fall enrollment dataset from IPEDS contains stock data on the total number of enrolled students in the beginning of each academic year, which is different from a direct influx measure (e.g. new enrollment data). On a given year t, total enrollment in university j is given by $\text{Total}_{j,t} = \text{Domestic}_{j,t} + I_{j,t}$. We can decompose international enrollment $I_{j,t}$ into

$$I_{j,t} = \underbrace{(I_{j,t-1} - D_{j,t-(t-1)})}_{\text{Retained enrollment}} + \underbrace{I_{j,t} - (I_{j,t-1} - D_{j,t-(t-1)})}_{\text{New enrollment } (\Delta IS_{j,t})} \tag{1}$$

where $D_{j,t-(t-1)}$ gives the outflow as measured by number of degrees of international students who graduated within $t-1$ and t. An annual international student *inflow* $\Delta IS_{j,t}$ increases international enrollment if incoming students more than offset the number of students who left university j.

The constructed international student influx $\Delta IS_{j,t}$ is a suitable proxy for actual incoming foreign students if two main conditions are satisfied: proper measurement of gross inflows and that students actually reside in the college town. First, if $I_{j,t}$ includes non-degree seeking students, we cannot track their departure from campus by design. This creates a discrepancy between $\Delta I_{j,t} - I_{j,t-1}$ and $D_{j,t-(t-1)}$, which might introduce measurement error in the gross influx. To avoid the issue, we only use degree-seeking students, both part and full time.

Second, international students are only relevant to the local demand for housing given that they *reside* in the location where the campus is situated. Thus, a potential concern is that $IS_{j,t}$ also tracks foreign students undertaking only distance learning classes, while still living in their home country. IPEDS offers data on distance learning starting only in 2012. From Fall 2012 to Fall 2015, around 2% of international degree-seeking students were exclusively enrolled online and living outside of US. Considering that prior to 2006 institutional rules limited the relative importance of distance education (Deming et al. (2015)), it is very likely that the share of international students enrolled in US universities while living abroad during the entire program extension was well below 2% before 2012.

Finally, the annual international student influx to university j located in city k is obtained from

$$\Delta IS_{k,t} = \sum_{j \in k} \Delta IS_{j,t}. \tag{2}$$

Since the only aggregation level of official international student influx data available is for the entire U.S., we construct a version of our influx measure with all 4-year universities in the IPEDS database to evaluate its precision against student entry data made available by the Institute of International Education (IIE). Our constructed international influx into the U.S. variable has a correlation of 99% with the actual total new number of degree-seeking students coming to the U.S. according to IIE.

B. House prices, rents and other data

For our context, an ideal price index would track home values at place or census block geographies, where the latter can be easily aggregated back to the former. Using metropolitan statistical areas (MSAs) would ultimately include areas with almost no relevance to the student population, whose housing consumption is more likely to concentrate concentrically to the campus area (as we show in Section (6)). County-level and other geographic units would similarly incorporate extraneous price trends and confound the analysis. In contrast, places are a more useful aggregation level because they are a natural way to define geographic boundaries for college *towns*.

Recently, Bogin et al. (2016a,b,c) greatly improved the richness of the Federal Housing Finance Agency (FHFA) House Price Index (HPI) geographic coverage, rendering the novel annual home price index as probably the repeat-sales housing price index publicly available. With more 5-digit ZIPs than Zillow.com and information for 54,901 census tracts, the FHFA HPI tracks transaction information from 97 million conforming mortgages secularized or purchased by Fannie Mae and Freddie Mac since 1975. We construct a unique dataset combining college towns and annual house prices from FHFA tract-level data using census block assignment files which enable recovered census tracts to be mapped onto city identifiers. This dataset with *very* local prices allows for the first time the observation of housing prices with considerable time variation in small locations such as Lewisburg, PA, with less than 6,000 inhabitants.

Although rents appear as a more natural choice of outcome variable for the impact of international student housing demand, we focus on prices due to better data availability, and also to capture broader effects particularly to the nonstudent population. In Section (8), we show how a demand shock caused by international students affects prices given the housing market structure of college towns. This is a richer characterization of how upward pressure on rents is transmitted to home prices than simply using the dynamic Gordon model framework (Campbell et al. (2009)).

We complement our analysis with two alternative sources of rental data. We first use the Zillow Rent Index (ZRI) from Zillow.com. The index is available for 164 out of 241 college towns and only since 2012, which considerably reduces our sample dimension. More importantly, it misses the beginning of the accelerated international student influx that occurred during the housing bust. To improve on the reduced ability to capture time variation, we also use city-level rents from 5% ACS samples with 2005 and 2016 as initial and end years, respectively.

The remaining of the data is obtained from multiple sources and manually matched to the dataset of college towns. For a complete description of data sources and construction of variables, see Appendix (A). Selected descriptive statistics are displayed in Table (I).

4 Empirical strategy and results

A. Motivating empirical evidence

Is there evidence of distinctive house price behavior in college towns? We motivate our empirical analysis with a comparison between returns to housing in college towns and the national housing market. In Figure (III), we show the comparative growth in home prices from 2000 to 2016 between the U.S. (national average), college towns and those college towns with a high participation of international students in total enrollment.

When the housing bubble started to collapse around 2007, prices in college towns were more resilient than in the national market. Particularly for those towns with a high participation of international students in total enrollment, the drop in prices was slower and less dramatic. Although influenced by the common national downward trend, the "portfolio" of internationalized college towns excess return over the U.S. benchmark jumped from 0.5% to 10% from 2007 to 2016. Moreover, price trends pre-2006 indicate that college towns were experiencing a slower price increase during the run-up in house prices. This suggests that in the aggregate, returns to housing in college towns have not been secularly higher than the national average. We revisit this point in more detail in Section (5).

B. First-difference estimation

The main model we use to estimate the impact of international students on local housing markets employs the following first-difference specification:

$$\Delta \log \text{Price}_{k,t} = \beta \times \frac{\Delta IS_{k,t-1}}{\text{Total students}_{k,t-2}} + \alpha \Delta x_{k,t-1} + \gamma w_k + \theta_t + \Delta \varepsilon_{k,t} \tag{3}$$

where the main explanatory variable is the annual inflow of international students to college town k, $_{k,t-1}$, as a share of total students in the same city in the previous year. The ratio captures a very intuitive idea: an influx of 40 international students should be allowed to exert a greater impact in a city with 50 students compared to one with 50,000 students. The interpretation of β is also intuitive. It measures the impact on price changes of an annual inflow of international students equal to 1% of preexisting *total* students.

The dependent variable in (3) is the annual house price index measured by the novel census-tract FHFA HPI, aggregated to the college town level. We include a series of controls in the regression. Time-varying variables in $x_{k,t-1}$ contain personal income per capita, count-level unemployment rate, and local population. We also control for initial characteristics of each college town in w_k. These include weather and area, which broadly capture amenities and supply constraints, in addition to the share of local population with college degree and violent crime rate.

A potential concern with using $\frac{\Delta IS_{k,t-1}}{\text{Total students}_{k,t-2}}$ is that higher share values do not necessarily identify a greater international student influx if both international inflow and total enrollment are shrinking, with the latter decreasing at a faster rate. The enrollment growth plotted in Figure (I) shows that total enrollment has *increased* over time, but at a much lower rate than the inflow of foreign students. The aggregate international influx to college towns grew annually 7% from 2005-2015, compared to a 1.4% annual growth in total enrollment in the same period. Thus, the share of international inflows to total enrollment does not increase artificially. A more detailed analysis reveals that the majority of college towns experienced a disproportionately larger increase in the international influx with respect to total enrollment growth (see Figure (A.2) in the Appendix).

We use panel unit root tests robust to cross-sectional dependence to check the first-difference model specification. These procedures are detailed in Appendix (C). All dynamic variables are stationary in first differences, and although we report clustered standard errors throughout the paper, Driscoll and Kraay (1998) robust standard errors yield qualitatively indistinguishable results. Year dummies θ_t intend to capture aggregate trends in the housing sector and other time-varying common components that may induce cross-sectional correlation in prices across college towns.

The lagged structure of independent variables reflects measurement delays in the international student inflow variable and potential stickiness in house prices to economic drivers such as income (Lamont and Stein (1999)). Some degree of time adjustment of housing costs to demand determinants seems very reasonable in college towns. The demand of students for housing is highly cyclical, following the academic calendar with peak months prior to the beginning of each academic year when most new students arrive and move into rental properties. If we assume that house prices capture the discounted value of future rents (Campbell et al. (2009)), larger expected capital gains to housing from observing an increasing influx of international students in the upcoming academic year may take some time to reflect in prices for the following housing demand cycle.

As a final remark, one might be interested in the effect of a change in international enrollment relative to previous total enrollment, and not the actual influx size.[10] After all, if an international influx is offset by foreign students graduating so that enrollment remained constant, the increase in demand from additional students would be null. However, using changes in international enrollment as opposed to new enrollment introduces a number of issues to the estimation of β. First, imposing that new and exiting international students impact local housing markets to the same degree neglects changes in international students' countries of origin that modify local demographics and influence the degree to which they impact housing markets.[11] Second and relatedly, with the new student enrollment measure ΔIS_t, we allow market imperfections and frictions affect price

[10] That is, if we decompose total enrollment as $\text{Total}_{j,t} = \text{Domestic}_{j,t} + I_{j,t-1} + (I_{j,t} - I_{j,t-1})$, where the term in parenthesis measures the annual number of *added* international students.

[11] See Figure (A.6).

adjustments more broadly. For example, it is a common practice from student housing providers to offer annual lease contract renewals at discounted rates compared to market rates for new tenants.

Table (II) presents OLS estimates of model (3). An influx of international students equivalent to 1% of the city's student population is associated with an increase in home prices of 0.11%. Due to endogeneity concerns, we should not interpret this estimate causally. This motivates our IV strategy below.

C. Instrumental variable strategy

Our analysis of the the international student migration impact on housing markets is subject to several empirical challenges. Despite controlling for year trends and changes in economic conditions at the local level, the estimation of β in (3) by ordinary least squares may still suffer from endogeneity issues.

First, unobserved omitted variables could be driving both foreign student inflows and housing prices. Suppose, for example, that a college town becomes more attractive because of improved amenities or expectations of future economic growth. This causes demand for housing to increase as native nonstudents would immigrate into the city, leading to higher home prices, and also attracts more international students. In this case, OLS estimates of the international student share would be upward-biased.

Secondly, foreign-born student inflows could be endogenous if students self-select into college towns where housing costs are increasing more slowly. Now, the impact of international inflows on prices would be underestimated. This could be caused by persistent negative shocks to state appropriations associated with poor local economic conditions, and followed by universities compensating constrained budgets by expanding international enrollment.

In order to identify the causal effect of the international student enrollment boom on prices, we need to use variation in international student inflows that is plausibly exogenous to the evolution of house prices and rents in college towns. We make use of a modified version of the "immigrant enclave", or shift-share instrument introduced by Altonji and Card (1991) and widely used in the literature.

International students face a similar problem as domestic students when deciding to apply for college. Conditioned on the country they want to study, these students must select from a portfolio of alternatives to which institutions they should apply. They also have higher search costs than native counterparts, in part because obtaining detailed information about universities and college towns is difficult, but especially because many regionally important U.S. institutions are relatively unknown abroad. Without a national-level policy to recruit students from abroad, American universities need to compete for international applicants by investing in initiatives that reduce search frictions.[12]

In this context, universities that entered the international market earlier are more likely to have built stronger international outreach networks and popularized their "brand" abroad. Thus, institutions historically able to attract larger populations of international students might have a competitive edge over colleges starting internationalization more recently. Not surprisingly, 36 out of the 50 universities with the largest number of international students in 1996 were still in the top 50 destinations in 2015. If college towns with high shares of previous international student inflows into the U.S. are more likely to receive larger inflows in the future, historical international inflows into college towns can be used to predict future inflows.

We use this idea to motivate our national level shift-share instrument. The instrument is constructed according to each university's historical presence of total foreign students, as of 1996. It uses the total influx of international students in the U.S. in each year and the historical share of student migrants who moved into each city in 1996 to obtain the shift-share prediction of inflows by college town and year. Total student migration levels in the U.S. are translated into expected migration by city, according to the formula:

$$\widehat{\Delta IS_{k,t}} = \left(\frac{\Delta IS_{k,1996}}{\Delta IS_{US,1996}}\right) \Delta IS_{US,t} \tag{4}$$

where $\widehat{\Delta IS_{k,t}}$ is the predicted influx of international students into college town k and year t and $\Delta IS_{US,t}$ is the total influx of foreign students in the United States in year t. The term in parenthesis represents the share of influx of foreign students into city k in 1996.

By relying only on the aggregate inflow of international students, the national level instrument does not explore country of origin variation. Although we do not rule out that college towns with historically larger Chinese student populations might be more likely to attract higher future inflows of Chinese students, due to ethnic amenities and networks, the fast-changing composition of sending countries makes the country of origin version of (4) less attractive in our context compared to immigrant settlement patterns.[13]

We make two identifying assumptions. First, international student inflows in the base year 1996 are assumed not to be driven by omitted variables that will affect housing prices in the future. That is, we assume that foreign students in 1996 did not predict the future evolution of prices better than the local market participants. Second, we

[12] The fraction of institutions sponsoring international travels of staff with intent to recruit undergraduates from abroad increased from 31% in 2001 to 44% in 2016, according to surveys conducted by the American Council on Education.

[13] China accounted for less than 10% of the 1996 international inflow into the U.S. and now represents more than 35%.

assume that annual changes in *national* foreign student inflows are exogenous to the economic conditions in the destination college towns. We assess the plausibility of the first assumption in Section (5).

D. Instrumental variable results

The first stage of the 2SLS estimation is reported in Table (A.4) in the Appendix. We regress the potentially endogenous variable, the international students inflow over lagged total students, on the same set of controls from the OLS procedure in addition to the shift-share instrument. Following the recommendation from Andrews et al. (2018), we report the effective F-statistic of Montiel Olea and Pflueger (2013), accompanied by its critical values. The coefficient of the instrument is large and significant, indicating the strong predictive power of the national-level shift-share measure, and the effective F-statistic appropriate. We therefore consider $\widehat{\Delta IS_{kt-1}}$ to be a sufficiently strong instrument, and employ standard IV inference. Further, the plausibility test of the identifying assumption in the section above lends further credibility to our IV estimates.

The main results of this paper are contained in Table (II). Instrumenting the international student impact with the national shift-share instrument slightly decreases the magnitude of our estimate of β. This indicates the presence of an upward bias in the OLS estimates we found earlier, possibly caused by faster growing cities "attracting" more foreign students. Nonetheless, the small change induced by the instrument might be justified by limitations to the influx of international students (and students in general) to a college town. Contrary to immigrants who choose freely where they locate, international students only immigrate into a city if they are admitted to an American university.

At the mean, international students caused nominal housing price gains over 2005-2016 of \$2,500 ($1.5\%\widehat{\beta} \times \$155,000 = \$210$ annually, where 1.5% is the average international student share in the sample). With actual annual returns to housing of \$940 on average, nearly 20% of the 2005-2016 price appreciation was attributed to foreign students. In the last part of this section, we explore long-run effects of the international student boom on home prices and rents by employing a long-differences version of (3).

E. Long-differences estimation

In order to estimate the impact of international student migration on local rents, we implement the following long-differences model:

$$\Delta \ln \text{Rent}_{k,2016-t_0} = \beta \times \frac{\sum_{t=t_0-1}^{2015} \Delta IS_{k,t}}{\text{Total students}_{k,t_0-2}} + \alpha \Delta x_{k,2015-(t_0-1)} + \gamma w_k + \Delta \varepsilon_{k,2016-t_0} \quad (5)$$

which is defined similarly to (3), but instead of year changes it considers the total log return of rents from a base year t_0 to 2016. For Zillow.com data, $t_0 \equiv 2012$ and for Census rents, $t_0 \equiv 2005$. The variable of interest corresponds to the cumulative inflow of international students into college town k from (base year $-$ 1) to 2015. Total student enrollment, dynamic controls and initial city characteristics are defined analogously. We employ long-differences since rental data does not allow for sufficient year-over-year variation.

In Table (III), a cumulative influx of international students corresponding to 1% of total enrollment in 2011 causes the median rent per square foot to increase by 0.12% (column (2)). The model spanning 2005-2016 in column (4) estimates an increase in the gross rent of approximately half: 0.05%. The reasons for the difference in magnitude between both estimates are twofold. A model with rents from 2012 onward fails to capture the beginning of the international student boom and only considers established market effects from an accelerated international student influx underway since 2005. Second, rent returns with respect to 2012 instead of 2005 lower the base year used as reference: while rents and home prices peaked around 2005, in 2012 they were recovering from the housing boom and thereby at lower levels compared to 2005. With an average cumulative international inflow equal to 21% of previous total enrollment, international students caused rents to increase by 1% from 2005 (about $90 in annual rental costs).

Given the variation of estimates from dynamic controls and initial city characteristics across columns (1)-(4), we stress the robustness of our international student coefficients across distinct rent measures, sample sizes, and alternative datasets. For instance, the estimated effects of income, population and unemployment rate change considerably from column (2) to column (4). Population growth from 2011 to 2015 moves from being a strong predictor of rental returns between 2012 and 2016, to null explanatory power over rental appreciation from 2005 to 2015.

We also implement a long-differences version of equation (3). The results of long-difference home price regressions are consistent with findings from the main model. An increase of 1% in the cumulative inflow of international students amounting to 1% of total enrollment in 2003 lead to a 0.06% growth in log price returns in the last decade, implying average nominal price gains of $2,300.

These estimates showing a positive effect on prices and rents caused by an increase in the share of international students have important implications for students *and* nonstudents. While current homeowners directly benefit from increased housing equity, students who rent are negatively impacted by higher rents. Even if the effects of higher living costs on currently enrolled students is limited, future students may modify enrollment choices if desirable college options locate in increasingly unaffordable housing markets. Since many college towns are usually less costly than large

MSAs, the rise in housing costs we find affects particularly those locations at the lower end of the cost of living associated with attending college, impacting college affordability.

5 Additional checks

In this section, we perform a battery of tests to address potential issues with our empirical methodology. All the results validate our main conclusions of the international student boom effects on both prices and rents in college towns.

A. Testing the plausibility of the identifying assumption

One of the identifying assumptions we make is that international student inflows in the base year 1996 are not driven by omitted variables that will affect house prices in the future. While this exclusion restriction is not directly testable, we can test its plausibility by assessing the balance of the historical international share across potential cofounders (Goldsmith-Pinkham et al. (2018)). We explore the relationship between the share of international students coming to each college town of the total influx of international students into the U.S. in 1996, and local characteristics that may be correlated with the future evolution of house prices. This analysis is useful because it provides descriptive evidence of what channels could be problematic for the exclusion restriction.

The correlation of the historical share of international students for each college town, $\frac{\Delta IS_{k,1996}}{\Delta IS_{US,1996}}$, with city characteristics in the base year reflects the cross-sectional variation that our instrument uses. Finding a high correlation between the 1996 city-share of students from abroad and confounding factors might imply the presence of omitted variables. Table (IV) shows the relationship between 1996 city characteristics and the city share of international students influx into the U.S. in the same year. The R^2 is fairly low: we can explain only 9% of the variation in the historical international share with the set of covariates. While income and city area are statistically correlated with the share, suggesting that foreign students are concentrated in cities with higher income and fewer housing supply restrictions, the estimated coefficients are very small.

B. Pre-trends

Even with controls for common economic conditions and initial college town characteristics, local secular trends predating 2005 could result in persistent price behavior that continues into our analysis period. In this case, a potential concern is that we could attribute observable changes in home values to the influx of international students that in reality reflect long-term growth determinants.

From 1998 to 2004, only 9 out of 241 college towns experienced a drop in home values, and the average nominal price increase reached 35%, against a 43% appreciation at the national level. For the greater part of the housing bubble buildup, prices in college towns were below the national average. To rule out the possibility that college towns coincide with a "sample of winners", in Figure (A.1) we show that real price growth patterns prior to 2005 are negatively associated with price performance from 2005 to 2016. A simple standardized regression of the log price change in the 2005-2016 period on the price appreciation between 1998 and 2004 returns a correlation of $\widehat{\rho} = -0.35$, suggesting that local price trends from the housing bubble buildup did not predict a subsequent price movement in the same direction. This is consistent with low frequency mean reversion of house prices, an empirical regularity in housing markets (Glaeser et al. (2014)).

Additional evidence shows that the top decile of college towns experiencing the largest annual price increase during 2005-2016 did not differ systematically from the bottom 10% along several dimensions (Table (A.5)).

C. Further tests

In column (1) of Table (V), we run the first-differences specification using *native* student inflows instead of the international student measure to measure price impact. As previously argued, domestic enrollment has been increasing at a much slower rate than foreign-born enrollment. Moreover, for many college towns where international inflows grew faster, domestic enrollment was slightly lower than historical annualized growth rates. These facts are reflected on the non-significant coefficient of the impact on prices from an inflow of domestic students equal to 1% of previous total enrollment. They also align with the stylized facts and mechanisms we describe later in the paper.

Since domestic student inflows might also be endogenous, we generate alternative shift-share instruments to analyze how prices reacted to certain domestic student inflows. These subsets of overall domestic student enrollment allow us to derive instruments using variation in the state of residence and field major. We start with students' state of residence. There is a persistent relationship between students' home state and college choices, beyond obvious patterns of public universities receiving large in-state student contingents.[14] Since IPEDS only contains place of residence of first-time degree-seeking undergraduate students for 2-year intervals, we run a two-year differences version of (3) using OLS and 2SLS.[15]

We instrument the domestic undergraduate entry class using:

$$\widehat{\text{New domestic}}_{k,t} = \sum_j \frac{\text{New domestic}_{j,k,1998}}{\text{New domestic}_{j,1998}} \times \text{New domestic}_{j,US,t} \tag{6}$$

where $\frac{\text{New domestic}_{j,k,1998}}{\text{New domestic}_{k,1998}}$ is the share of new undergraduates from state j studying in college town k in 1998, and New domestic$_{j,US,t}$ gives student inflows from state j into all college towns at t. The large effective F-statistic in column (3) confirms the strong predictive power of past state of residence distributions. The non-significant IV estimate of domestic freshmen inflows on home prices aligns with the lack of effect of OLS estimates from aggregate native students inflows.

As an alternative to the state of residence instrument (6), we predict inflows of domestic degree-seeking students using $\sum_f \frac{\Delta\text{Domestic}_{f,k,2002}}{\Delta\text{Domestic}_{j,2002}} \times \Delta\text{Domestic}_{f,US,t}$, where ΔDomestic$_{f,k,2002}$ gives changes in 2002 domestic enrollment across six fields f.[16] Once again, the estimated effect of native inflows on home prices is non-significant. However, the effective F-statistic on this instrument indicates a poor correlation with the endogenous domestic inflow share, which makes the robust confidence interval $[-0.346, 0.352]$ more appropriate for inference. We conclude with another falsification test in column (6) that indicates that the international student boom from 2005 to 2015 did not explain past price appreciation from 1998 to 2004.

D. Alternative data and specifications

We now conduct additional tests to assess the robustness of our main specification. First, a potential concern is that second-order effects from population growth driven by large inflows of native nonstudents could increase the demand for rental and home units. As shown in Figure (IV), college towns that concentrated more international students experienced a small overall population growth. This implies that additional housing demand as a response to more international students is unlikely to play a significant role in college towns.

[14]That might be largely driven by geographic proximity. For example, 4% of 1998 freshmen from Mississippi were attending The University of Alabama in Tuscaloosa, AL. Almost two decades later, this fraction was 6%. Another example: 40% of 1998 freshmen from Hawaii lived in 15 college towns along the West Coast, again a similar fraction in 2016.

[15]Submission of place of residence was optional in odd-years.

[16]For more details on the construction of domestic student inflows, see the Appendix.

To conclude, we use city-level census income data as an alternative data to our county-level income per capita variable. Since college town income levels may differ from nearby places within the county, the BEA income variable is a noisy proxy for local income. Results are displayed in columns (1) and (2) of Table (A.6). The magnitude of the international student impact decreases slightly from the results using county-level income. Column (3) regresses log prices on the international student share without covariates. Column (4) drops year dummies, while in column (5) we add state-fixed effects to purge potential heterogeneity across states. Column (6) concludes by expanding the set of controls to include another natural amenity, the distance to coast or Great Lake, and new faculty hired, which intends to capture university-driven expansion. There is little variation in our main estimate across specifications.

In Table (A.7), we restrict the estimation of our main model to progressively shorter time periods. This goes beyond testing for the sensibility of our estimates to a certain timespan, as it also gives a clean assessment of international students' impact at different stages of the housing cycle. Column (1) starts by dropping 2015, column (2) excludes 2014 and 2015, and so on until column (8) where the estimation years are only 2006 and 2007. Strong effects concentrated in "bust-only" years imply that college towns receiving larger international student inflows relative to initial enrollment were better able to insulate their housing markets.

6 Student housing choice: Stylized facts

In this section, we document three empirical regularities of housing markets in college towns. These characteristics will motivate our additional empirical analysis in sequence.

Student housing tenure. To begin our analysis within college towns, we establish the first stylized fact with respect to student housing *tenure*, especially for international students. According to 5% ACS 5-year samples, foreign-born students are almost in totality renters, with as little as 3% owning single-family homes in 2016 (Table (VI)). Although domestic students also mainly live in rentals, some of them might find advantageous to acquire home equity throughout the duration of college, with nearly 20% owning single-family homes (SFHs) in 2005. Reliance on parental income and greater access to domestic credit likely account for these differences between foreign and U.S. students. It is clear that an accelerated influx of international students *directly* impacts local rental housing markets, and particularly the inventory availability of multi-family units, where over 90% of these students live.[17]

[17] About 24% of students in our sample lived in college dorms in 2000, which is the last census year with precise data for this type of group quarter. We only consider students living outside college dormitories.

Apartment rentals. The second stylized fact from student housing choice we document is a direct consequence of student preferences for dwelling type and tenure. Because students represent a significant share of local population (at least 10%) and most of them live in multi-family home (MFH) rentals, a large fraction of the housing stock in college towns should comprise multi-unit rentals. Accordingly, 40% of the housing stock of college towns is made up by renter-occupied multi-family units. To put this magnitude in perspective, the proportion of renter-occupied MFHs to the national housing stock was only 25% in 2016.

Students' location. A final empirical regularity we present relates to students' preferences for housing *location*. Students disproportionately locate near the university campus, with 70% of all students living within 2 miles from campus on average in college towns. Consistent with patterns of student tenure and location choices, the stock of renter-occupied MFHs is distributed unevenly within a college town: 60% of MFH rentals are also located within 2 miles from campus.

To show this last point more formally, we run a series of regressions of the form:

$$\text{Outcome}_{g,k} = \theta \times \ln \text{Dist. Campus}_{g,k} + \delta_k + \varepsilon_{g,k} \tag{7}$$

with the following outcomes: (1) share of student population, (2) homeownership, and (3) share of MFH rentals. We regress each outcome in a census block group g in college town k on the log distance in miles from the university campus to that block group and on a college town fixed effect. Census block groups cluster census blocks that contain between 600 and 3,000 people, and represent the smallest geographic area with these data available. We manually obtain all census block groups contained in each college town k, and calculate the distance from the centroid of these geographic units to campus.

Since we use the main office address listed at IPEDS to pinpoint the center of campus, distances within a city always refer to the same fixed locale. We construct two samples. One uses the 134 college towns from our full sample that contain only one university. In the other sample, we add the remaining college towns with more than one university, taking the city center as the main office address of the largest university. Regression results are shown in Table (VII).

We start with the relationship between the share of the population living on a block group made up by students and the distance from campus, given in column (1). The strong negative association confirms that students disproportionately locate near campus. Furthermore, homeownership increases as one moves away from the university area (column (2)), and the share of multi-family home rentals increases in the opposite direction. Consistent with the fact that students rent MFHs, areas with greater student density also concentrate MFH rentals.

Taken together, these three stylized facts imply that a randomly selected American college town displays a well-defined structure. Near the university campus, student housing dominates the landscape, with multi-family rentals and students massively occupying neighborhoods. As one moves away from this region, multi-family rentals and student populations become rare. Neighborhoods gradually become characterized by single-family homes and nonstudents.

7 Impact on rents

Given that the demand push of international students has increased faster from 2005 to 2015, it is no surprise that they exert a disproportional pressure on rents. In this section, we complement this explanation by showing that international student inflows are *different* from domestic student inflows. To do so, we start to delve into housing markets within college towns, motivated by the empirical regularities from the previous section. We first show that students and nonstudents segregate into distinct neighborhoods, and consume different housing. In effect, international students settle near campus, where most domestic students live. The two groups then compete for student apartment rentals.

Without domestic student flight and with a growing demand pressure, rents near campus increased faster during the housing bust, and continued to grow faster during the housing market recovery. We also show in this section that, perhaps surprisingly, foreign-born students pay *higher* rents for all housing types. Different from "traditional" immigrants, who tend to occupy low-quality units and pay lower rents than natives (Saiz (2003), Albert and Monras (2019)), students from abroad pay a premium over natives that might capture preferences for better housing quality or income effects. We present descriptive evidence of a large supply expansion of luxury apartment buildings in college towns, and show that the fraction of international students' personal funds to local income increased over 2005-2013, even during the 2007-2009 economic downturn.

A. Student segregation

Students not only live near campus in college towns, but they reside in different areas than nonstudents. We present Champaign-Urbana, IL in Figure (V) to provide a visual example of well-defined patterns of residential segregation based on college enrollment. These patterns are fairly consistent across American college towns, with 92% of them displaying at least moderate segregation (Figure (A.4)).

The main implication of student segregation, combined with the fact that students live in multi-family rentals near campus, is the existence of a segmented rental market in college towns. International students compete with domestic students for rentals in student "ghettos", and nonstudent homeowners are mainly affected through the mechanisms we explore in Section (8). As a result, construction of multi-family housing near campus is almost certainly new supply of *student* housing. This segmented market also justifies our empirical strategy of dividing international inflows by total *student* population.

The residential segregation dynamics of college towns has changed little with increasing international student inflows. Student segregation patterns were well-defined before international enrollment was expressive, and although the share of student population near campus increased slightly from 29% to 31% over 2000-2016, the change was mainly driven by increased enrollment, and not necessarily nonstudent population decline.[18] Thus, (native) students and nonstudents already segregated when the international student density was near zero.

Students may prefer to live near campus due to heavy reliance on public transportation, leveraged by multiple daily "commutes", and proximity to local student amenities, such as bars, restaurants, and college facilities. Intuitively, these preferences should not be weaker for internationals, which implies that they are at least as likely as native students to live near campus. Conversely, nonstudent *renters* have little incentive to pay a distance premium for nearby campus units or to occupy dwellings usually supplied to students.

Using our sample of college towns, a regression of log rents on distance predicts an increase of 0.04% in rents for a 1% decrease in the distance to campus. Rents per bedroom within 0.5 mile from campus come at a premium of 8% on average.[19] To verify whether rents also increase faster closer to campus, we run model (7) using change in rent per bedroom from 2005 to 2016 as an outcome. To do so, we convert block group boundaries based on 2000 census definitions to 2010 boundary definitions by determining the fraction of a 2000 block group land area allocated to its 2010 respective definition. Column (4) of Table (VII) shows that rents grew faster in units closer to campus.[20]

Increasingly larger inflows of international students accompanied by native student retention put a sizable pressure on rental units near campus. Before addressing how

[18]Our data shows no evidence of student outflows from the city center toward farther areas, and even of nonstudents within 2 miles from campus. An exception is within census block groups less than 0.5 mile away from campus. In these areas, nonstudent population declined by 8% from 2000 to 2016, and the share of student population jumped from 63% to 68%. This appears to be the area where single-family conversion was more pronounced.

[19]Earlier work by Lewis and Kapp (1994) identified rent gradients around campus in Provo and Logan, Utah.

[20]In unreported regressions, we confirm that rental growth within 2 miles from campus was caused by international students by using a long-differences specification.

housing investment and prices reacted, we conclude this section by taking a closer look at international students' income and student housing quality.

B. Quality of rentals

Although international students compete for the same housing stock with domestic students, they pay higher rents for all multi-family rental types (Table (VIII)), perhaps because they occupy better quality housing. International student rent premiums over domestic students reach as much as 20%, with larger rents per room concentrated in mid- and high-rises. Rents in these dwellings well above multi-family rentals below 20 units reflect the fact that many of these buildings are increasingly accompanied by luxury amenities and high-end finishes, features commonly observed in markets characterized by competition with product differentiation.[21]

We gather evidence on real estate investing that points to a large supply expansion in college towns of rental units of high quality. We manually retrieve data on projects completed from 2005 to 2017 (since student apartments are preleased one year in advance) from the largest student housing developers in the U.S. The data come from Securities and Exchange Commission (SEC) 10-K forms of real estate investment trusts (REIT), e.g. American Campus Communities, and from each company's online portfolio information when they do not file 10-K forms (e.g. Landmark Properties, CA Student Living etc). These projects are mid- and high-rise buildings located near campus, and include upscale, resort-style amenities. Each construction has on average 192 units.[22]

At least 159 luxury student apartment buildings were constructed in 63 of our college towns. These high-quality rental units expanded the supply of student housing by almost 100,000 beds, which accounts for 40% of *total* enrollment growth in those college towns over 2005-2015. Moreover, cities with larger shares of enrollment made up by international students received more high-quality multifamily rentals (Figure (A.5)). To causally connect these trends in student housing real estate investing to the international student boom, we would need to observe whether foreign students live in these apartment buildings. Without tenant-occupancy data, we use these construction patterns for two main reasons. First, to confirm a supply expansion toward high-quality rental units. Second, the completed projects validate a substantial increase of MFH units in proximity to campus.

[21]Similar to reported income, self-reported year of construction is prone to large measurement error, particularly for student renters. International students live in rental units one year newer on average than domestic students, but averages display large variability.

[22]This is an example from the 10-K form filled by American Campus Communities in 2015: "*Our communities contain modern housing units and are supported by a resident assistant system and other student-oriented programming, with many offering resort-style amenities.*"

More broadly, newly built units charging high rents might also affect rents of lower quality units. Conditioned on the imbalance and relative quality between new and old units (assuming excess demand in the short-run), new stock with superior quality could increase rents for existing rentals with lower quality level (Sweeney (1974)). It is also important to stress that except for Albany, NY, all college towns were not subject to rent controls, which to some extent leaves rent appreciation unconstrained.

International students may have preferences for better quality housing due to higher income than domestic students. Major supply- and demand-side factors that account for the recent patterns in international enrollment growth are related to the ability of foreign students to afford higher education abroad.[23] Particularly, declining state appropriation levels and thereby the need for alternative sources of funding create powerful incentives for U.S. universities to boost international enrollment (Bound et al. (2016)). These students face tuition rates three times higher than in-state students in public universities, and over 80% of undergraduates from abroad have as primary source of funding personal and family funds.[24]

Finally, because international students' savings are likely exogenous to local economic shocks in college towns, a change in the mix of students toward internationalization provides income inflows supportive of rents and construction even amid local economic distress, which affects nonstudents and potentially domestic students. We show in Figure (VI) how personal funds declared by international students compare to local income from 2005 to 2013. These funds represent a lower bound on country of origin resources, since international students are required to report income to at least cover the net cost of attendance. During the national housing collapse (2006-2012), students' funds relative to local income increased by over 8 percentage points. This provides suggestive evidence that inflows from abroad exerted income effects in college towns, as international students brought home savings to spend locally.

[23]Structural changes in China and other common factors in major sending countries considerably shifted the world supply of people qualified to pursue higher education. China currently accounts for almost a third of all international students in American universities, compared to a share of roughly 10% in 2005. China also corresponds to more than 20% of all students in OECD nations, while Asia as a whole represents more than half of the global supply. Main supply-side factors advocated to have expanded the number of competitive candidates from Asia, particularly from China, are consequence of the overall economic growth experienced in the region in the last decades, such as higher enrollment in secondary education and disposable income.

[24]Some examples of the tuition for in-state versus out-of-state students at public institutions in the 2014-15 academic year are: \$13,208 (in-state) versus \$42,394 (out-of-state) at the University of Virginia, \$13,486 vs. \$41,906 at the University of Michigan and \$12,972 vs. \$35,852 for the University of California-Berkeley. Thus, out-of-state tuition at many public institutions approach those of selective private institutions. Moreover, international students are not granted the same financing opportunities available to domestic students, such as student loans.

8 Impact on prices

In this section, we present two mechanisms that plausibly account for the effects of international student enrollment on home prices. First, the replacement of single-family homes with multi-family rentals in the neighborhoods students live, thereby increasing prices near campus. Second, the occurrence of price spillovers to other areas of college towns, once departing homeowners search for houses outside the university surroundings, exerting price pressure far from campus.

We start by showing multi-family housing construction patterns in college towns, and that this new supply concentrates near campus. Rather than using undeveloped land, we argue that most of the growth in the supply of multi-family rentals in areas near campus resulted from the conversion of land used by single-family homes into land cover consistent with multi-family houses. To finish, we find that international students induced SFH replacement and that college towns experienced within-price dynamics compatible with price spillovers from near campus to farther out.

A. The supply of multi-family rentals

The ratio of new MFHs built to new single-family homes in college towns is steadily rising at a faster rate than the national ratio (Figure (VII)), which is consistent with a supply expansion targeted at renters and thereby students. We refer to the ratio of multi-family units to single-family homes as *MFH impact*, and we use it to measure the strength of the rental market relative to the buyer's market. The national MFH impact of *new* inventory is roughly 1 MFH to 2 SFHs. For college towns, 4 multi-family homes are built for each 3 new SFHs. In 2016, college towns accounted for only 3% of the U.S. single-family housing stock, albeit concentrated 6% of all multi-family homes in the country.

Column (5) of Table (VII) presents evidence suggesting where new multi-family units tend to be built within college towns. We regress a stock version of the MFH impact over time, given by

$$\varDelta\text{MFH impact} = \left(\frac{\text{MFH rentals}_{2016}}{\text{owned SFH}_{2016}}\right) - \left(\frac{\text{MFH rentals}_{2000}}{\text{owned SFH}_{2000}}\right), \tag{8}$$

on the distance to campus. The estimate indicates that the closer to campus, the higher the increase in the MFH impact measure. That is, the number of MFH rentals relative to SFH homes increased faster near campus.

The change in the MFH impact is an important piece of evidence supporting our first mechanism. Before we test and confirm that land occupied by single-family homes near campus underwent conversion into multi-family housing, we rule out alternative explanations that could potentially drive the estimate in column (5). To build intuition, suppose there are 2 owner-occupied SFHs and 2 renter-occupied MFHs in a given block group in 2000 (thus MFH impact = 1). First, assume that undeveloped land is inexistent or fixed, and that no construction is possible. The first possibility is that a previously vacant multi-family rental becomes occupied. Under this scenario, MFH impact increases mechanically.

A simple test of this hypothesis is whether rental vacancy rates in a block group have decreased over time. For block groups within 2 miles from campus, the average rental vacancy rate remained almost unchanged from 2000 to 2016, slightly varying from 6.8% to 6.6%. Thus, since the proportion of the student population living in the 2-mile area stood at 70% in the same period, and the total student population increased on average, the supply of rental units nearby campus necessarily expanded via *new supply*. Part of this expansion was driven by new luxury student housing developments, as we discussed earlier.[25]

A second possibility in the example is to build one MFH dwelling on undeveloped land for residential use. In this case, the number of owned SFHs would remain constant, and the supply of MFH rentals expand. This is feasible if, first, there is available land in that block group and second, if it is possible to use it for residential housing. In a typical college town, more than half of the population living within 10 miles from campus reside in a 2-mile radius from the university. Areas near campus are not only densely populated by students, but densely populated relative to the entire college town. It seems plausible that the housing supply elasticity increases in the distance from campus, with the amount of developable land for residential use being concentrated in areas far from campus: a fact we confirm below.

A third possibility is described by our mechanism: one single-family home is replaced by one multi-family unit, because existing homeowners convert their homes into rentals or because student housing developers acquire and demolish SFHs, then construct multi-family rentals. With variation both in the number of MFH and SFH units, the MFH impact increases faster relative to an expansion of multi-unit rentals on the extensive margin.

[25] Even if higher demand for rental units implies vacancy rates lower than the structural vacancy level, new construction and conversion of SFHs would still arise as a result of higher rents (Rosen and Smith (1983)). Another possibility where supply is perfectly inelastic is that a previously occupied SFH could become vacant, implying a smaller owner-occupied housing stock. However, this possibility does not accommodate the increased demand for rental units in the area.

Since ΔMFH impact>0 occurs if MFH rentals are built on undeveloped land or by replacing single-family homes, our estimates in column (5) of Table (VII) are not informative of which process drives the expansion of rentals. Using land cover imagery data below, we show that most of the observed increase in the MFH impact came from the replacement of SFHs. We also show that international students caused the expansion of land occupied by multi-family rentals near campus.

B. Testing for the replacement of single-family homes

SFH replacement. With less available land near campus compared to farther out, a smaller housing supply elasticity implies that new construction in the city center is likely to partially replace existing housing units. The dwellings most likely to undergo conversion or demolition are owner-occupied SFHs. Thus, international student inflows push up rents and apartment rental construction, increasing density and home prices near campus.

We use high-definition satellite images describing land cover characteristics from the 2001 and 2011 USGS National Land Cover Datasets (NLCD) to determine land availability and use by construction type within college towns. These data provide very local units of observation based on imagery defined on 30×30 meters square cells. Older NLCD versions have been used by Burchfield et al. (2006) and Saiz (2010), and the newer versions we use still fit the description provided in their studies. We retrieve 1000-meter radii land cover characteristics based on each census block group centroid for all college towns. The 241 college towns in our sample have about 10,500 block groups.

For each grid area, we calculate the proportion of developed land according to land cover codes assigned by NLCD. We focus on low-developed areas, which contain less than 50% of the area covered by impervious surfaces, medium-developed areas, where developed land accounts for 50-79%, and high-developed areas, where developed land amounts to at least 80% of land cover. A proportion of 50% of constructed materials to vegetation essentially corresponds to single-family units in medium or large lots, and lawn grass. In contrast, proportions of 80% of impervious surfaces usually indicate areas where people work and reside in high numbers, with a large presence of multi-family housing units.

Several land use patterns are common across college towns. The share of land with any development intensity within 2 miles from campus (extensive margin) increased from 83% to 84% from 2001 to 2011. While it is not possible to observe whether the increase came from university expansion or private housing, this advance on undeveloped land was lower than the developed land growth within 2-5 miles farther out: from 68% to 71%.

In the 2-mile radius from campus, land occupied by single-family homes in medium or large lots, and lawn grass decreased from 40% to 38% over the decade, while the share of medium-highly developed land grew from 33% to 36%. Consistent with these satellite-generated data, census counts show that college towns had on average 3,015 owner-occupied SFHs within 2 miles from campus in 2000 and only 2,891 by 2012-2016. Thus, the growth in medium-highly developed land near campus partially occurred on undeveloped land, but it was mostly driven by the replacement of large lot-sized single-family homes with multi-family units.[26]

In Table (IX), we take a closer look at the relationship between growth of highly developed land and distance from campus, and inflows of international students. Column (1) in the table shows that the share of highly developed land increases in block groups closer to campus. In 2011, 11% of the land within 2 miles from campus was occupied by construction types consistent with multi-family housing. This implies a 40% larger fraction of highly developed land cover compared to areas farther than 2 miles. Results in (2) give a negative relationship between distance from campus and the growth of highly developed land in the 2-mile region. This relationship between distance from campus and high development growth becomes null in areas farther than 2 miles (column (3)), which indicates that beyond the threshold where most students live, there is no relationship between distance from campus and MFH new construction.

Columns (4) and (5) show long-differences style regressions similar to model (5) using collapsed growth rates of highly developed land nearby campus at the college town level. The outcome thus captures the 2001-2011 change in land occupied by multi-family rentals within 2 miles from campus. The IV estimate in column (5) confirms that college towns receiving larger cumulative inflows of international students relative to initial total enrollment saw faster replacement of land occupied with single-family homes and expansion of multi-family housing. This is an important causal result that substantiates our mechanism, underscoring the nature of residential investment following international student inflows. We conclude the table by showing that college towns that received more luxury apartment units also experienced higher densification near campus.

C. Price spillovers

City-wide price increase. A second possible mechanism through which international students impact home prices emerges as a consequence of the replacement of on-campus owned with rental units. "Displaced" nonstudent homeowners can substitute

[26] Although NLCD classifies medium developed land as occupied by "single-family homes", how much land assigned to this code resembles multi-family or single-family houses in unclear. Since MFH rentals increased from 3,747 to 3,976 nearby campus from 2000 to 2012-2016, it seems likely that a substantial portion of medium-developed land actually contained MFH units.

away on-campus living for housing in more distant areas. This in turn increases demand for far-from-campus housing, leading to spillovers to house prices in neighborhoods farther from campus.[27]

The process of price appreciation occurring nearby campus by SFH replacement leads to our second mechanism. As homeowners move out from nearby campus and relocate to other areas within the college town, the demand for homes in block groups farther from campus rises, pushing prices up. This dynamics corresponds to price spillovers from the central area of the college town (i.e. around the university campus), where prices appreciate faster and first, to more distant areas, where prices grow with some delay. In the main regressions in Section (4), we aggregated FHFA tract-level price indices to capture average college town prices. By using prices at the tract level as the outcome in a model similar to (7) for census tracts, we test whether the log HPI change from 2005 to 2016 increased faster closer to campus. An estimate of $\widehat{\theta} = -0.02(0.009)$, ($R^2 = 0.85$) confirms that tracts farther from campus saw slower price increments. Because most of our college towns contain few tracts, this regression is less informative than specifications using census block groups.

We conclude our analysis with the results in Table (X). For each college town, we group home prices pre-2005 and during 2005-2016 into four distance bins from campus: less than one mile, from one to three, three to five, and five to seven miles. In most college towns the closest census tract to the campus' tract is more than one mile away, so that we consider the distance set "less than a mile" to be the on campus housing market. We then regress log housing price changes in off-campus neighborhoods on lagged values of on-campus home price changes and own lagged prices for each subperiod. Overall, the estimates of past price changes near campus impact prices in other neighborhoods only in the second period.

9 Conclusion

We provide evidence that the international student boom initiated in 2005 increased rents and home prices in American college towns. We estimate the growth in housing costs attributed to foreign students attending 4-year universities using a shift-share instrument that exploits the historical distribution of these students across college towns. Our results

[27]Note that since we aggregate HPI values over all census tracts within a college town, our price variable captures average city-wide price movements over time. We use the average of all census tracts since various college towns have few or just one tract, and also to capture price effects in the entire college town for those areas with various tracts.

indicate that international students increased rents by 1% and home prices by 1.6% on average relative to the housing boom peak. Leveraging the within-city dynamics in college towns with a variety of empirical analyses, we find that students from abroad drove the expansion of land occupied by multi-family rentals near campus, which mainly occurred with the replacement of single-family homes.

College towns host one third of the U.S. 4-year college enrollment, and along with student housing have remained unexplored in the literature due to scarce data. We circumvent this limitation by assembling a comprehensive dataset and analyzing how exogenous temporary migration inflows impact local housing markets amid economic downturns. International students consume locally with home country savings instead of host country earnings, do not compete in local labor markets with natives, and were an important countercyclical demand push for rentals and residential investment in college towns during the housing collapse and recovery.

Our results show one new dimension of broader effects resulting from the shift toward internationalization in American universities. Larger international student inflows have provided the average homeowner with $2,500 in nominal value increase relative to the housing boom peak, but also raised the local cost of living. Most college towns rate among the most affordable places to attend high quality postsecondary institutions, especially for in-state students who pay discounted tuition. Higher cost of attendance associated with more expensive housing impacts both current and future students, by raising the cost of going to college.

References

Albert, Christoph and Joan Monras (2019) "Immigration and Spatial Equilibrium: The Role of Expenditures in the Country of Origin," *Mimeo.*

Albouy, David (2016) "What Are Cities Worth? Land Rents, Local Productivity, and the Total Value of Amenities," *The Review of Economics and Statistics*, Vol. 98, No. 3, pp. 477–487.

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*: University of Chicago Press, pp. 201–234.

Andrews, Isaiah (2018) "Valid Two-Step Identification-Robust Confidence Sets for GMM," *The Review of Economics and Statistics*, Vol. 100, No. 2, pp. 337–348.

Andrews, Isaiah, James Stock, and Liyang Sun (2018) "Weak Instruments in IV Regression: Theory and Practice," *Mimeo. Harvard University.*

Andrews, Michael (2018) "How Do Institutions of Higher Education Affect Local Invention? Evidence from the Establishment of U.S. Colleges," *Mimeo. Northwestern University.*

Avery, Christopher and Sarah Turner (2012) "Student Loans: Do College Students Borrow Too Much–Or Not Enough?" *Journal of Economic Perspectives*, Vol. 26, No. 1, pp. 165–92.

Basso, Gaetano and Giovanni Peri (2016) "Foreign Born College Students: How much could they contribute to the US economy?" *Working Paper, UC Davis.*

Bayer, Patrick, Robert McMillan, and Kim Rueben (2004) "An Equilibrium Model of Sorting in an Urban Housing Market," Working Paper 10865, National Bureau of Economic Research.

Black, Dan, Seth Sanders, and Lowell Taylor (2003) "Measurement of Higher Education in the Census and Current Population Survey," *Journal of the American Statistical Association*, Vol. 98, No. 463, pp. 545–554.

Bogin, Alexander N., William M. Doerner, and William D. Larson (2016a) "Local house price dynamics: New indices and stylized facts," *FHFA Staff Working Paper 16-01.*

——— (2016b) "Local House Price Growth Accelerations," *FHFA Staff Working Paper 16-02.*

——— (2016c) "Missing the Mark: House Price Index Accuracy and Mortgage Credit Modeling," *FHFA Staff Working Paper 16-04*.

Borjas, George J. (2004) "Do Foreign Students Crowd Out Native Students from Graduate Programs?" Working Paper 10349, National Bureau of Economic Research.

——— (2005) "The Labor-Market Impact of High-Skill Immigration," *American Economic Review*, Vol. 95, No. 2, pp. 56–60.

Bound, John, Breno Braga, Gaurav Khanna, and Sarah Turner (2016) "A Passage to America: University Funding and International Students," *NBER Working Paper No. 22981*.

Burchfield, Marcy, Henry G. Overman, Diego Puga, and Matthew A. Turner (2006) "Causes of Sprawl: A Portrait from Space," *The Quarterly Journal of Economics*, Vol. 121, No. 2, pp. 587–633.

Campbell, Sean D., Morris A. Davis, Joshua Gallin, and Robert F. Martin (2009) "What moves housing markets: A variance decomposition of the rent-price ratio," *Journal of Urban Economics*, Vol. 66, No. 2, pp. 90 – 102.

Card, David (2009) "How immigration affects US cities," *Making cities work: Prospects and policies for Urban America*, pp. 158–200.

Cutler, David M. and Edward L. Glaeser (1997) "Are Ghettos Good or Bad?," *The Quarterly Journal of Economics*, Vol. 112, No. 3, pp. 827–872.

Deming, David J., Claudia Goldin, Lawrence F. Katz, and Noam Yuchtman (2015) "Can Online Learning Bend the Higher Education Cost Curve?" *American Economic Review*, Vol. 105, No. 5, pp. 496–501.

Driscoll, John C. and Aart C. Kraay (1998) "Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data," *The Review of Economics and Statistics*, Vol. 80, No. 4, pp. 549–560.

Dustmann, Christian, Francesca Fabbri, and Ian Preston (2005) "The Impact of Immigration on the British Labour Market," *The Economic Journal*, Vol. 115, No. 507, pp. F324–F341.

Favilukis, Jack and Stijn Van Nieuwerburgh (2016) "Out-of-town Home Buyers and City Welfare," *Mimeo*.

Glaeser, Edward L., Joseph Gyourko, Eduardo Morales, and Charles G. Nathanson (2014) "Housing dynamics: An urban approach," *Journal of Urban Economics*, Vol. 81, pp. 45 – 56.

Goldsmith-Pinkham, Paul, Isaac Sorkin, and Henry Swift (2018) "Bartik Instruments: What, When, Why, and How," Working Paper 24408, National Bureau of Economic Research.

Gumprecht, Blake (2003) "The American College Town," *Geographical Review*, Vol. 93, No. 1, pp. 51–80.

Holly, Sean, M. Hashem Pesaran, and Takashi Yamagata (2010) "A spatio-temporal model of house prices in the USA," *Journal of Econometrics*, Vol. 158, No. 1, pp. 160 – 173.

Lamont, Owen and Jeremy C. Stein (1999) "Leverage and House-Price Dynamics in U.S. Cities," *RAND Journal of Economics*, Vol. 30, No. 3, pp. 498–514.

Lewis, W. Cris and Tim J. Kapp (1994) "The Rent-Distance Tradeoff for Student Housing: An Empirical Analysis," *Journal of Regional Analysis and Policy*, Vol. Volume 24, No. Issue 1, pp. 42. – 14.

Liu, Shimeng (2015) "Spillovers from universities: Evidence from the land-grant program," *Journal of Urban Economics*, Vol. 87, pp. 25 – 41.

Manson, Steven, Jonathan Schroeder, David Van Riper, and Steven Ruggles (2017) "IPUMS National Historical Geographic Information System: Version 12.0 [Database]," *Minneapolis: University of Minnesota.*

Mikhed, Vyacheslav and Petr Zemčík (2009) "Do house prices reflect fundamentals? Aggregate and panel data evidence," *Journal of Housing Economics*, Vol. 18, No. 2, pp. 140 – 149.

Montiel Olea, José Luis and Carolin Pflueger (2013) "A Robust Test for Weak Instruments," *Journal of Business & Economic Statistics*, Vol. 31, No. 3, pp. 358–369.

Moretti, Enrico (2004) "Estimating the social return to higher education: evidence from longitudinal and repeated cross-sectional data," *Journal of Econometrics*, Vol. 121, No. 1, pp. 175 – 212, Higher education (Annals issue).

Pesaran, M. H. (2004) "General Diagnostic Tests for Cross Section Dependence in Panels."

Pesaran, M. Hashem (2007) "A simple panel unit root test in the presence of cross-section dependence," *Journal of Applied Econometrics*, Vol. 22, No. 2, pp. 265–312.

Rosen, Kenneth T. and Lawrence B. Smith (1983) "The Price-Adjustment Process for Rental Housing and the Natural Vacancy Rate," *The American Economic Review*, Vol. 73, No. 4, pp. 779–786.

Rothstein, Jesse and Cecilia Elena Rouse (2011) "Constrained after college: Student loans and early-career occupational choices," *Journal of Public Economics*, Vol. 95, No. 1, pp. 149 – 163.

Ruggles, Steven, Katie Genadek, Ronald Goeken, Josiah Grover, and Matthew Sobek (2017) "Integrated Public Use Microdata Series: Version 7.0 [dataset]," *Minneapolis: University of Minnesota*.

Sá, Filipa (2014) "Immigration and House Prices in the UK," *The Economic Journal*, Vol. 125, No. 587, pp. 1393–1424.

Saiz, Albert (2003) "Room in the Kitchen for the Melting Pot: Immigration and Rental Prices," *The Review of Economics and Statistics*, Vol. 85, No. 3, pp. 502–521.

——— (2007) "Immigration and housing rents in American cities," *Journal of Urban Economics*, Vol. 61, No. 2, pp. 345 – 371.

——— (2010) "The Geographic Determinants of Housing Supply," *The Quarterly Journal of Economics*, Vol. 125, No. 3, pp. 1253–1296.

Saiz, Albert and Susan Wachter (2011) "Immigration and the Neighborhood," *American Economic Journal: Economic Policy*, Vol. 3, No. 2, pp. 169–88.

Shih, Kevin (2017) "Do International Students Crowd-Out or Cross-Subsidize Americans in Higher Education?" *Journal of Public Economics*.

Sweeney, James L. (1974) "Quality, Commodity Hierarchies, and Housing Markets," *Econometrica*, Vol. 42, No. 1, pp. 147–167.

Online Appendix

A Detailed data description

A.1 Main variables and sample selection

Students. The main source of student enrollment and university-related data used in this paper is the Integrated Postsecondary Education Data System (IPEDS) of the US Department of Education. We initially include all 4-year public, private not-for-profit and private for-profit higher education institutions in the U.S. mainland. The selection returns 3,097 universities with 2016 as the base year. For each one of these universities, we gather data on Fall enrollment of full-time degree seeking undergraduate, part-time degree seeking undergraduate, full time graduate and part-time graduate (graduate programs are degree-granting), both nonresident and total (domestic and international) students. The number of degrees awarded to international and total students and institutional characteristics complement the data retrieved from IPEDS.

We drop institutions with less than 500 students enrolled during Fall 2011 and without at least one international student in any year from 2001-2015. Variables of the resulting 1,370 universities are aggregated to the city level, using the place identifier provided by IPEDS. The city identifiers may not map onto Census Designated Place (CDP) nomenclatures, which requires that we homogenize IPEDS and Census names by hand to match data from different sources.

Population. Local population data for 19,506 incorporated places come from the "*Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2016*" and "*Intercensal Estimates of the Resident Population for Incorporated Places and Minor Civil Divisions: April 1, 2000 to July 1, 2010*" files from the U.S. Census Bureau. We combine both datasets and match city-level population to city-level student data. This results in 953 cities, of which 523 locations have at least 10% of local population made up by students, according to 2011-2015 population and total enrollment averages. Finally, we drop places with less than 100 international students enrolled during Fall 2015, further reducing the sample to 351 places.

Isolation. We then calculate the orthodromic distance using the Haversine formula between each city and the nearest MSA with more than 1 million residents. Only the locations no less than 30 miles away from the nearest large metropolitan area are selected to compose the final sample of 241 college towns.

Prices. The novel FHFA Annual House Price Index (HPI) is obtained at the census tract level and then averaged within each college town to correspond to local house prices. We use state-specific Census Block Assignment Files (BAFs) with 2000 and 2010 definitions that enable connecting census blocks to places. We manually convert blocks into tracts, where the latter supersedes the former as the geographic entity for matching FHFA prices and college towns.

Rents. Main data on rents is obtained from Zillow.com from 2012 onward. We use the Zillow Rent Index (ZRI) which is only available for 200 out of 241 college towns. Alternative rental data corresponds to city-level median gross rents from the 5 percent American Community Survey (ACS) samples 2005-2009 and 2011-2016, obtained from the National Historical Geographic Information System (NHGIS) (Manson et al. (2017)). We use the 2005-2009 sample as equivalent to 2005 and 2011-2016 as 2016 in the regressions with yearly variables. These data are available for all college towns in our sample.

Domestic inflows (instrument). Major-based domestic inflows use IPEDS two-year Fall enrollment figures for first-time degree-seeking undergraduate students in 6 broad majors: Education, Engineering, Biological Sciences/Life Sciences, Math, Physical Sciences, and Business Management and Administrative Services. State-of-residence domestic inflows are also constructed with IPEDS data on two-year Fall enrollment figures for first-time degree-seeking undergraduate students. For each university in our sample, we categorize students' state of residence when first-admitted. Aggregate inflows are sums across all majors in the first domestic inflow variable and states of residence in the second inflow variable.

A.2 Dynamic controls

Income. There are two alternative variables for income. From the main specification, county-level personal income per capita observations come from the Bureau of Economic Analysis (BEA). These data are not available down to the place level, hence we construct college town average income series combining 1 percent American Community Survey (ACS) and 5 percent U.S. Census samples from the Integrated Public Use Microdata Series (IPUMS) (Ruggles et al. (2017)). We use the MAPLE/Geocorr2k (up to 2011) and MAPLE/Geocorr14 (2012 onward) Geographic Correspondence Engines provided by the Missouri Census in order to determine which fraction of each public-use microdata area (PUMA) should be allocated to a corresponding college town. We then reweight individual total income observations using person weights interacted with the new allocation factor based on puma and college town populations prior to obtaining city averages, similarly to Albouy (2016). Since the IPUMS data is unavailable for 2004, we assume that college town personal income appreciated at the same rate as income per capita in the college town's county since 2000. The BEA county-level and IPUMS constructed college-town series have an average correlation of 0.68 between 2004 and 2015.

Unemployment. The unemployment rate used throughout the paper corresponds to annual average unemployment rates at county level from the Local Area Unemployment Statistics (LAUs), provided by the Bureau of Labor Statistics (BLS).

A.3 Initial characteristics

Crime. Rates per 100,000 population of violent crime, murder and nonnegligent manslaughter, legacy rape, robbery and aggravated assault are obtained from the FBI's database Uniform Crime Reporting Statistics (UCR). The reported crime data is available at the agency level and covers cities with more than 10,000 people. Whenever observations in 2004 are missing, we use the most recent year prior to 2004 of data available. If a certain city only shows statistics for after 2004, we adjust each series assuming that the state-level change from 2004 to the appropriate year is identical to the city-level growth of the statistic. For example, if data for Carbondale, IL only becomes available in 2010, we use the change in robbery in Illinois from 2004-2010 to project the robbery rate in Carbondale in 2004, given the observed value in 2010. We then use the variation of violent crime in the state in the same period to update Carbondale's 2010 violent crime rate and similarly to all other variables. For college towns with population smaller than 10,000, we combine multiple-year "*Offenses Known to Law Enforcement*" tables adopting the same methodology just described for variables missing in 2004. The violent crime variable encompasses the other offenses (murder, aggravated assault etc.). In 2013, FBI's definition of rape changed from including "forcible" in the offense definition to a broader description to characterize rape. Both revised and previous − denominated "legacy" − rape variables are available for more recent data. We use legacy rape statistics to maintain consistency with previous years.

Natural amenities. County-level Winter average temperature and hours of sunlight (January 1931-1970), and relative humidity during Summer (same period) variables are available at the United States Department of Agriculture (USDA) Economic Research Service (ERS) Natural Amenities Scale dataset. Data on land area (squared miles) is retrieved from the 2016 U.S. Gazetteer Files, from the U.S. Census Bureau. We calculate the distance from each college town to the closest coastal border or Great

Lake similarly to the computation of the distance to the nearest 1 million people MSA. Coastline limits are defined in the "*Coastline National Shapefile*" from the U.S. Census Bureau. Based on latitude and longitude information for each college town, we obtain the minimum distance in miles to the coastline (or Great Lake) using the Haversine formula.

Population with college degree. Given by the fraction of a college town's population with bachelor's degree or higher, for individuals of age at least 18. The city-level data is compiled from the 5% 2005-2009 ACS sample, available at IPUMS.

B Tracking international students in the US

In this Appendix segment, we demonstrate why US Census Bureau microdata is inappropriate to track international students with sufficient yearly variation. In reality, even cross-sectional variation for a given year would produce misleading data.

B.1 Aggregate student populations

In Table (A.8), we compare American Community Survey (ACS) 1% samples to official data provided by IPEDS.[28] For brevity, we focus on non-citizen and American individuals who reported being enrolled in college as undergraduate, graduate, and professional students in 2016. The ACS domestic student count in 2016 overestimates the official data by about 7%. This discrepancy could originate from measurement error in self-reported school enrollment, documented as "educational attainment error" in Black et al. (2003). Since the international student population count from ACS is 80% higher than the actual international enrollment, measurement error solely attributed to individual misreporting seems unlikely.

B.2 Countries of origin

Although IPEDS data lacks individual-level country of origin and where these students locate, there is widely available *national* data from the Institute of International Education (IIE) with annual shares of all countries of origin. These data correspond to administrative information and should accurately reflect countries. In Table (A.9), we

[28] We also report ACS 5% samples for comparison purposes.

select leading countries of origin using 1% samples of the ACS in the Integrated Public Use Microdata Series (IPUMS) for 2005 and 2016 and the IIE data, used the official comparison group. The ACS variable that more closely tracks international students is the indicator for “not a citizen enrolled in tertiary education”. The distribution of countries of origin shows striking differences from the comparison data. In 2005, the calculated share of Mexicans studying in the U.S. amounted to 14%, well above the actual 2.3% share. Chinese students, on the other hand, held nearly half of their true national participation. ACS 5% samples yield similar comparisons (see Table (A.10)).

Distortion in the representativeness of countries of origin may explain the acute overestimation from the ACS international student enrollment. International students born in a given country who disproportionately locate in larger metropolitan areas could be sampled more often than subgroups of students who locate in smaller cities such as our college towns. Second, and related, the definition for “non citizens” according to the Census Bureau is not equivalent to visa-holding international students accounted for in the IPEDS and IIE official data. If individuals counted as “non-citizen students” are more likely to live in larger areas, the discrepancy between the ACS and IPEDS data is likely to increase. Individuals mistakenly treated as international students would include, for example, DACA-eligible (Deferred Action for Childhood Arrivals) students. DACA-eligible students in college are estimated as more than 240,000.[29]

C Panel time series specification checks

Another dimension to the first-difference estimator in addition to controlling for unobserved individual-specific effects is to rule out the possibility of spurious regression. That is achieved if the dynamic variables in the panel are stationary in first-differences. We conduct a series of tests to check whether our data present unit roots.

We first test for cross-sectional dependence in the panel of the following form:

$$p_{k,t} = \alpha_k + \boldsymbol{\beta'}_k \boldsymbol{x}_{k,t-q} + u_{k,t} \tag{9}$$

where $p_{k,t}$ is the log housing price in college town k, $k = 1, ..., N$, in year $t = 2005, ..., 2016$, $\boldsymbol{x}_{k,t-q}$ includes the international student inflow share measure, unemployment rate, log population, and log income per capita, with lag $q \in [1, Q]$, and α_k is just a nuisance parameter. Cross-sectional heterogeneity is captured by allowing $\boldsymbol{\beta}_k$ to differ across cities. This is a much more flexible model than fixed effects estimation, for example, which

[29]For more details, see https://www.migrationpolicy.org/research/education-and-work-profiles-daca-population.

imposes homogeneity constraints on coefficients associated with time-varying regressors, $\boldsymbol{\beta}_k = \boldsymbol{\beta}$, for all k. It can also accommodate $\boldsymbol{x}_{k,t-q}$ with dynamic dependent variables, variables integrated of order 1, and $u_{k,t}$ correlated across k. We then proceed to test for the existence of unit roots.

Table (A.1) displays selected tests of cross-sectional dependence and panel unit root tests. Results in column (2) justify the use of unit root tests that do not assume cross-section independence. Average cross correlation coefficients in column (1) indicate strong correlation across college towns in some variables, specially in variable levels when compared to growth rates. As both income and unemployment data are at county level (in the main specification for income), a disproportional number of same-county college towns may influence testing in these two variables. Nonetheless, a much lower correlation in income growth suggests that the 19 counties with more than one college town do not pose systematic measurement error from less disaggregated variables. The relative coefficient magnitude found for price and income levels, generally aligns with findings in Holly et al. (2010) for US states. Overall, CD tests reject cross-sectional independence in all series and warrants for implementing a robust unit root procedure such as CIPS. In the same vein, year fixed effects could help in alleviating cross-sectional dependence originating from common time effects for inference purposes.

The unit root tests in column (3) confirm stationarity of all variables in first-differences, as well as for the international student share and unemployment rate in levels, except for log income and log population.[30] Although all variables are stationary in second-differences, we still employ first-differencing in our OLS and IV regressions to take advantage of more years of data. Also, over-differencing may introduce moving-average components in the series.

We conclude that the first-difference estimator is appropriate for inference with our data. Moreover, aligned with Mikhed and Zemčík (2009), we reject the presence of a unit root in log house prices, but fail to reject stationarity of log income, which trivially implies that both variables cannot be cointegrated. A final caveat is that the time series dimension (T) in the panel is "small" compared to the number of cross section unities (N). Given the importance of an appropriate time length for stationarity testing, our results should be accepted with caution. In any case, they provide additional support for employing first-difference estimation.

[30]Recall that the international student share is already first-differenced.

TABLE I

Descriptive Statistics of College Towns

	Average	Max.	Min.	Std. Dev.
International students influx$_{2015}$	475	3,342	0	277
International students influx$_{2005}$	229	1,615	0	289
Total students$_{2015}$	23,001	83,571	735	14,898
Total students$_{2005}$	18,961	60,089	741	12,494
Population$_{2015}$	50,801	285,281	1,764	48,816
Income per capita$_{2015}$ ($)	41,993	78,335	23,926	7,090
Mean January temperature (Fahrenheit)	33	66	4	13
Mean July relative humidity	58	80	19	14
Unemployment rate$_{2015}$ (%)	4.9	9.5	2.3	1.1
College town land area (square mile)	25	134	1	25
Home price$_{2016}$ ($)	165,586	1,052,720	41,224	102,645
Rent$_{2016}$ ($)	789	1575	505	170

Notes: There are 241 college towns selected for sample statistics. Reported sample mean and standard deviation values are population-weighted.

TABLE II

Impact of International Students on House Prices

Main Model

Δ Log price$_t$	OLS (1)	IV (2)
$\frac{\text{International students inflow}_{t-1}}{\text{Total students}_{t-2}}$	0.109	0.090
	(0.038)***	(0.033)***
		$[0.034, 0.154]^a$
Dynamic controls		
Δ Log income$_{t-1}$	0.302	0.301
	(0.056)***	(0.056)***
Δ Log population$_{t-1}$	0.175	0.175
	(0.098)*	(0.097)*
Δ Unemployment rate$_{t-1}$	−0.011	−0.011
	(0.002)***	(0.002)***
Initial characteristics		
Log college town area	0.002	0.002
	(0.001)**	(0.001)**
Log July humidity	−0.003	−0.003
	(0.003)	(0.003)
Log January temperature	−0.0001	−0.0001
	(0.002)	(0.002)
Log January sunlight	−0.0001	−0.0001
	(0.002)	(0.002)
Log crime rate per 100,000	−0.004	−0.004
	(0.001)***	(0.001)***
% College degree	0.002	0.004
	(0.010)	(0.010)
Year fixed effects	X	X
Observations (college towns $\times$ T)	2410	2410
R-squared	0.38	0.38

Notes: (1) displays OLS results of a model regressing log differences of home prices (FHFA annual index) on the international students share measure (the ratio of international students inflow in a year to total students in the previous year at college town k). Controls include dynamic price drivers and initial city characteristics. There are 241 college towns, defined as census places with at least 10% of local population made up by degree-seeking students enrolled in 4-year higher education institutions and no less than 30 miles away from a large MSA (1 million people). Standard errors in () are clustered at city level. (2) is estimated with the international student inflow $IS_{k,t}$ instrumented with the national shift-share variable $\widehat{IS_{k,t-1}}$. The national shift-share instrument uses the total influx of international students in the US each year and the share of new foreign students in each city in 1996, to predict the influx of students by city and year. [a]Denotes two-step weak-instruments-robust confidence set from Andrews (2018).

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

TABLE III
Impact of International Students
on Rents and Prices

	Δ Log rent (2012-2016)		Δ Log rent (2005-2016)		Δ Log price (2005-2016)	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)
$\frac{\text{International students inflow}}{\text{Total students}}$	0.141	0.121	0.060	0.051	0.078	0.065
	(0.071)**	(0.050)**	(0.024)***	(0.023)**	(0.027)***	(0.029)**
Δ Log income	0.430	0.427	0.132	0.130	0.781	0.778
	(0.128)***	(0.124)***	(0.074)*	(0.072)*	(0.175)***	(0.171)***
Δ Log population	0.946	0.944	0.042	0.042	0.192	0.193
	(0.266)***	(0.257)***	(0.076)	(0.074)	(0.081)**	(0.078)***
Δ Unemployment rate	−0.019	−0.019	−0.001	−0.002	−0.003	−0.003
	(0.005)***	(0.005)***	(0.005)	(0.005)	(0.009)	(0.009)
Log college town area	0.005	0.005	−0.007	−0.007	0.029	0.029
	(0.007)	(0.007)	(0.006)	(0.006)	(0.010)***	(0.010)***
Log July humidity	−0.015	−0.014	0.010	0.010	−0.025	−0.025
	(0.018)	(0.017)	(0.015)	(0.015)	(0.032)	(0.031)
Log January temperature	−0.006	−0.006	0.009	0.009	0.016	0.016
	(0.019)	(0.018)	(0.011)	(0.011)	(0.022)	(0.022)
Log January sunlight	0.006	0.006	−0.002	−0.002	−0.054	−0.055
	(0.027)	(0.026)	(0.02)	(0.019)	(0.032)*	(0.031)
Log crime rate per 100,000	0.003	0.003	−0.014	−0.014	−0.042	−0.042
	(0.008)	(0.008)	(0.008)*	(0.008)*	(0.013)***	(0.013)***
% College degree	0.010	0.014	0.012	0.016	0.109	0.118
	(0.089)	(0.085)	(0.059)	(0.06)	(0.109)	(0.106)
Observations (N)	164	164	241	241	241	241
R-squared	0.29	0.29	0.08	0.08	0.33	0.33

Notes: (1) and (2) are OLS and IV results, respectively, of a model regressing long differences of median ZRI Zillow.com rent per square foot on the cumulative international student inflow version of the international impact measure and the set of dynamic and initial characteristic controls. (3) and (4) implement the same model, but using census city-average rents as the outcome of interest. (5) and (6) regress the FHFA annual index price variable using long-differences.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE IV
Relationship Between Historical Share and Characteristics

	International students inflow$_{k,1996}$ / International students inflow$_{US,1996}$
Log income (1996)	0.00185 (0.001)***
Log population (1996)	−0.00005 (0.000)
Unemployment rate (1996)	−0.00001 (0.000)
Log college town area	0.00044 (0.000)***
Log July humidity	−0.00019 (0.000)
Log January temperature	−0.00022 (0.000)
Observations	241
R-squared	0.09
F	4.95
P	0.000

Notes: OLS results of a model regressing the historical share of international students (computed as the inflow of international students in 1996 to college town k divided by the national inflow in the same year) on the covariates: college town population growth, unemployment rate, log difference of personal income, and weather attributes. There are 241 college towns. Standard errors clustered at city level.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE V

FALSIFICATION TESTS

MAIN MODEL

	OLS (1)	OLS (2)	IV (3)	OLS (4)	IV (5)	OLS (6)
$\frac{\text{New domestic students}_{t-1}}{\text{Total students}_{t-2}}$	0.001	−0.032	0.021	0.001	−0.053	
	(0.001)	(0.043)	(0.055)	(0.013)	(0.080)	
$\frac{\text{International students inflow}_{t-1}}{\text{Total students}_{t-2}}$						0.056
						(0.132)
Effective F-statistic			120.35		4.77	
Confidence set[a]			$[-0.082, 0.123]$		$[-0.346, 0.352]$	
Full set of controls	X	X	X	X	X	X
Year fixed effects	X	X	X	X	X	
Observations						
(College towns $\times$ T)	2410	1205	1205	1205	1205	
(College towns)						241
R-squared	0.38	0.48	0.48	0.48	0.48	0.16

Notes: (1) reproduces the long-differences model regressing change in home prices on the cumulative *domestic* inflow relative to total enrollment instead of international inflow. (2) uses a two-year-differences version of our main empirical specification with domestic first-time degree-seeking undergraduate student inflows. (3) instruments these domestic inflows using the shift-share instrument in (6). The instrument predicts two-year domestic student inflows using historical patterns of state of residence. (4) uses a two-year-differences version of our main empirical specification with domestic first-time degree-seeking undergraduate student inflows in 6 broad majors. (5) instruments these domestic inflows using the shift-share instrument in (6). The instrument predicts two-year domestic student inflows using historical patterns of distribution in 6 majors. These majors are: Education, Engineering, Biological Sciences/Life Sciences, Math, Physical Sciences, and Business Management and Administrative Services. (6) implements a long-differences specification where we regress past price growth from 1998 to 2004 on the international student share variable and past controls. We report the Montiel Olea and Pflueger (2013) effective F-statistic (critical value at $\alpha = 0.05$ is ≈ 37). Standard errors in () are clustered at city level. [a]Denotes two-step weak-instruments-robust confidence set from Andrews (2018).
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE VI
Dwelling Occupancy in College Towns

	Renters		Share of renters in MFH		SFH owners	
	2005	2016	2005	2016	2005	2016
International students[‡]	91.3%	94.6%	94.6%	92.5%	5.1%	3.1%
Native students	75.3%	79.3%	80.7%	78.5%	19.3%	17.1%
Non-students	34.3%	38.0%	65.4%	64.6%	55.7%	53.0%

Notes: [‡]Only undergraduate, graduate and professional students non-American citizens. Observations weighted by city-adjusted person weights from the Integrated Public-Use Microdata Series (IPUMS) for each correspondent year. Weights are adjusted according to the procedure described in Appendix (A).

TABLE VII

RELATIONSHIP BETWEEN DISTANCE FROM CAMPUS AND OUTCOMES

	% Student population (1)	Home ownership (2)	% MFH rentals (3)	Δ Rent per BR (4)	Δ MFH impact (5)
Monocentric college towns					
ln Dist. from campus	−0.206	0.163	−0.052	−0.016	−0.423
	(0.009)***	(0.008)***	(0.008)***	(0.007)***	(0.202)**
College town FE	X	X	X	X	X
R-squared	0.58	0.29	0.18	0.14	0.04
Observations (Block groups × college towns)	2958	2921	2759	2642	3082
All college towns					
ln Dist. from campus	−0.194	0.163	−0.145	−0.020	−0.660
	(0.007)***	(0.007)***	(0.007)***	(0.004)***	(0.280)**
College town FE	X	X	X	X	X
R-squared	0.53	0.26	0.25	0.12	0.02
Observations (Block groups × college towns)	8509	8440	8439	9287	8807

Notes: Each column shows regressions of the form $\text{Outcome}_{g,k} = \theta \times \ln \text{Dist. Campus}_{g,k} + \delta_k + \varepsilon_{g,k}$. Standard errors in parentheses are clustered at the college-town level. In specification (1), we regress the share of each block group's population in 2016 composed of college, graduate or professional students on the log distance in miles from that block group to the university's main office address. In (2), the outcome is the number of owner-occupied dwellings in 2016 divided by total dwellings. In (3), the share is with respect to multi-family rentals. Outcome (4) tracks log changes of rents from 2000 to 2016. We calculate the rent per number of bedroom by dividing the midpoint of the average gross rent paid by the number of bedrooms in that unit. In (5) we regress the constructed MFH impact given in (8) on the same distance variable. Data is compiled from the National Historical Geographic Information System (NHGIS). Monocentric college towns showed on the first panel are those with only one university in our sample. The second panel includes all 241 college towns, including those with more than one university. In such cases, we take the distance of each census block group to the main office address of the largest university in the college town.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

TABLE VIII
HOUSING COSTS IN COLLEGE TOWNS

Rent per room	International students		Domestic students		Non-students	
	2005	2016	2005	2016	2005	2016
SFH	197.5	239.4	170.5	196.9	142.2	165.8
1-family home, attached	208.0	256.7	181.2	225.3	176.5	209.4
2 units	187.7	238.8	188.0	221.5	161.0	198.4
$3-4$ units	226.8	261.4	196.7	236.2	175.4	216.2
$5-9$ units	210.0	290.2	205.8	263.5	181.4	227.3
$10-19$ units	234.9	298.4	215.0	266.4	196.9	252.2
$20-49$ units	276.3	351.6	235.9	297.8	228.3	305.8
> 50 units	288.5	407.6	257.6	360.1	249.0	346.2

Notes: Only undergraduate, graduate and professional students non-American citizens. Observations weighted by city-adjusted person weights from the Integrated Public-Use Microdata Series (IPUMS) for each correspondent year. Weights are adjusted according to the procedure described in Appendix (A).

TABLE IX
Residential Densification in College Towns

	% Highly developed land	Δ Highly developed land				
	< 2 miles	< 2 miles	> 2 miles	< 2 miles OLS	< 2 miles IV	< 2 miles
	(1)	(2)	(3)	(4)	(5)	(6)
Log dist. from campus	−0.034	−0.002	−0.0004			
	(0.004)***	(0.0004)***	(0.001)			
$\frac{\text{International students inflow}}{\text{Total students}}$				0.545	1.113	
				(0.250)**	(0.423)***	
Log luxury rental units						0.092
						(0.026)***
Full set of controls				X	X	X
College town FE	X	X	X			
R-squared	0.45	0.37	0.21	0.35	0.33	0.61
Effective F-statistic					72.81	
Observations	4211	4211	3783	235	235	62
(Block groups × college towns)	X	X	X			
(College towns)				X	X	X

Notes: (1) regresses the combined share of highly developed land in all block groups within 2 miles from campus on the log distance of that block group to campus and a college town fixed-effect. (2) regress the change in the share of highly developed land within 2 miles from campus on the log distance of that block group to campus and a college town fixed-effect. (3) is similar to (2), but with data using census block groups farther than 2 miles from campus. (4) is a long differences model regressing the change in the combined share of highly developed land from 2001 to 2011 of all census blocks within 2 miles from campus at the college town level on the cumulative international student inflow variable and the full set of dynamic and initial characteristic controls. (5) implements the same model using the instrumental variable as described in the main text. We report the Montiel Olea and Pflueger (2013) effective F-statistic (critical value at $\alpha = 0.05$ is ≈ 37). (6) shows a regression of the change in highly developed land on the log number of luxury rental units, in addition to the full set of controls. Values in () are standard errors clustered at the college town level.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE X

Price Spillovers in College Towns

	Δ lnPrice$_t$					
	1-3m from campus		3-5m from campus		5-7m from campus	
	1998-2004 (1)	2005-2016 (2)	1998-2004 (3)	2005-2016 (4)	1998-2004 (5)	2005-2016 (6)
Δ lnPrice$_{t-1}$						
< 1 mile from campus	0.104	0.258	−0.009	0.300	0.001	0.300
	(0.051)**	(0.089)***	(0.062)	(0.083)***	(0.062)	(0.138)***
1-3 miles from campus	−0.454	−0.062				
	(0.065)***	(0.087)				
3-5 miles from campus			−0.410	−0.307		
			(0.044)***	(0.155)*		
5-7 miles from campus					−0.294	−0.170
					(0.108)***	(0.136)
Year FE	*X*	*X*	*X*	*X*	*X*	*X*
College town FE	*X*	*X*	*X*	*X*	*X*	*X*
R-squared	0.51	0.25	0.34	0.28	0.55	0.33
Observations	368	871	325	776	213	510
(College towns)	74	74	65	65	43	43

Notes: (1) regresses annual log home price changes in census tracts within 1-3 miles from the university campus in the 1998-2004 period on its lagged value and lagged log home prices changes in tracts within 1 mile from campus. (2) runs the same regression for the 2005-2016 period. (3) regresses annual log home price changes in census tracts within 3-5 miles from the university campus in the 1998-2004 period on its lagged value and lagged log home prices changes in tracts within 1 mile from campus. (4) runs the same regression for the 2005-2016 period. (5) regresses annual log home price changes in census tracts within 5-7 miles from the university campus in the 1998-2004 period on its lagged value and lagged log home prices changes in tracts within 1 mile from campus. (6) runs the same regression for the 2005-2016 period. We keep college towns with consistent price observations for all tracts used between 1998 and 2016. For each distance bin, we take simple averages of FHFA Home Price Indices. Values in () are standard errors clustered at the college town level.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

TABLE A.1

PANEL CROSS-SECTIONAL DEPENDENCE AND UNIT ROOT TESTS

VARIABLE†	AVERAGE CROSS CORRELATION (1)	Pesaran (2004) CROSS-SECTIONAL TEST (2)	Pesaran (2007) UNIT ROOT TEST‡ (3)
Price	0.294	166.04***	−2.720***
Income	0.928	523.35***	−1.415
Population	0.337	190.03***	−1.621
ΔPrice	0.465	250.04***	−2.726***
ΔIncome	0.514	276.33***	−1.769
Δ Population	0.025	14.17***	−1.680
Unemployment	0.882	497.44***	−1.866***
Int'l Students Share	0.146	82.49***	−2.278***

Notes: (1) Reports average cross correlation coefficients $\widehat{\rho_{k,j}}$, where k and j are college towns, and $k \neq j$, for cross-sectional dependence in panels, given by $[2/N(N-1)]\sum_{k=1}^{N-1}\sum_{j=k+1}^{N}\widehat{\rho_{k,j}}$. (2) The null hypothesis is nonexistence of cross-sectional dependence. Values reported are the CD statistic $[2/N(N-1)]^{1/2}[\sum_{k=1}^{N-1}\sum_{j=k+1}^{N}(T_{k,j})^{1/2}\widehat{\rho_{k,j}}]$, which follows the standardized normal distribution under the null. (3) Panel unit root proposed by Pesaran (2007) that is robust under cross-sectional dependence. The values displayed in the table are CIPS test statistics, $N^{-1}\sum_{k=1}^{N}\widetilde{t_k}(N,T)$, where $\widetilde{t_k}(N,T)$ is the cross-sectional ADF statistic for the k-th college town. The null hypothesis is non-stationarity.
†Price, Income and Population and respective first-differences are log variables.
‡Test specifications for Price, Income, ΔPrice, and ΔIncome include an intercept and a linear trend. The other variables are tested under the existence of an intercept.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE A.2

Distribution of 4-Year Universities: College Towns and U.S.

	College Towns		National	
	Count	%	Count	%
4-year public	126	39%	567	42%
4-year private, not-for-profit	188	58%	759	56%
4-year private, for-profit	10	3%	27	2%
Land-grant	10	3%	63	5%

Notes: There are 324 4-year universities in 241 college towns. and 1,353 4-year institutions in the U.S.

TABLE A.3
List of College Towns

	College town†	Students (2015)	Inter. students (2015)	Population (2016)	Income per capita (2016 $)	Avg. home value (2016 $)‡	Dist. nearest large MSA (miles)*	Number of universities
1	Ada, OH	2,953	122	5,607	31,940	137,426	71	1
2	Aiken, SC	3,152	125	30,937	39,030	121,116	128	1
3	Akron, OH	21,248	1,294	197,633	46,382	87,811	30	4
4	Albany, NY	19,270	1,608	98,111	56,948	165,624	85	8
5	Ames, IA	35,200	3,860	66,191	38,469	165,753	205	1
6	Angola, IN	1,978	324	8,591	38,033	128,246	97	1
7	Ann Arbor, MI	43,459	6,193	120,782	52,814	285,648	35	2
8	Arcata, CA	8,758	114	17,974	43,573	291,350	209	1
9	Ashland, OH	5,179	222	20,489	34,985	120,891	54	1
10	Ashland, OR	4,983	129	21,639	41,852	269,805	230	1
11	Athens, OH	28,979	1,670	25,341	32,183	113,281	65	1
12	Auburn, AL	27,052	1,408	63,118	34,372	136,721	99	1
13	Baton Rouge, LA	30,272	1,604	227,715	45,248	176,467	72	7
14	Beaumont, TX	14,758	1,287	118,299	41,813	116,644	77	1
15	Bellevue, NE	9,589	482	53,505	45,934	157,165	159	2
16	Bellingham, WA	15,266	155	87,574	44,273	374,846	80	3
17	Belton, TX	3,850	357	20,873	41,380	116,220	57	1
18	Berrien Springs, MI	3,146	637	1,752	44,007	138,783	67	1
19	Bethlehem, PA	9,228	1,230	75,293	48,834	171,894	48	3
20	Big Rapids, MI	13,938	485	10,437	30,441	111,595	52	1
21	Blacksburg, VA	32,606	3,517	45,038	33,650	157,456	141	2
22	Bloomington, IN	42,844	6,201	84,465	37,076	191,726	46	1
23	Boca Raton, FL	31,784	1,484	96,114	71,946	681,073	41	4
24	Boone, NC	17,768	103	18,834	34,069	147,867	82	1
25	Bowling Green, KY	17,872	1,232	65,234	36,505	139,023	59	2
26	Bowling Green, OH	16,474	727	31,588	44,029	131,203	73	1
27	Bozeman, MT	15,091	587	45,250	47,959	340,317	343	2
28	Bradenton, FL	9,014	170	55,687	44,158	200,658	33	1
29	Brookings, SD	11,407	761	23,895	43,111	120,347	179	1
30	Burlington, VT	15,778	586	42,260	56,501	309,520	184	2
31	Campbellsville, KY	2,529	237	11,387	33,504	89,735	67	1
32	Canyon, TX	9,477	281	15,138	45,294	167,942	250	1
33	Cape Girardeau, MO	10,498	987	39,628	41,245	121,881	98	2
34	Carbondale, IL	17,119	1,451	26,179	34,125	83,705	82	1
35	Carlisle, PA	2,381	227	19,162	51,384	140,244	70	2
36	Carrollton, GA	12,390	117	26,562	34,723	131,279	42	1
37	Cedar City, UT	6,823	337	31,223	27,068	185,436	154	1
38	Cedar Falls, IA	11,746	531	41,390	40,837	129,534	175	2
39	Champaign-Urbana, IL	44,644	9,975	128,651	42,829	138,435	115	1
40	Charleston, IL	8,381	289	21,133	36,374	88,221	109	1
41	Charleston, SC	21,091	196	134,385	53,272	273,008	174	6
42	Charlottesville, VA	22,935	1,915	46,912	60,964	331,068	67	1
43	Cheney, WA	11,822	428	12,237	42,028	240,752	222	1
44	Chico, CA	16,996	667	91,567	41,725	241,703	83	1
45	Clemson, SC	22,422	1,514	16,058	34,835	154,748	111	1
46	Cleveland, TN	4,632	326	44,271	37,941	128,784	103	2
47	Clinton, NY	1,861	108	1,878	40,236	153,917	113	1
48	Cocoa, FL	12,266	106	18,102	41,685	154,730	39	1
49	College Station, TX	63,561	5,269	112,141	34,776	202,262	80	1
50	Collegedale, TN	2,989	138	11,437	48,053	189,753	98	1
51	Columbia, MO	49,334	2,635	120,612	43,292	178,573	117	3
52	Columbia, SC	34,419	1,406	134,309	42,245	176,754	83	10
53	Conway, AR	12,521	512	65,300	35,159	132,540	137	3
54	Conway, SC	9,937	125	22,761	33,820	133,566	136	1
55	Cookeville, TN	10,574	825	32,622	37,218	132,409	71	1
56	Corvallis, OR	28,620	2,849	57,110	42,245	288,374	72	1
57	Dalton, GA	4,794	125	34,077	36,068	123,514	78	1
58	Dayton, OH	27,529	3,471	140,489	43,051	66,979	50	4
59	Daytona Beach, FL	35,746	1,567	66,645	38,807	172,907	49	4
60	Decorah, IA	2,286	144	7,918	44,138	140,361	138	1
61	DeLand, FL	4,288	182	31,569	38,807	147,917	34	1
62	Denton, TX	51,900	2,756	133,808	51,332	208,053	36	2
63	Dover, DE	16,137	303	37,786	38,498	159,136	58	3
64	Duluth, MN	14,239	370	86,293	43,126	121,061	136	3
65	Durant, OK	3,616	116	17,583	31,902	71,247	87	1

66	East Lansing, MI	50,248	7,344	48,870	37,952	170,772	62	2
67	East Stroudsburg, PA	6,766	103	10,189	39,104	154,002	64	1
68	Eau Claire, WI	10,419	168	68,339	43,543	146,557	88	2
69	Edinburg, TX	28,510	966	87,650	24,805	62,056	216	2
70	Ellensburg, WA	10,982	342	19,786	40,161	229,635	93	1
71	Elon, NC	6,631	117	10,147	36,246	125,061	54	1
72	Emporia, KS	5,960	497	24,816	34,653	65,194	99	1
73	Ephraim, UT	3,470	106	7,072	25,798	186,778	98	1
74	Erie, PA	11,011	1,395	98,593	40,764	86,423	81	4
75	Eugene, OR	23,714	3,274	166,575	41,027	253,146	104	3
76	Evansville, IN	11,148	470	119,477	42,024	96,808	98	2
77	Fairfield, IA	1,521	1,114	10,206	39,956	102,799	190	1
78	Fargo, ND	14,198	988	120,762	53,662	190,187	215	2
79	Fayetteville, AR	26,410	1,372	83,826	36,776	169,957	193	1
80	Flagstaff, AZ	28,898	1,220	71,459	42,057	255,817	123	2
81	Flint, MI	10,070	812	97,386	37,675	41,224	58	3
82	Fort Myers, FL	25,509	506	77,146	45,768	204,733	100	4
83	Fort Pierce, FL	14,403	196	45,295	36,196	152,447	100	1
84	Fredonia, NY	4,802	140	10,639	36,577	98,396	39	1
85	Frostburg, MD	5,645	121	8,676	38,372	109,815	79	1
86	Fulton, MO	3,079	151	13,103	35,473	137,803	96	2
87	Gaffney, SC	3,029	119	12,920	30,026	82,623	47	1
88	Gainesville, FL	62,910	4,862	131,591	41,008	125,147	61	6
89	Geneva, NY	2,264	134	12,988	49,477	150,413	38	1
90	Gettysburg, PA	2,442	131	7,700	45,853	197,054	50	2
91	Grambling, LA	4,537	161	5,217	36,585	98,469	237	1
92	Grand Forks, ND	14,183	737	57,339	48,566	156,138	272	1
93	Greeley, CO	11,701	261	103,990	42,701	240,125	48	1
94	Greencastle, IN	2,229	176	10,508	34,742	106,854	38	1
95	Greensboro, NC	30,763	936	287,027	43,556	167,618	70	5
96	Greenville, NC	26,947	193	91,495	37,943	109,900	72	1
97	Greenwood, SC	2,648	104	23,320	34,478	110,314	103	1
98	Grinnell, IA	1,663	258	9,151	43,876	147,484	207	1
99	Hammond, LA	12,051	226	20,609	35,833	134,848	45	1
100	Harrisonburg, VA	22,596	493	53,078	36,021	204,582	100	2
101	Hattiesburg, MS	18,232	454	46,926	35,451	127,946	104	2
102	Houghton, MI	7,144	1,159	7,987	33,957	89,740	269	1
103	Huntingdon, PA	1,483	118	6,990	37,077	130,552	105	1
104	Huntington, WV	12,883	521	48,113	38,676	102,047	111	1
105	Huntsville, TX	20,031	359	41,208	25,719	102,378	66	1
106	Iowa City, IA	29,457	3,719	74,398	47,456	222,068	202	1
107	Ithaca, NY	28,540	4,718	30,756	40,763	222,705	75	2
108	Jacksonville, AL	7,556	209	12,657	34,401	108,355	63	1
109	Johnson City, TN	13,902	510	66,677	39,909	148,024	115	2
110	Jonesboro, AR	12,727	755	74,889	35,378	97,568	58	1
111	Joplin, MO	5,931	160	52,195	36,598	113,611	140	2
112	Kalamazoo, MI	23,141	1,627	75,984	44,729	122,160	48	2
113	Kearney, NE	6,458	248	33,520	48,026	119,781	263	1
114	Keene, TX	735	101	6,293	38,247	143,646	40	1
115	Kirksville, MO	9,002	463	17,519	30,177	88,563	131	2
116	Knoxville, TN	28,801	1,210	186,239	46,305	134,339	156	6
117	La Crosse, WI	12,984	210	52,109	45,731	153,663	129	2
118	Lafayette, LA	16,729	622	127,626	47,591	196,490	119	1
119	Lake Charles, LA	7,278	544	76,848	44,743	135,907	133	1
120	Lake Worth, FL	26,351	505	37,812	71,946	209,406	58	1
121	Laramie, WY	12,445	817	32,382	38,898	191,822	114	1
122	Las Cruces, NM	14,851	1,151	101,759	32,852	119,472	317	2
123	Las Vegas, NM	3,394	205	13,285	33,062	154,144	286	1
124	Lawrence, KS	26,798	2,278	95,358	39,440	187,548	38	2
125	Lewisburg, PA	3,578	202	5,699	36,251	179,222	115	1
126	Logan, UT	25,628	753	50,676	33,896	190,643	68	2
127	Lubbock, TX	42,421	3,115	252,506	38,757	115,485	282	3
128	Lynchburg, VA	83,571	1,470	80,212	35,818	152,716	97	4
129	Macomb, IL	11,094	505	18,352	34,587	82,167	130	1
130	Madison, SD	2,221	108	7,425	53,278	116,829	201	1
131	Madison, WI	54,877	5,247	252,551	55,232	233,364	77	8
132	Magnolia, AR	3,831	651	11,601	33,634	80,738	210	1
133	Manchester, NH	61,609	1,212	110,506	56,531	180,807	48	5
134	Manhattan, KS	23,730	1,876	54,983	39,592	136,996	109	2
135	Mankato, MN	14,303	1,006	41,720	41,663	143,072	66	2
136	Marietta, OH	1,300	167	13,650	39,140	101,395	90	1
137	Marquette, MI	8,074	112	20,570	38,387	153,421	244	1
138	Marshall, MN	2,708	185	13,664	44,580	114,031	129	1

139	Marshall, MO	1,405	224	12,897	37,880	91,141	74	1
140	Marshall, TX	2,411	129	23,561	41,146	124,596	143	2
141	Martin, TN	6,380	172	10,768	33,491	99,833	106	1
142	Maryville, MO	6,263	767	11,846	30,591	84,616	87	1
143	Mechanicsburg, PA	3,206	112	9,007	51,384	204,226	67	1
144	Menomonie, WI	9,367	280	16,464	36,411	148,500	67	1
145	Middletown, PA	4,552	486	9,229	47,864	156,531	63	1
146	Missoula, MT	12,442	355	72,364	44,134	266,589	394	1
147	Monmouth, OR	5,418	324	10,174	37,818	260,282	54	1
148	Monroe, LA	7,279	267	49,297	38,217	127,570	214	1
149	Moorhead, MN	7,765	434	42,492	41,173	130,113	212	3
150	Morehead, KY	8,130	167	7,758	28,775	89,430	85	1
151	Morgantown, WV	27,858	2,168	30,855	40,949	142,803	56	2
152	Morris, MN	1,741	184	5,295	48,530	117,613	135	1
153	Moscow, ID	10,082	625	25,322	37,996	194,831	258	2
154	Mount Pleasant, MI	26,364	1,176	26,313	32,728	106,292	63	1
155	Muncie, IN	20,283	580	69,010	34,452	91,942	50	1
156	Murray, KY	9,621	690	19,006	33,745	141,362	91	1
157	Nacogdoches, TX	12,269	118	33,932	33,812	106,860	135	1
158	Natchitoches, LA	7,956	110	18,319	35,543	106,630	192	1
159	New Haven, CT	24,360	2,558	129,934	52,603	178,504	34	4
160	New London, CT	3,415	150	26,984	53,885	179,997	41	3
161	New Paltz, NY	7,550	352	7,046	45,030	230,241	72	1
162	Newark, DE	22,105	2,029	33,398	51,034	273,286	37	2
163	Normal, IL	20,677	332	54,264	45,718	143,914	117	1
164	Northampton, MA	2,867	370	28,483	47,440	313,502	39	1
165	Northfield, MN	5,000	433	20,445	40,167	178,915	37	2
166	Oberlin, OH	2,929	237	8,331	42,089	160,898	31	1
167	Ocala, FL	6,670	104	59,253	34,765	123,115	64	2
168	Ogden, UT	17,483	361	86,701	37,691	195,873	33	2
169	Orem, UT	25,936	601	97,499	36,215	265,693	34	4
170	Oxford, OH	18,664	1,774	22,341	42,620	153,512	31	1
171	Pensacola, FL	20,189	279	53,779	39,582	153,404	176	3
172	Pittsburg, KS	6,851	357	20,366	34,508	87,230	117	1
173	Platteville, WI	8,752	208	12,537	39,588	166,186	132	1
174	Plattsburgh, NY	5,613	310	19,780	40,965	128,660	202	1
175	Pocatello, ID	10,847	1,361	54,746	34,709	138,711	149	1
176	Poughkeepsie, NY	8,518	476	30,267	50,132	214,494	64	2
177	Princeton, NJ	8,552	1,779	31,249	63,237	521,098	38	2
178	Provo, UT	33,469	1,226	116,868	36,215	262,599	38	3
179	Pueblo, CO	10,682	138	110,291	36,148	116,162	103	2
180	Pullman, WA	29,316	2,095	33,282	35,697	198,672	250	1
181	Rexburg, ID	28,457	2,006	28,222	24,054	172,669	212	1
182	Richmond, IN	4,341	223	35,664	37,624	95,818	54	3
183	Richmond, KY	16,010	270	34,652	33,139	107,856	88	1
184	Rohnert Park, CA	9,343	182	42,622	56,567	479,828	42	2
185	Rolla, MO	8,794	1,314	20,075	34,489	106,791	97	1
186	Rome, GA	6,937	118	36,407	36,470	100,022	58	2
187	Russellville, AR	9,662	444	29,583	33,331	101,888	175	1
188	Ruston, LA	9,318	457	22,370	36,585	123,474	234	1
189	Salisbury, MD	8,434	131	33,114	39,722	160,514	84	1
190	San Luis Obispo, CA	20,867	409	47,536	51,442	555,347	159	1
191	Santa Barbara, CA	25,960	2,177	91,930	56,048	1,052,720	87	5
192	Saratoga Springs, NY	13,523	798	27,763	62,295	307,054	106	2
193	Savannah, GA	23,301	2,570	146,763	43,076	147,234	119	6
194	Scranton, PA	8,202	238	77,291	43,616	100,335	99	4
195	Searcy, AR	6,009	294	24,318	32,966	90,361	96	1
196	Seaside, CA	6,862	162	34,312	52,448	687,481	50	1
197	Siloam Springs, AR	2,339	106	16,448	76,554	158,798	175	1
198	Sioux Center, IA	1,430	130	7,501	46,732	161,458	196	1
199	Socorro, NM	2,035	158	8,612	32,608	131,585	300	1
200	Spartanburg, SC	8,255	126	37,876	39,386	126,572	64	4
201	Springfield, MO	25,237	1,502	167,319	40,019	115,785	149	10
202	State College, PA	46,744	6,983	41,992	41,032	248,917	115	2
203	Statesboro, GA	19,669	350	31,419	29,737	93,376	146	1
204	Stevens Point, WI	9,129	141	26,423	42,386	148,260	132	1
205	Stillwater, OK	25,558	1,868	49,504	35,896	104,200	53	1
206	Superior, WI	2,395	182	26,475	38,861	154,046	132	1
207	Syracuse, NY	28,274	4,364	143,378	47,865	105,318	75	4
208	Tahlequah, OK	8,019	135	16,741	29,609	87,777	146	1
209	Tallahassee, FL	61,215	1,962	190,894	40,758	178,248	155	5
210	Terre Haute, IN	15,380	1,221	60,852	35,457	84,963	68	2
211	Thibodaux, LA	5,923	126	14,610	43,752	122,556	46	1

212	Tiffin, OH	4,556	361	17,545	38,203	109,668	80	2
213	Troy, AL	17,640	726	19,191	35,287	86,854	128	1
214	Troy, NY	6,899	1,163	49,702	45,212	199,589	84	2
215	Turlock, CA	9,276	282	72,796	41,299	250,330	58	1
216	Tuscaloosa, AL	36,145	1,276	99,543	35,909	156,443	46	2
217	Tyler, TX	19,413	441	104,798	49,857	141,288	93	4
218	University Park, IL	5,894	389	7,052	56,669	141,544	30	1
219	Utica, NY	7,084	246	60,652	40,236	132,880	120	2
220	Valdosta, GA	11,198	288	56,474	34,088	95,110	103	1
221	Valparaiso, IN	4,486	700	33,104	46,965	180,502	41	1
222	Vermillion, SD	8,741	253	10,844	37,265	167,629	238	1
223	Waco, TX	16,737	678	134,432	38,125	111,252	87	2
224	Warrensburg, MO	13,413	2,690	20,251	33,236	104,067	51	1
225	Waterville, ME	1,857	196	16,406	42,194	121,116	167	2
226	Waverly, IA	1,497	124	10,093	44,514	118,180	161	1
227	Weatherford, OK	4,888	214	11,978	35,834	117,026	66	1
228	West Haven, CT	6,726	1,041	54,516	52,603	240,486	37	1
229	West Lafayette, IN	40,145	9,209	45,872	35,804	163,517	62	1
230	Whitewater, WI	11,823	126	14,517	43,989	183,636	44	1
231	Wilkes-Barre, PA	7,170	295	40,569	41,809	87,088	97	2
232	Williamsburg, VA	8,443	665	15,214	59,632	293,612	44	1
233	Williamsport, PA	6,676	137	28,834	40,185	130,181	133	2
234	Wilmore, KY	3,315	196	6,312	39,551	152,362	66	2
235	Winchester, VA	3,801	157	27,516	46,356	225,993	64	1
236	Winfield, KS	1,430	112	12,284	36,240	67,359	126	1
237	Winona, MN	14,204	384	27,139	44,354	143,036	102	2
238	Worcester, MA	22,121	2,513	184,508	52,320	177,389	37	7
239	York, PA	5,576	161	43,859	45,918	105,921	47	3
240	Youngstown, OH	11,508	266	64,312	40,456	48,944	57	2
241	Ypsilanti, MI	21,148	722	21,018	52,814	184,655	30	1

.

Notes:
†College towns selected as places for which students comprise at least 10% of total population and the nearest MSA with more than 1 million people is no less than 30 miles away.
‡Average home values are calculated for each city in the following manner: first, we obtain weighted-average home values at the city level from 2000 census data. Weights are adjusted-household factors, where 2000 household weights are adjusted according to the proportion of the city's population in its PUMA. We then capitalize 2000 average home values by the annual FHFA indices used in the paper.
*Large MSAs defined as those with more than 1 million people.

TABLE A.4
FIRST STAGE OF INSTRUMENT (MAIN MODEL)

$\frac{\text{International students inflow}_{t-1}}{\text{Total students}_{t-2}}$	(1)
$\frac{\text{Predicted international students inflow}_{t-1}}{\text{Total students}_{t-2}}$	0.39
	(0.018)***
Observations ($N \times T$)	2410
R-squared	0.60
Effective F-statistic	642.87
Full set of controls	X
Year fixed effects	X

Notes: First stage regression of the actual international student influx $IS_{k,t}$ relative to total students in the previous year on the shift-share instrument $\widehat{IS_{k,t}}$ divided by (lagged) total enrolled students. The national shift-share instrument uses the total influx of international students in the US each year and the share of new foreign students in each city in 1996, to predict the influx of students by city and year. Values in () are standard errors clustered at the college town level, and controls are the same as in Table (II). We report the Montiel Olea and Pflueger (2013) effective F-statistic (critical value at $\alpha = 0.05$ is ≈ 37).
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE A.5

Observable Characteristics: Top and Bottom College Towns

	College towns (Top decile)			College towns (Bottom decile)		
	1996-2001	2001-2005	2006-2016	1996-2001	2001-2005	2006-2016
Income growth	18%	14%	28%	18%	13%	21%
Population growth	23%	3%	13%	17%	4%	3%
Unemployment change (p.p.)	0.9	0.4	0.3	-0.7	0.4	0.5
Cum. int. inflow over total	16%	9%	32%	6%	4%	13%

Notes: Evolution of selected characteristics of top-performing and worst-performing college towns. We first rank college towns according to annualized price growth rates between 2005 and 2016, and then select top and bottom deciles. Top decile: College Station, TX, Grand Forks, ND, Weatherford, OK, Sioux Center, IA, Fargo, ND, Lake Charles, LA, Thibodaux, LA, Huntsville, TX, Denton, TX, State College, PA, Provo, UT, Grambling, LA, Fairfield, IA, Corvallis, OR, Orem, UT, Lewisburg, PA, Ruston, LA, Kearney, NE, Vermillion, SD, Moorhead, MN, Murray, KY, Princeton, NJ, Natchitoches, LA, Ithaca, NY. Bottom decile: Bradenton, FL, Big Rapids, MI, Bowling Green, OH, Oberlin, OH, Salisbury, MD, Daytona Beach, FL, Fort Myers, FL, Dayton, OH, Cocoa, FL, Winchester, VA, DeLand, FL, Ocala, FL, Worcester, MA, Ypsilanti, MI, Turlock, CA, West Haven, CT, Fort Pierce, FL, Seaside, CA, York, PA, Poughkeepsie, NY, University Park, IL, East Stroudsburg, PA, New London, CT, Flint, MI.

TABLE A.6
Robustness Checks
Main Model

	OLS (1)	IV (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)
$\frac{\text{International students inflow}_{t-1}}{\text{Total students}_{t-2}}$	0.094	0.081	0.144	0.138	0.105	0.098
	(0.038)***	(0.033)***	(0.030)***	(0.037)***	(0.028)***	(0.043)***
Full set of controls	*X*	*X*		*X*	*X*	*X*
Log inverse distance to coast & New faculty						*X*
Year fixed effects	*X*	*X*			*X*	*X*
State fixed effects					*X*	
Observations (College towns × T)	2410	2410	2410	2410	2410	2410
R-squared	0.37	0.36	0.01	0.15	0.40	0.38

Notes: (1) displays OLS results of a model regressing log differences of home prices (FHFA annual index) on the international students share measure (the ratio of international students inflow in a year to total students in the previous year at college town k). Controls include dynamic price drivers and initial city characteristics. In this specification, we use alternative city-level average income data from IPUMS. There are 241 college towns, defined as census places with at least 10% of local population made up by degree-seeking students enrolled in 4-year higher education institutions and no less than 30 miles away from a large MSA (1 million people). (2) is estimated with the international student inflow $IS_{k,t}$ instrumented with the national shift-share variable $\widehat{IS_{k,t-1}}$. The national shift-share instrument uses the total influx of international students in the US each year and the share of new foreign students in each city in 1996, to predict the influx of students by city and year. (3) runs the OLS model without covariates. (4) provides OLS estimates of the same model without year fixed effects. (5) adds state-fixed effects and (6) uses two additional controls. Standard errors in () are clustered at city level.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE A.7
Restricting Sample Years
Main Model

End year	2014 (1)	2013 (2)	2012 (3)	2011 (4)	2010 (5)	2009 (6)	2008 (7)	2007 (8)
$\frac{\text{IS inflow}_{t-1}}{\text{Total students}_{t-2}}$	0.090	0.111	0.134	0.134	0.125	0.140	0.057	0.007
	(0.034)***	(0.038)***	(0.042)***	(0.042)***	(0.042)***	(0.037)***	(0.047)	(0.047)
Full set of controls	X	X	X	X	X	X	X	X
Year fixed effects	X	X	X	X	X	X	X	X
Observations								
(College towns $\times$ T)	2169	1928	1687	1446	1205	964	723	482
R-squared	0.39	0.40	0.40	0.43	0.45	0.49	0.49	0.42

Notes: (1) Each regression reproduces our main specification (3) by progressively dropping the end year of the sample. Column (1) drops out 2015, (2) excludes 2014 and 2015 and so on. Standard errors in () are clustered at city level.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

TABLE A.8
SHARE OF INTERNATIONAL AND
DOMESTIC STUDENTS IN THE U.S.

	1% ACS*		ACS 5-year**		Official***	
	2005	2016	2005-2009	2011-2015	2005	2016
Foreign-born students†	14.88%	15.23%	13.58%	14.46%	-	-
Non-citizen students‡	8.21%	7.89%	7.27%	7.59%	3.35%	4.83%
Total students (U.S.)	18,064,063	22,559,830	21,262,793	23,362,075	17,710,798	20,389,307
Domestic students	16,581,003	20,779,859	19,716,988	21,588,894	17,117,486	19,404,503

Notes:
†Foreign-born students include undergraduate, graduate and professional students born abroad from American parents, naturalized American and not citizens.
‡Only undergraduate, graduate and professional students non-American citizens.
*Observations weighted by person weight from the Integrated Public-Use Microdata Series (IPUMS) for each correspondent year. Total students represent the sum of weights for all students across a year.
**Observations weighted by person weight from the Integrated Public-Use Microdata Series (IPUMS) for the 5% ACS 5-year sample. Total foreign-born (not-citizen) students represent the sum of weights for all foreign-born (not-citizen) students across the 5-year period.
***Comparison data uses nationwide Fall enrollment from the Integrated Postsecondary Education Data System (IPEDS), National Center for Education Statistics (NCES). The variable that tracks international students in the IPEDS dataset comprises nonresident alien students, as directly reported by all colleges, universities, and technical/vocational institutions that participate in federal student financial aid programs.

TABLE A.9

International Students: Leading Countries of Origin

2005

Source	ACS 1% sample*	Comparison**		ACS 1% sample	Official
Variable	Foreign-born†	Int'l students		Not a citizen‡	Int'l students
Country	Share	Share	Country	Share	Share
Mexico	12.26%	2.31%	Mexico	13.98%	2.31%
Korea	5.30%	9.44%	Korea	5.85%	9.44%
Philippines	5.24%	0.62%	China	5.78%	11.07%
India	4.94%	14.24%	India	5.71%	14.24%
China	4.48%	11.07%	Philippines	3.30%	0.62%
Vietnam	3.68%	0.65%	Japan	2.96%	7.47%
Germany	3.16%	1.53%	Canada	2.44%	4.98%
Canada	2.39%	4.98%	Haiti	2.31%	0.18%
Japan	2.34%	7.47%	Colombia	2.22%	1.30%
Jamaica	2.31%	0.77%	Taiwan	2.05%	4.59%
Total	2,688,788	565,039	Total	1,482,810	565,039

2016

Source	ACS 1% sample	Comparison		ACS 1% sample	Official
Variable	Foreign-born	Int'l students		Not a citizen	Int'l students
Country	Share	Share	Country	Share	Share
Mexico	12.87%	1.60%	Mexico	15.10%	1.60%
China	9.96%	31.47%	China	15.09%	31.47%
India	6.48%	15.89%	India	8.10%	15.89%
Philippines	4.11%	0.28%	Korea	4.05%	5.84%
Korea	3.63%	5.84%	Saudi Arabia	2.79%	5.87%
Vietnam	2.90%	2.05%	Philippines	2.30%	0.28%
Germany	2.48%	0.97%	Vietnam	2.11%	2.05%
Colombia	2.12%	0.75%	Canada	2.10%	2.58%
Haiti	2.12%	0.09%	Brazil	1.87%	1.86%
Canada	2.06%	2.58%	Haiti	1.69%	0.09%
Total	3,435,436	1,043,839	Total	1,779,307	1,043,839

Notes:
†The foreign-born variable includes undergraduate, graduate and professional students born abroad from American parents, naturalized American and not citizens.
‡Non-citizens are constituted as only undergraduate, graduate and professional students non American citizens.
*Observations weighted by person weight from the Integrated Public-Use Microdata Series (IPUMS) for each correspondent year. Total foreign-born (not-a-citizen) students represent the sum of weights for all foreign-born (not-a-citizen) students across a year.
**Comparison variable uses total international enrollment in tertiary education data from the Institute of International Education (IIE).

TABLE A.10
LEADING COUNTRIES OF ORIGIN
(ACS 5% 5-YEAR DATA)

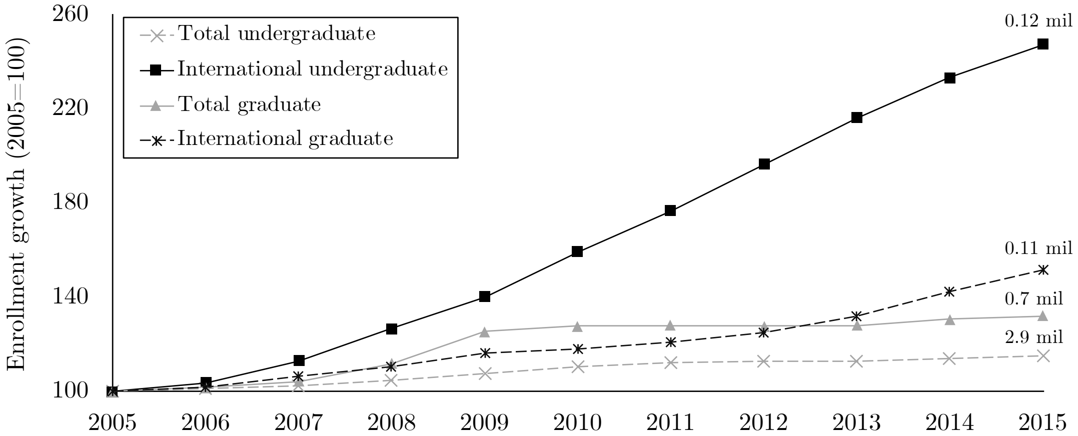
2005-2009

Country	ACS* (Foreign-born)†	Country	ACS (Not a citizen)‡
Mexico	11.89%	Mexico	13.58%
India	5.29%	China	6.75%
Korea	5.19%	India	6.39%
China	5.14%	Korea	5.79%
Philippines	4.80%	Philippines	3.02%
Germany	3.50%	Canada	2.70%
Vietnam	3.31%	Japan	2.46%
Canada	2.52%	Colombia	2.22%
Jamaica	2.31%	Haiti	2.08%
Haiti	2.13%	Taiwan	2.00%
Total foreign-born	2,887,893	Total non-citizens	1,545,120

2011-2015

Country	ACS (Foreign-born)†	Country	ACS (Not a citizen)‡
Mexico	12.39%	Mexico	14.41%
China	8.28%	China	12.51%
India	5.34%	India	6.22%
Korea	4.47%	Korea	5.38%
Philippines	4.43%	Philippines	2.78%
Vietnam	3.07%	Saudi Arabia	2.40%
Germany	2.94%	Canada	2.22%
Haiti	2.25%	Vietnam	2.09%
Canada	2.18%	Colombia	1.96%
Colombia	2.10%	Haiti	1.92%
Total foreign-born	3,377,430	Total non-citizens	1,773,663

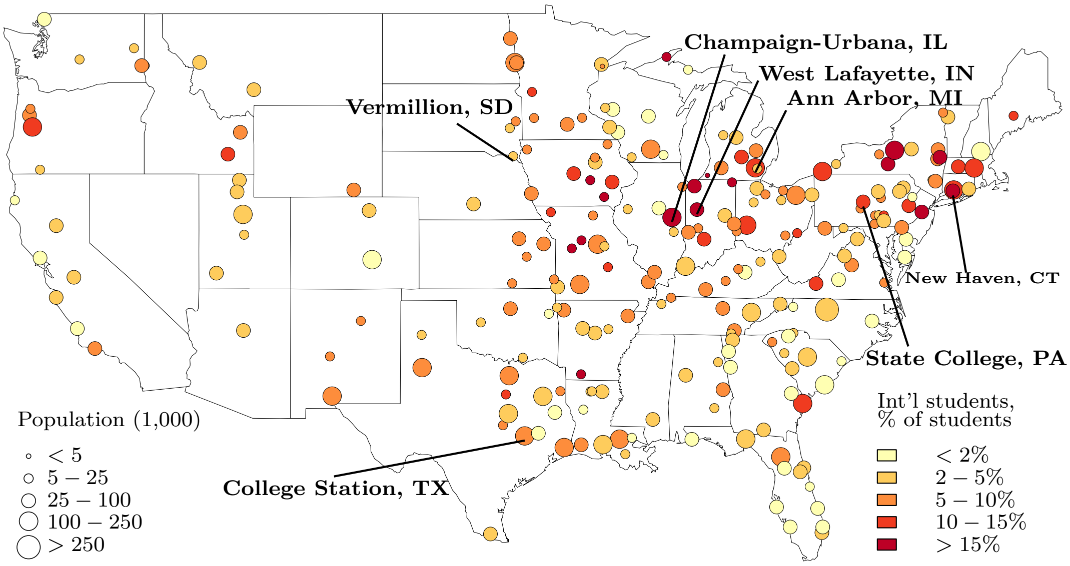
Notes:
†Include undergraduate, graduate and professional students born abroad from American parents, naturalized American and not citizens.
‡Only undergraduate, graduate and professional students non American citizens.
*Observations weighted by person weight from the Integrated Public-Use Microdata Series (IPUMS) for the 5% ACS 5-year sample. Total foreign-born (not-citizen) students represent the sum of weights for all foreign-born (not-citizen) students across the 5-year period.



Notes: Annual growth in the enrollment of degree-seeking international and total students in 241 college towns, by student level. International undergraduate enrollment grew 160% in the 10-year period, reaching 120 thousand students in 2015. Over the decade, international enrollment grew over 4 times faster than domestic enrollment. Selected college towns must satisfy two criteria: (1) places where degree-seeking students in four-year higher education institutions constitute at least 10% of total city population and (2) the nearest 1 million people MSA is no less than 30 miles away.

FIGURE I

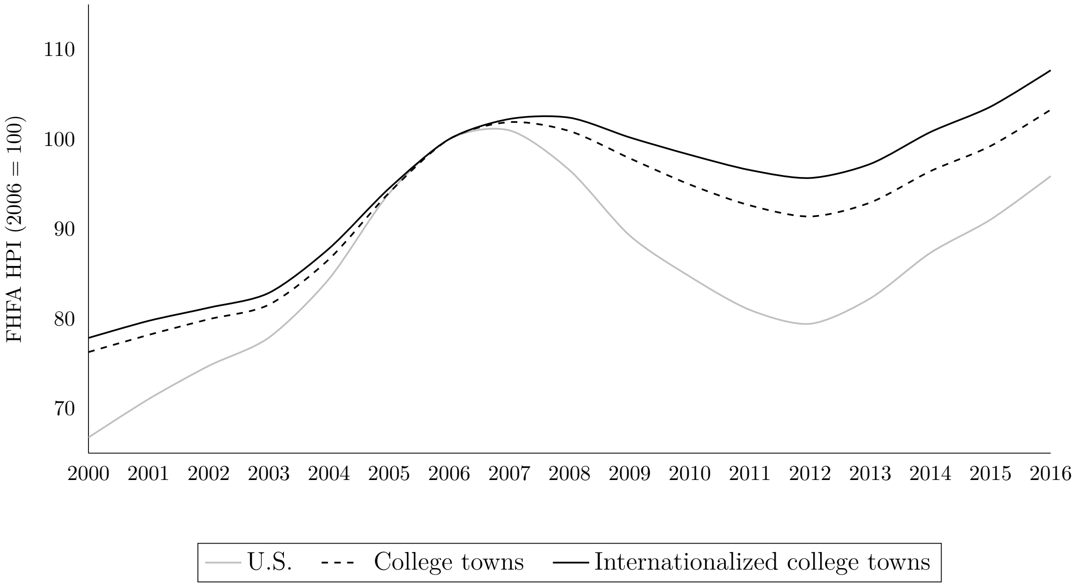
Recent Changes in Student Enrollment in College Towns



Notes: The map shows college towns for which students comprise at least 10% of total population and the nearest MSA with more than 1 million people is no less than 30 miles away. There are 241 locations. The student population share is the ratio between average Fall enrollment for 2011-2015 and average population in the same period. Enrollment data considers only degree-seeking students in four-year universities. The participation of international students as a share of total city population follows the same methodology. Longitude and latitude data come from the database "*U.S. Census Bureau and Erik Steiner, Spatial History Project, Center for Spatial and Textual Analysis, Stanford University*". Whenever college town coordinates are unavailable in this dataset, we manually select longitude and latitude from the US Bureau Census gazetteer files.

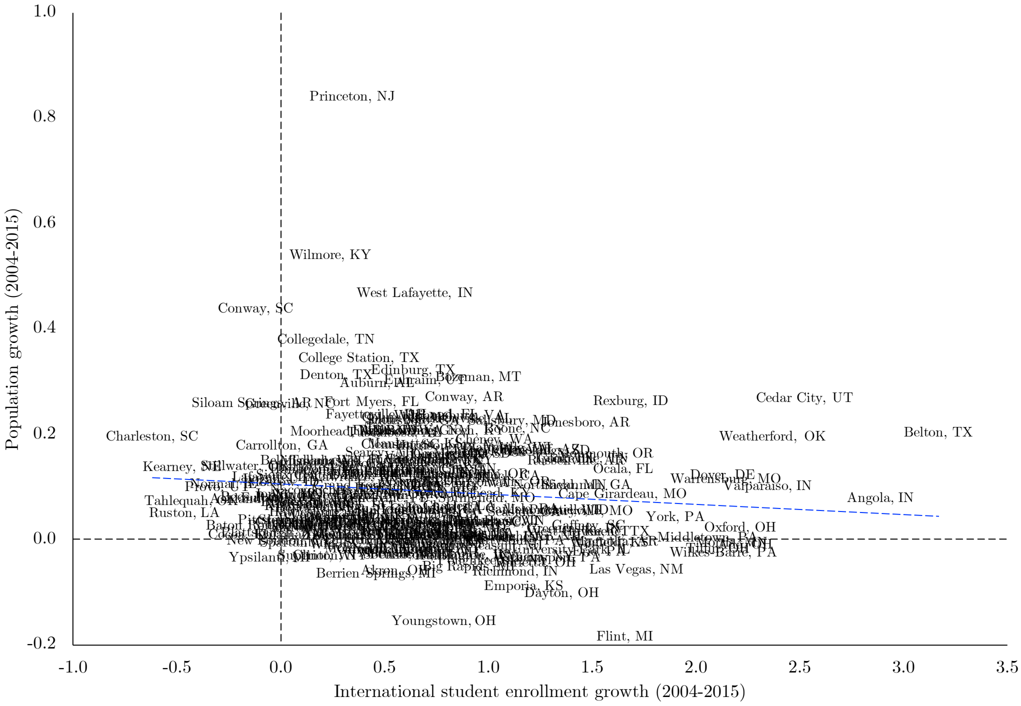
FIGURE II

College towns in the U.S.



Notes: This figure compares the variation in house prices from 2000 to 2016 in American college towns, college towns with a high share of international students and nationwide. We normalize the 2006 house price peak to 100, so that values are always relative to the year immediately before the bust. For example, prices in the U.S. were 5% lower in 2016 than the 2006-level, while prices in internationalized college towns were 22% lower in 2000 compared to the base year. Internationalized college towns are those with at least 5% of students being non-residents. House prices are the annual HPI from the Federal Housing Finance Agency (FHFA). The index displayed for (internationalized) college towns is the average annual index of all census tracts within a city, averaged over all towns in the sample. There are 241 college towns and 117 internationalized locations reported. The US index is the standard FHFA HPI for the U.S. (all transactions). More details regarding sample and variable construction in the main text.

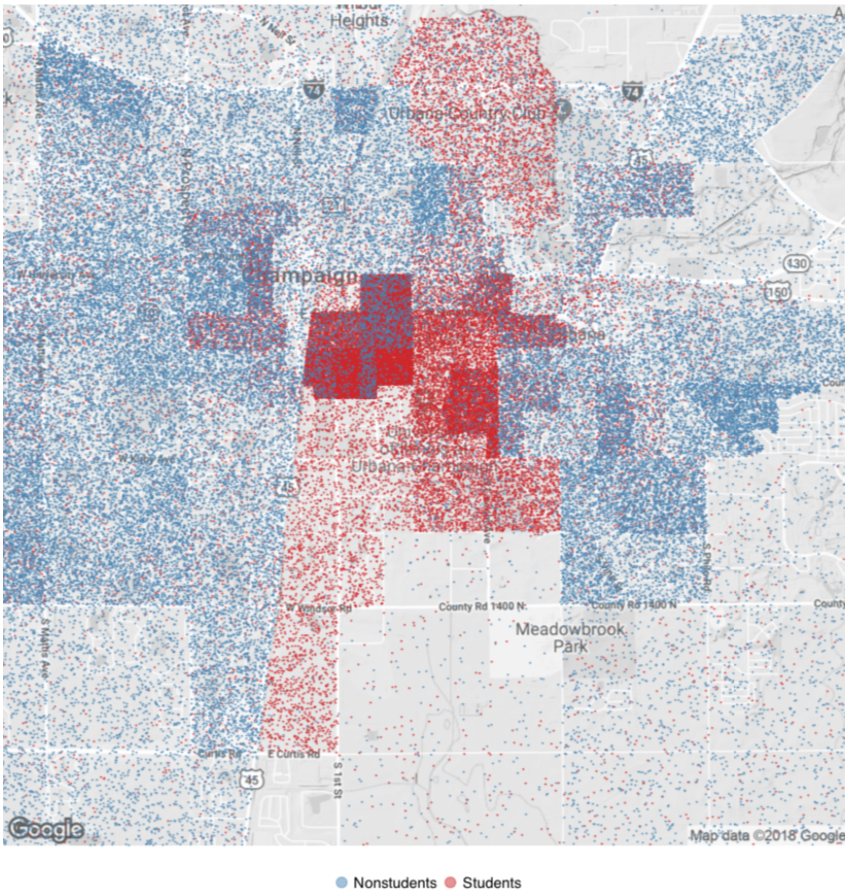
FIGURE III
House Prices in (Internationalized) College Towns and the U.S.



Notes: Data description in Appendix (A).

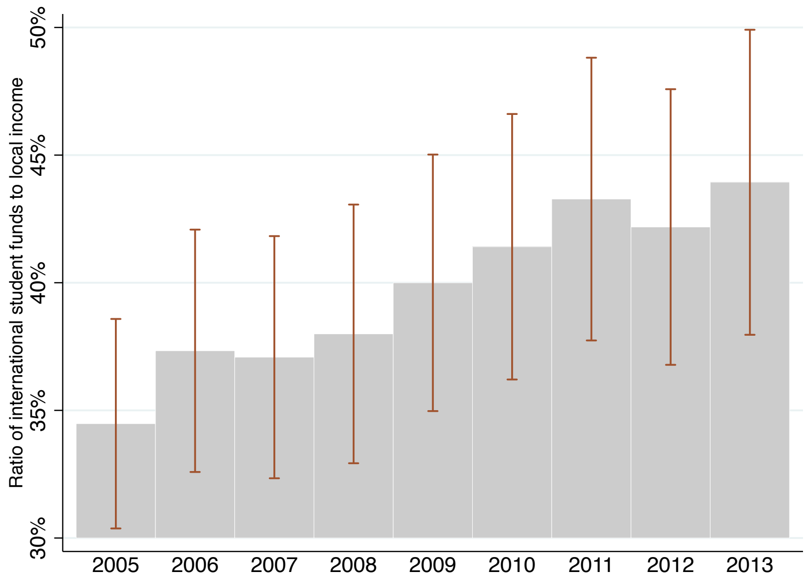
FIGURE IV

Relationship between Population and International Enrollment Growth



Notes: The figure displays student and nonstudent population counts by census block group using the ACS 2012-2016 5% sample. The student population is defined as individuals attending college, graduate or professional school. We randomly assign individuals within their census block group for visualization purposes. Each dot represents one person.

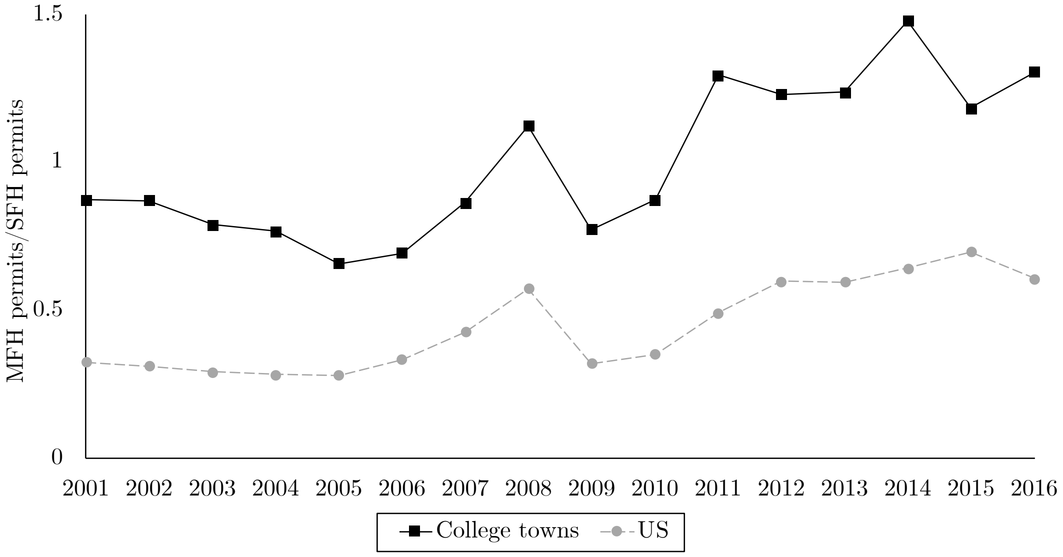
FIGURE V
Student segregation in Champaign-Urbana, IL



Notes: This figure compares the evolution of personal funds self-declared by international students in I-20 forms to total personal income in a consistent sample of 108 college towns. The raw administrative data on students come from U.S. Immigration and Custom Enforcement (ICE), from the Department of Homeland Security (DHS). These data have average personal funds declared by international students on I-20 forms per country of origin and university. I-20 forms supplement information on F and M visas, and while personal funds do not perfectly indicate students' actual income from abroad, the amount must at least cover the expected cost of attendance uncovered by all types of aid students might receive. For each year and college town, we first take enrollment-weighted averages of personal funds across all countries. We then divide this amount by total personal funds from 1% ACS samples. We only use college towns with shares above 10% from 2005 onward.

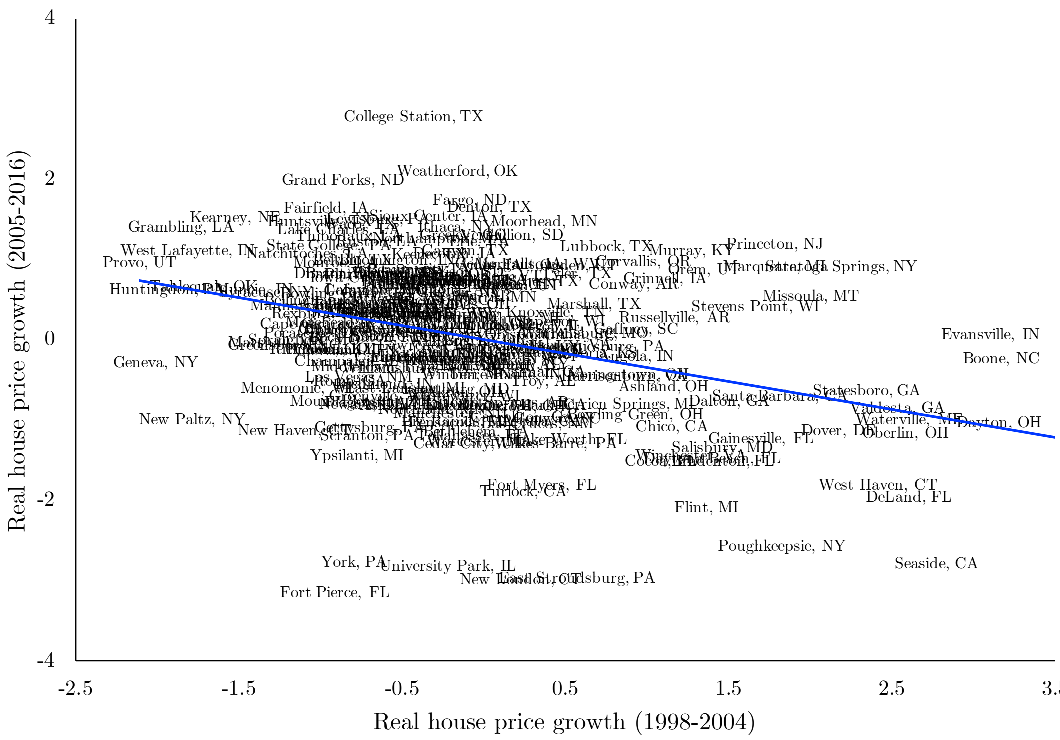
FIGURE VI

Personal Funds of International Students in College Towns



Notes: The lines show how annual building permits issued in college towns and the U.S. compare between multi-family homes (MFH) and single-family homes (SFH). The shares plotted indicate the relative strength of MFHs with respect to SFHs. For example, new construction of multi-family units in college towns exceeded new SFHs by almost 50% in 2014. The data come from Building Permits Surveys from the U.S. Census Bureau as of December of each year with the accumulative building permit issuance over the reference period. The sample of college towns varies from 171 to 181 locations (out of 241 in the full sample). City-level data includes imputations by the Census Bureau.

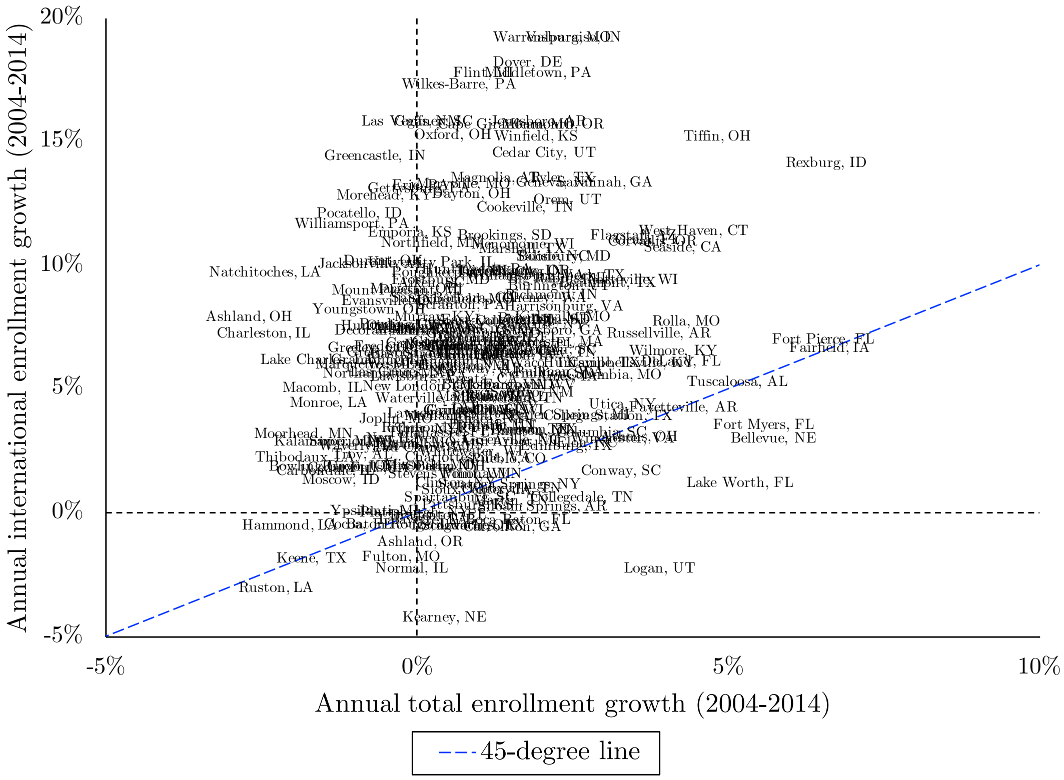
FIGURE VII
New Residential Construction



Notes: The figure shows how well the pre-period real price growth (1998-2004) in college towns predicts subsequent real price variation between 2005 and 2016. All variables are normalized to a SD of 1, so that the coefficient of the fitted line $\Delta \widehat{\ln \text{Price}}_{2016-2005} \approx -0.35 \Delta \ln \text{Price}_{2004-1998}$ represents the correlation between the price growth in both periods. College town housing prices are constructed as described in the main text, deflated with the CPI less shelter.

FIGURE A.1

Correlation Between Housing Price Pre-Trend and In-Period Growth



Notes: Annualized growth in the enrollment of degree-seeking international and total students in the selected 241 college towns.

FIGURE A.2
International and Overall Enrollment Growth

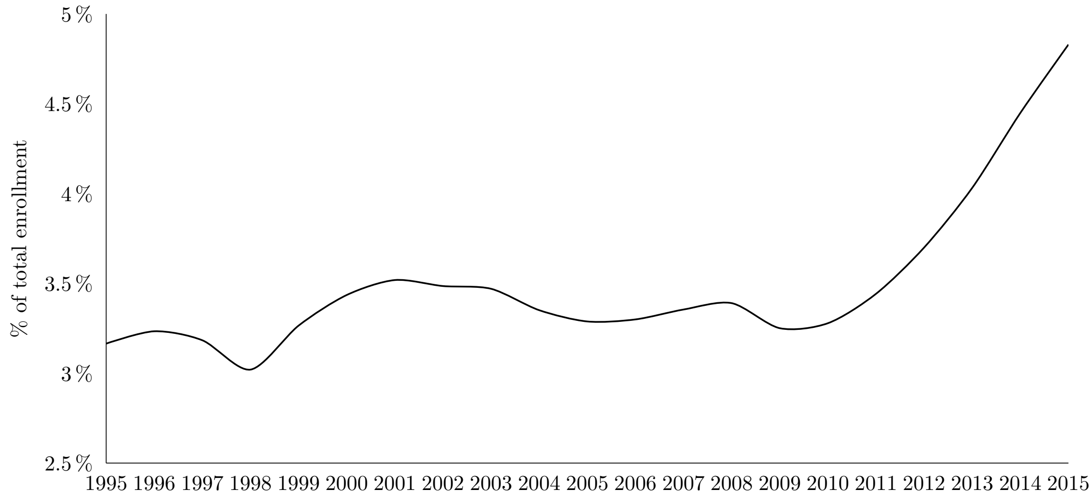
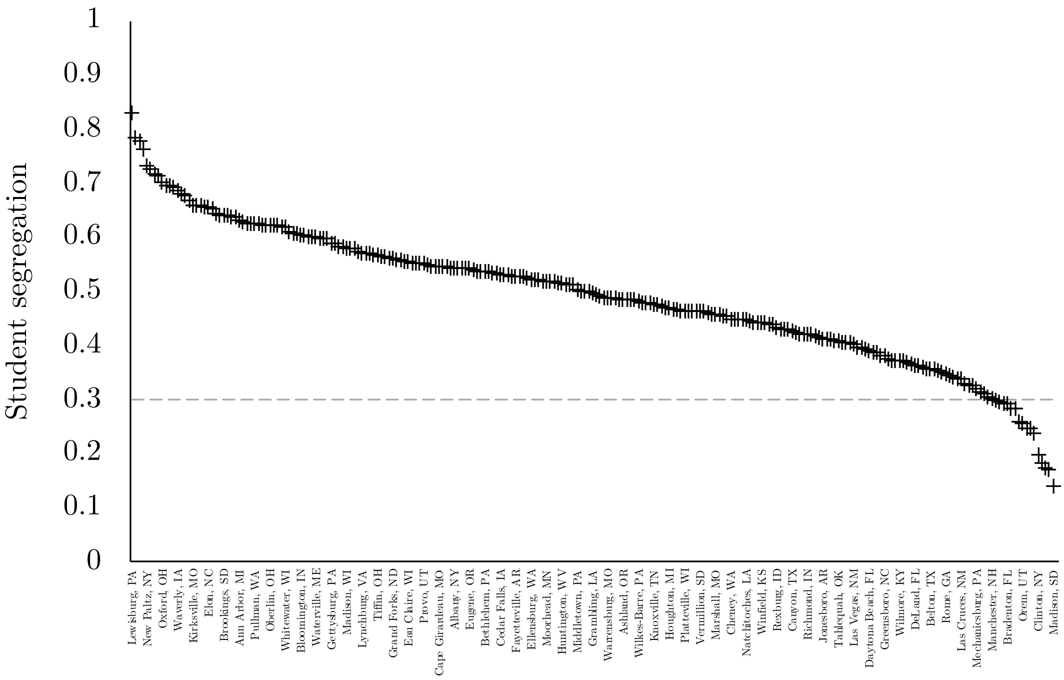


FIGURE A.3
Long-term Share of International Students as part of U.S. Higher Education

Notes: Includes degree-seeking full and part-time students in 4-year universities.

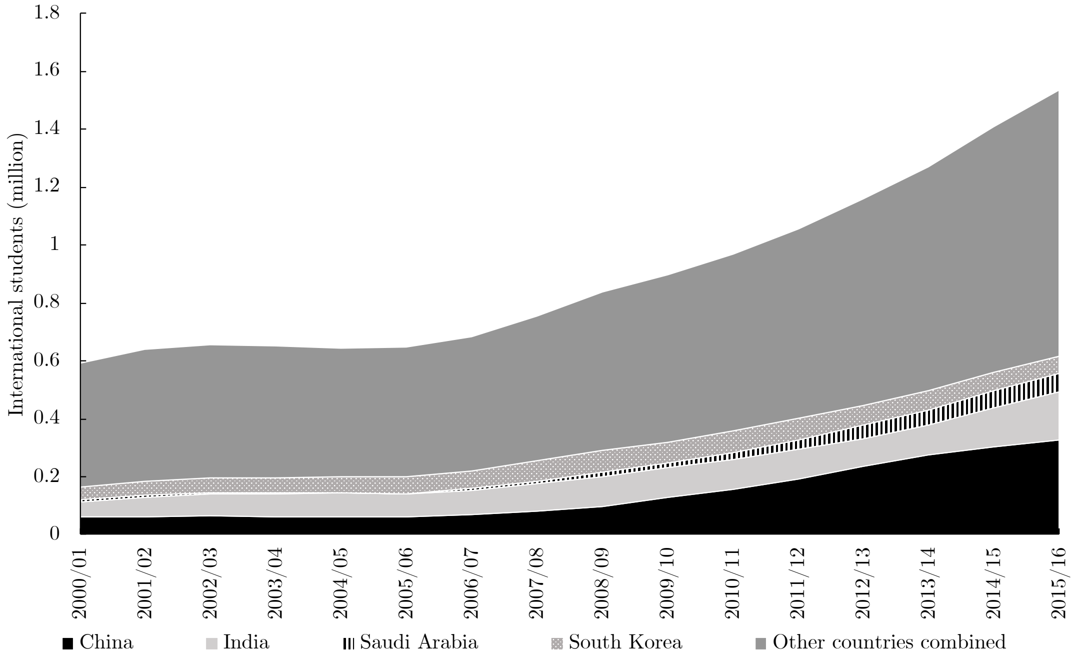


Notes: These are dissimilarity indices $+$ calculated for college towns with student and nonstudent populations in census group blocks. A value of 1 indicates complete segregation. If a college town is completely segregated, students and nonstudents never reside in the same block group. We set a "moderate segregation" threshold to 0.3, represented by the dashed line. 92% of 241 college towns are at least moderately segregated. The dissimilarity index for college town k is calculated as: $+_k = \frac{1}{2}\sum_g |\frac{s_g}{s} - \frac{ns_g}{ns}|$, where s_g is the number of students in census block group g, ns_g is the number of nonstudents in that block group, and variables without subscript represent college town aggregate quantities. Each dissimilarity index $+$ has an intuitive interpretation. For example, in Oxford, OH, approximately 70% of students would need to move out from their current block groups so that students and nonstudents would be evenly distributed in the city. Students refer to undergraduate, graduate, and professional students. Not all college towns have labels in the figure. Data come from the 2012-2016 ACS 5% sample.

FIGURE A.4

SEGREGATION BETWEEN STUDENTS AND NONSTUDENTS IN COLLEGE TOWNS

FIGURE A.5
Luxury Student Construction and International Enrollment Growth



Notes: Data on national levels of international enrollment by country of origin from the Institute of International Education (IIE). These data correspond to all international students admitted into the U.S. to higher education institutions.

FIGURE A.6
Leading Countries of Origin