The Impact of International Students on Housing Markets*

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Abstract

We study the impact of the 2005-2015 international student boom in US universities on local housing markets. By constructing a sample of American college towns characterizing rarely studied local markets in small urban areas, we show that international students exogenously sustained demand for rentals and residential investment, representing countercyclical shocks during the Great Recession. Exploiting the historical distribution of foreign enrollment across college towns and country-of-origin networks, we find that international students increased rents by 1.3% and home prices by 2.5% relative to the housing boom peak, translating into home equity gains of $4,000. An analysis exploiting within-city dynamics reveals that neighborhoods near campus absorbed international inflows by replacing single-family homes with apartment rentals.

Keywords: housing markets, residential investment, international students
JEL Classification: F22, R33, G01, R31, I23.

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1 Introduction

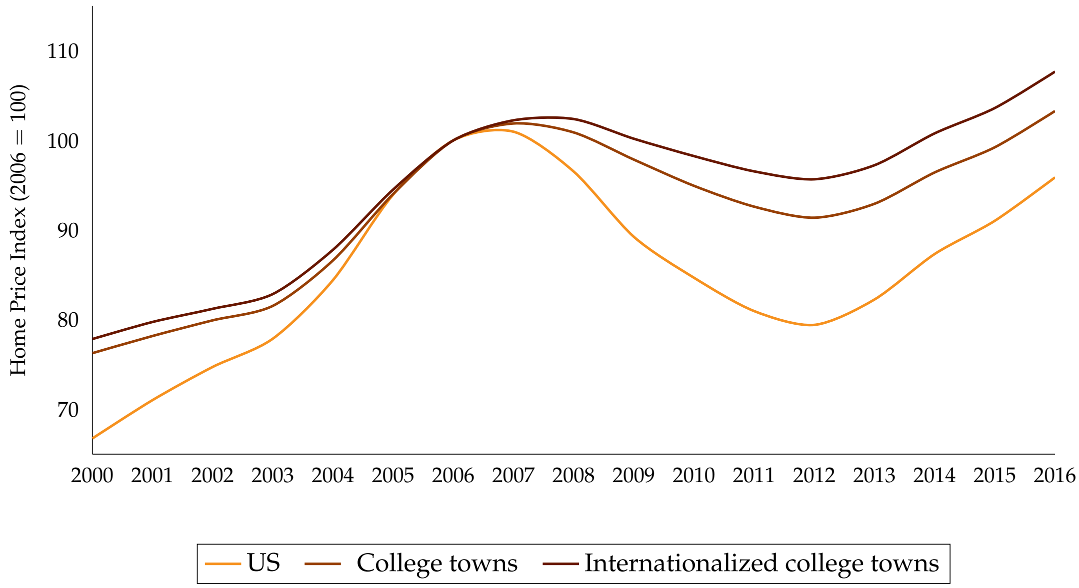
The presence of international students in American universities has increased dramatically in the last decade, doubling to over a million enrolled students. The education sector has become a major US export, generating over $30 billion in annual trade surplus. While foreign students have provided schools with important tuition revenue stream and subsidized domestic enrollment (Bound et al. (2020), Shih (2017)), little is known about how the increasing reliance of universities on international enrollment impacts local economies.

International students spend home country savings when consuming local goods and services since they are precluded from federal aid for college expenses and from joining the labor force under visa restrictions. Many of these students attend colleges in small urban economies, where local markets, especially housing, largely depend on student demand. As home prices collapsed and the US economy struggled during the Great Recession, prices in college towns were more resilient than in the national market, particularly in towns receiving larger inflows of international students (Figure (I)).[1]

In this paper, we study how universities enrolling increasing numbers of foreign students affects local economies, focusing on housing markets. We find that international students represented countercyclical income shocks that sustained residential investment, raising prices, rents, and housing density. Our estimates indicate that international student inflows increased average home equity by $4,000 relative to the housing boom peak, accounting for 40% of the price growth in college towns during the housing slump and subsequent recovery years. We also find that foreign inflows increased rents and stimulated local housing development, leading to the replacement of single-family homes by large apartment buildings near campus.

We capture the spatial heterogeneity of international students' college choices by constructing a comprehensive sample of American college towns, matching higher education data from the Integrated Postsecondary Education Data System (IPEDS) to local prices, rents, and local economic indicators from the the Federal Housing Agency, US Census, Zillow.com, and

[1] 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.



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 US (all transactions). More details regarding sample and variable construction in the main text.

FIGURE I
HOUSE PRICES IN (INTERNATIONALIZED) COLLEGE TOWNS AND THE US

other sources. 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 to the composition of student enrollment without being heavily affected by extraneous factors.[2]

To circumvent endogeneity concerns, we employ two instruments exploring different sources of variation. First, by using the historical distribution of international students across

[2]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)).

college towns, our instrument leverages the fact that top destinations for students in the past remain the most internationalized universities decades later. Colleges that become more well-known abroad, either because of more aggressive international outreach or prestige, or due to the establishment of alumni networks persistently receive more foreign students over time. Because these networks are likely country-specific, our second instrument also uses variation in the country-of-origin of students to obtain causal estimates.

Housing markets in college towns provide a clean setting to identify how university responses to the business cycle generate effects beyond the higher education sector. State schools in particular have been very responsive to funding shortfalls in the last decade, expanding foreign enrollment (Bound et al. (2020), Bound et al. (2021)) by tapping into larger pools of qualified and financially apt candidates. In our sample, almost 70% of international students enroll in public universities. Indeed, declared personal funds by students to immigration authorities has grown steadily since 2005.[3] With home country wealth plausibly exogenous to local earnings and foreign recruitment intensifying as a response to local negative economic condition, international students represent positive demand shocks where they move which are plausibly countercyclical.

We begin by documenting several stylized regularities of college town housing markets. First, students, particularly foreign-born, rent much more often than nonstudents, with over 95% of international students 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. International students pay as much as 20% more in rents than domestic students, particularly in large apartment buildings.

These 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 owner-occupied dwellings are located farther out. Akin to

[3] According to data obtained from the U.S. Immigration and Custom Enforcement (ICE), from the Department of Homeland Security (DHS) that we detail in Section 2.

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 enclave.

We then propose a mechanism to explain the impact of the international enrollment boom on house prices. 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. 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 mechanism with a variety of empirical tests. These rely on data from various sources, including detailed land cover satellite-imagery. Taken together, these tests indicate that the supply of multi-unit rentals grew disproportionately near campus primarily through conversion of land sparsely occupied by single family homes into construction types consistent with multi-unit housing. We find that international student inflows were responsible for this residential replacement effect.

A series of robustness checks indicate that our results are unlikely to be driven by local secular trends, domestic enrollment growth, university-provided housing, or other confounding effects. We show that over longer time horizons, housing markets in college towns experience mean reversion — a common characteristic of housing markets — 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 from out-of-state domestic students also indicate that domestic enrollment failed to account for housing price increases in college towns. This underscores the differential economic impact of not only enrollment expansion, but increasing recruitment of particular groups of students.

[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.

This paper makes four main contributions. First, it contributes to a growing literature on international students. Previous research has studied the drivers and consequences of foreign enrollment for education outcomes (Bound et al. (2020), Bound et al. (2021), Khanna et al. (2020), Chen (2019), Chen et al. (2020), among others). Particularly, Bound et al. (2020) and Shih (2017) find that these students affect domestic enrollment positively due to direct financing in public research universities and cross-subsidization, respectively. We provide evidence on the role international students play, beyond the higher education sector. Our findings imply that, while homeowners benefit from increased home equity, students face higher living expenses in college towns.

This paper also shows how college recruitment choices have impacts well beyond university finances, campus diversity, and global competitiveness in research. Most work on the impact of universities on local economies has focused on long-term spillover effects related to the supply of college-educated individuals, productivity, and innovation (e.g. (Moretti (2004), Liu (2015), and Andrews (2018))). These spillovers originate from research activity and other education outputs when colleges are established in a certain area.

By focusing on international student inflows, our paper shows how an increasing reliance of universities on foreign enrollment has direct contemporaneous effects on local economies, particularly during economic downturns. One interpretation of our estimates is that college towns receiving larger international student inflows better insulated their housing markets during the housing collapse, as international students exogenously sustained demand for rentals and residential investment. Consistent with this effect, Graham (2020) shows that areas with greater corporate residential investment activity in the US, much of which rents out portfolio properties, were associated with smaller house price declines during the housing bust.

We also provide a formal analysis of the fundamentals and behavior of student housing markets. Student real estate is often regarded in the popular press as a "great yield opportunity" for home investors. The flagship student housing REIT, American Campus Communities, grew on average 10% per year during the housing bust, compared to 4.8% of all REITs. Despite this perception, we show that, historically, student housing markets do not necessarily overperform the national average. Although the demand for higher education and skill upgrading is countercyclical (Charles et al. (2018), Barr and Turner (2015)), domestic demand in the wake of financial recessions tends to expand in higher debt and non-traditional students (Lucca et al. (2018), Long (2014)), thereby not necessarily insulating student real estate markets against systemic shocks. Reliance on foreign enrollment diversifies college financing needs, leading to local spillovers in surrounding housing markets.

Finally, we contribute to numerous studies analyzing immigration and foreign capital inflows on determining real estate prices (Saiz (2003), Saiz (2007), Saiz and Wachter (2011),Badarinza and Ramadorai (2018), Favilukis and Van Nieuwerburgh (2016), Sá (2014)) by providing new evidence on the importance of certain 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 finance consumption with resources from their origin country, instead of sending remittances (Albert and Monras (2019)), and did not drive domestic students out of campus surroundings, where both rents and prices increased faster because of concentrated demand and income effects.

The rest of the paper is organized as follows. Section 2 provides background on international enrollment trends in the US and how foreign students differ from traditional immigrants and domestic students. Section 3 outlines the construction of the college town sample, while Section 4 details the international student inflow variable, its validation, and collection of prices, rents, and other data. Section 5 presents stylized facts of housing markets and student behavior in college towns that motivates our empirical analysis and mechanism. Section 6 introduces the methodology and discusses the main results of the paper. Section 7 discusses the mechanisms that account for our results. Section 8 concludes.

2 International Students in the US

Domestic college enrollment grew about 1% per year from 1995 until 2004 and again by 1% annually from 2005 to 2015, according to data from the Integrated Postsecondary Education Data System (IPEDS). In contrast, the annual growth rate of international enrollment had a twofold increase from 1995-2004 to 2005-2015, particularly pushed by undergraduate enrollment (Figure (II)). Asian countries, in particular China, have been the most important driving force of the international student boom of the last decade in the US. China alone currently accounts for almost a third of all international students in American universities, compared to a share of roughly 10% in 2005 (Figure (F.1) in the Online Appendix).

Bound et al. (2020), Khanna et al. (2020), Chen (2019), and Li and Zhang (2011) detail several domestic push factors in China accounting for this trend, including higher rates of high school completion, economic growth, and policy changes facilitating the use of students' personal resources to study abroad.[5] Available personal income is crucial to afford higher education abroad, as over 80% of international undergraduates have as primary source of funding personal and family funds.[6]

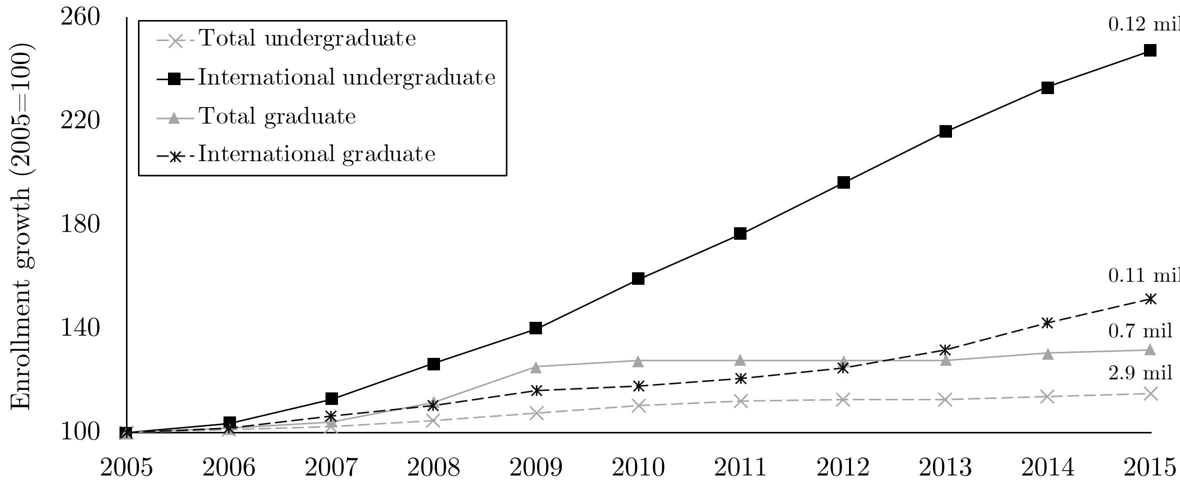
Figure (III) shows the evolution of personal funds international students declare on immigration forms relative to local personal income in US college towns from 2005 through 2016. These declared funds represent a lower bound on country of origin resources, since international students are required to report an income level to only cover the net cost of attendance. Even as local income in college towns fell during the 2007-2012 housing collapse, funds of international students continued to grow.

Demand-side factors also boosted international enrollment. The secular decline in state appropriations for higher education underway since the 1990s accelerated substantially with the 2008-09 Great Recession in typical fashion following economic downturns (Bound et al. (2020)). To make up for this funding shortfall with tuition revenue, universities have turned to foreign students, who not only pay a much higher sticker price than in-state students, but finance expenses abroad using home country savings.[7] Thus, inflows of foreign students into university areas represent positive income shocks to local economies. These countercyclical income flows are likely orthogonal to local economic conditions and generated by the need for alternative financing sources by universities as in the last economic downturn.

[5]More generally, the importance of economic growth in generating student outflows and funds is salient in the Online Appendix Figure (F.2): a 10-percent growth in a country's GDP per capita over 2005-2016 is associated with a 22% increase in student enrollment from that country in US universities and a 3.5% increase in personal funds declared to immigration officers.

[6]Conservative estimates of the annual economic spending of international students in the US range from $20 to $40 billion dollars according to the Association of International Educators (NAFSA).

[7]Bound et al. (2020) find that a 10% drop in state appropriations is associated with a 12% increase in international enrollment at research universities.



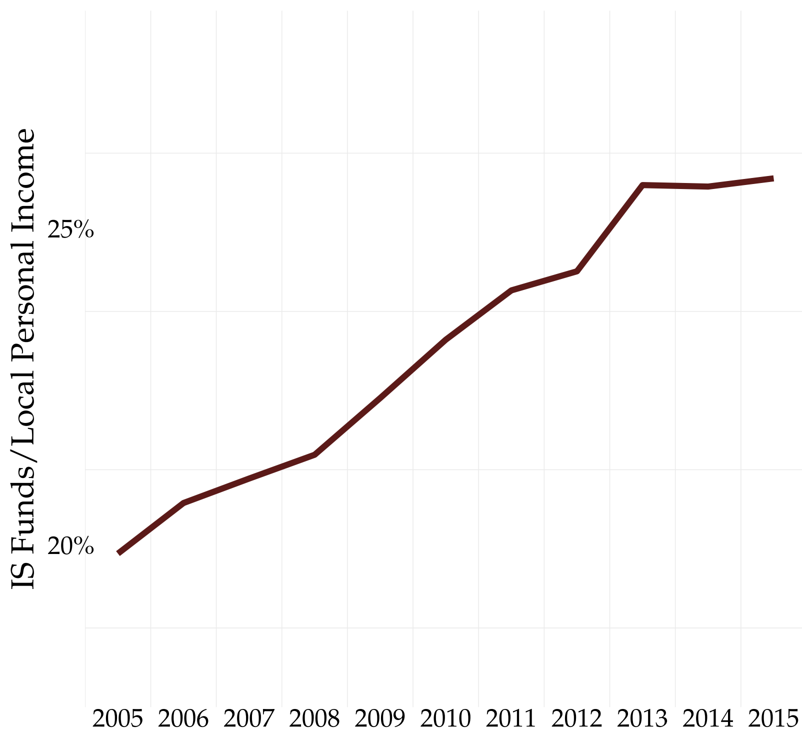
Notes: Annual growth in the enrollment of degree-seeking international and total students in 241 college towns, by student level. International undergraduate enrollment grew 160% in the 10-year period, reaching 120 thousand students in 2015. Over the decade, international enrollment grew over 4 times 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 II
RECENT CHANGES IN STUDENT ENROLLMENT IN COLLEGE TOWNS

The fact that international students largely finance consumption without using local earnings — as visa restrictions limit their ability to work outside the university — represents a key difference with respect to "traditional" immigration, even when comprised by wealthy migrants (Pavlov and Somerville (2020)). It also differentiates foreign from domestic students, since the latter group is subject to the same business cycle as universities (particularly in public schools whose majority of enrollment is comprised by in-state students).

3 American College Towns

We now define 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



Notes: This figure compares the evolution of personal funds self-declared by international graduate and undergraduate 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% Census American Community Survey (ACS) samples.

FIGURE III
PERSONAL FUNDS OF INTERNATIONAL STUDENTS IN COLLEGE TOWNS

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.

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. We exploit these similarities in housing markets across college towns later in the paper.

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.[8] As we document in Section (7), 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.

Data processing. 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 foreign and total (domestic and international) students.

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-

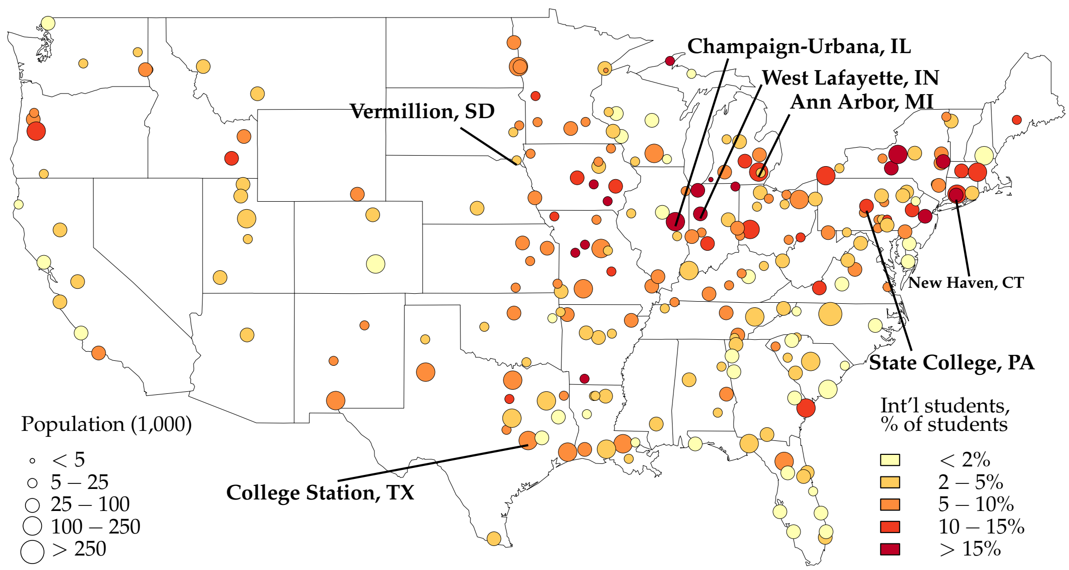
[8]From the Bureau of Transportation Statistics (https://www.bts.gov/bts/sites/rita.dot.gov.bts/files/publications/omnistats/volume_03_issue_04/pdf/entire.pdf).

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 Online Appendix Table (F.1).

With respect to spatial distribution and local characteristics, Figure (IV) 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, which hosts Texas Tech University (including the Texas Tech Health Sciences Center) and Lubbock Christian University. 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 and home to Penn State Harrisburg, 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



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 IV
AMERICAN COLLEGE TOWNS

have housing markets with very similar characteristics, shaped by students' preferences, as we discuss in Section 5. 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 Online Appendix.

4 Data & Sample Construction

4.1 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 the Online 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 $\text{Total}_{j,t} = \text{Domestic}_{j,t} + \text{International}_{j,t}$. We thus can decompose international enrollment into

$$\begin{aligned}\text{International}_{j,t} = &\underbrace{(\text{International}_{j,t-1} - \text{Degree}_{j,t-(t-1)})}_{\text{Retained enrollment}} + \\ &\underbrace{\text{International}_{j,t} - (\text{International}_{j,t-1} - \text{Degree}_{j,t-(t-1)})}_{\text{New enrollment } (\Delta\text{International}_{j,(t-1)\longrightarrow t})}\end{aligned} \tag{1}$$

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

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

Remote learning. 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 the variable $\text{International}_{j,t}$ 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. Further, none of our 325 sample universities were online-only during the period. Finally, 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.

International student inflow measure. Finally, the annual international student influx all universities j located in college town k is obtained from[9]

$$\Delta\text{International}_{k,(t-1)\longrightarrow t} = \sum_{j(k)} \Delta\text{International}_{j,(t-1)\longrightarrow t}. \tag{2}$$

Additional international student data. Finally, we complement the IPEDS data with administrative records obtained through a Freedom of Information Act (FOIA) request with the US Immigration and Custom Enforcement (ICE) from the Department of Homeland Security (DHS). These records aggregate individual I-20 forms filed by every international student in the

[9]We assess the accuracy of our constructed international student inflow measure in two ways. First, by comparing it to official data on the inflow of first-time degree seeking freshmen international students. Second, by comparing a national-version of the measure to official records of aggregate international student inflows into the US. Results are shown in Online Appendix Figure (F.3). Our constructed inflow measures track each corresponding inflow from official data extremely well, with correlations between 90% and 99%.

US, expanding on the IPEDS information along several dimensions. Specifically, the data track annual counts of international students by university×country of origin, university×country of origin×major, and university×country of origin×personal income. As these records lack degrees awarded, they only allow us to measure changes in enrollment, but not inflows, by student nationality, which we use in additional analysis later in the paper.

4.2 House prices, rents & other data

In our context, the ideal price index to study housing markets needs to match the relevant geography of college towns as closely as possible. Using prices at the metropolitan statistical area (MSA) would ultimately include locations with almost no relevance to the student population, whose housing consumption is situates concentrically to the campus area (as we show in Section 5). County-level prices would similarly incorporate extraneous price trends and confound the analysis. We therefore use home prices at the Census place level — that is, cities and towns.

Home prices. We measure house prices in college towns using the enhanced Federal Housing Finance Agency (FHFA) House Price Index (HPI) developed by Bogin et al. (2016a,b,c). This annual repeat-sales housing price index uses transaction information from 97 million conforming mortgages secularized or purchased by Fannie Mae and Freddie Mac since 1975. To match the geographic area of college towns, we collect the FHFA HPIs for 54,901 census tracts which we then map to Census places using Census block assignment files. The local home price in a college town is the average home value of all tract-level prices contained in that town.[10]

Rents. 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 7, 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

[10]This approach ensures that only home transactions recorded within the boundaries of a college town are assigned to that location, as converting FHFA tract-level prices into blocks and then into college towns preserves city boundaries. On average, college towns have 10 Census tracts that at least partially coincide with the town's boundaries.

rents is transmitted to home prices than simply using the dynamic Gordon model framework (Campbell et al. (2009)).

We use two alternative sources of rental data. We first use city-level Zillow Rent Index (ZRI) from Zillow.com. The index is available for 176 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% American Community Survey (ACS) 5-year pooled samples with 2005 and 2016 as initial and end years, respectively.

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.

Additional data. 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 Online Appendix (A). Selected descriptive statistics are displayed in Table (I).

5 Local Housing Markets in College Towns: Stylized Facts

In this section, we document empirical regularities of housing markets in college towns. These rarely studied places have unique features shaped by the reliance of local economies and housing on the student population and university activity. These characteristics will motivate our empirical analysis in sequence.

Students are renters. To begin our analysis within college towns, we establish the first stylized fact with respect to student housing tenure, especially for international students. Based on data from 5% ACS 5-year rolling samples, foreign-born students are almost in totality renters, with as little as 3% owning single-family homes in the 2012-2016 period. Although domestic students also mainly live in rentals, nearly 20% owned single-family homes (SFHs) in 2012-2016. 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.

MFHs represent large share of local dwellings. 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% in college towns) 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 live near campus. Another empirical regularity we present relates to student 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.

Taken together, these patterns imply that the landscape of a representative American college town displays a well-defined structure. Near the university campus, student housing dominates the housing stock, 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.

Students segregate from nonstudents. Students not only live near campus in college towns, but they reside in different areas than nonstudents. To formally calculate student segregation, we compute city-level dissimilarity indexes, $\frac{1}{2}\sum_g |\frac{s_g}{s} - \frac{ns_g}{ns}|$, 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. An index value of 1 represents complete segregation. Figure (V) shows the distribution of student segregation across all college towns. Over 90% of them display at least moderate segregation.[11]

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 enclaves, and nonstudent homeowners are mainly affected through the mechanism we explore in Section 7. As a result, construction of multi-family housing near campus is almost certainly new supply of student housing.[12]

6 Empirical Strategy & Results

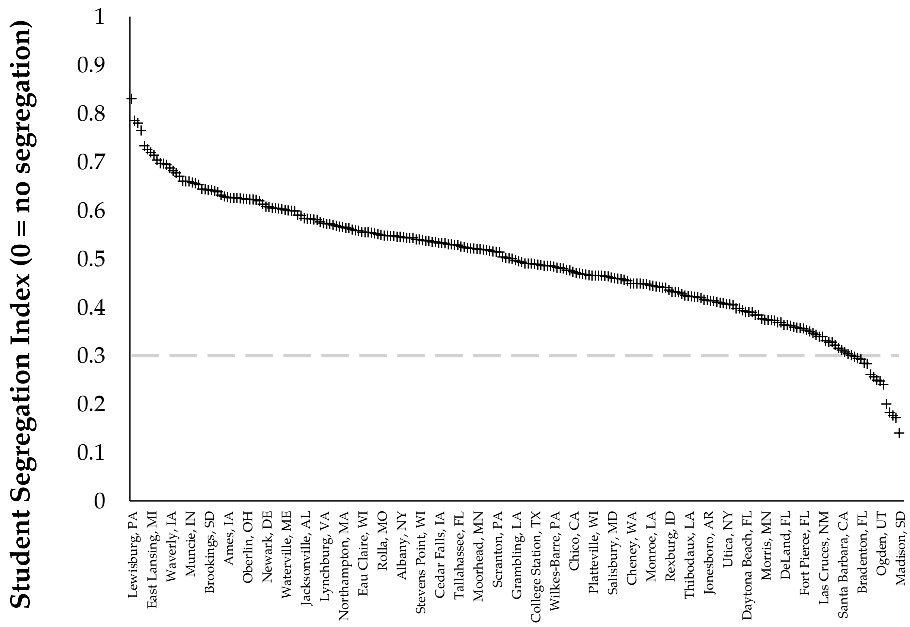
6.1 First-difference estimation

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

$$\Delta\text{Price}_{k,t\longrightarrow(t+1)} = \beta \times \frac{\Delta\text{International}_{k,(t-1)\longrightarrow t}}{\text{Population}_{k,(t-2)}} + \alpha\Delta x_{k,(t-1)\longrightarrow t} + \gamma_{s(k)} + \theta_t + \Delta\varepsilon_{k,t} \tag{3}$$

[11]We present Champaign-Urbana, IL in Online Appendix Figure (F.4) to provide a visual example of robust, pervasive patterns of residential segregation between students and non-students.

[12]In Online Appendix (D), we show that student segregation in college towns predates the international student boom, having changed little over time. Our data further shows no evidence of student outflows from the city center toward farther areas, and even of nonstudents within 2 miles from campus on average.



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 non-students 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 East Lansing, MI, 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 V

SEGREGATION BETWEEN STUDENTS AND NONSTUDENTS IN COLLEGE TOWNS

where the main explanatory variable is the annual inflow of international students to college town k, $\Delta\text{International}_{k,(t-1)\longrightarrow t}$, as a share of total population. The ratio captures the importance of relative international student inflows and gives β an intuitive interpretation: it measures the $\widehat{\beta}$% effect on the price change of an annual inflow of international students equal to 1% of the college town population. We also report regression results using log annual international inflows as an alternative variable of interest.

The dependent variable in (3) is the annual log house price index measured by the census-tract FHFA HPI, aggregated to the college town level. Time-varying variables in $x_{k,(t-1)\longrightarrow t}$ contain county-level personal income per capita and unemployment rate. Regressions are weighted by local population. In alternative model versions in the end of this section, we include several additional dynamic controls, including using city-level income data and controlling for local demographic characteristics. We also report unweighted versions of main regressions as part of an extensive robustness analysis. All variable changes are in logs, except for shares.

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.

We use panel unit root tests robust to cross-sectional dependence to check the first-difference model specification. These procedures are detailed in the Online Appendix (C). Home values and the main variable of interest are stationary in first-differences, although we fail to reject non-stationarity in levels for prices. This underscores an advantage of using first-differences instead of a model in levels controlling for college town fixed effects in our setting, as inference in the latter case could be spurious. We also present alternative versions of the year-to-year first-differences specification using long differences.

Finally, we report clustered standard errors throughout the paper, although Driscoll and Kraay (1998) robust standard errors as alternative 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. We further include state dummies $\gamma_{s(k)}$ to net-out state-specific price trends.

OLS estimates of model (3) are presented in Table (II). To establish a baseline reference, column (1) shows the relationship between log annual inflows and log price changes without benchmarking inflows by local population or controlling for any other factors. The estimated effect suggest that an increase of 10% in the annual inflow of international students increases prices by 0.2%. A close point estimate, about 0.2%, is reported in column (2) after including dynamic controls and fixed effects. Although this effect seems small in magnitude, the average

TABLE II

IMPACT OF INTERNATIONAL STUDENTS ON HOUSE PRICES

MAIN MODEL

	Δ Price$_{t\longrightarrow(t+1)}$						ΔPrice$_{2005\longrightarrow2016}$
	OLS (1)	OLS (2)	IV (3)	OLS (4)	OLS (5)	IV (6)	IV (7)
ΔInternational$_{(t-1)\longrightarrow t}$	0.002***	0.002***	0.003***				
	(0.001)	(0.001)	(0.001)				
			$[0.001, 0.004]^a$				
$\frac{\Delta\text{International}_{(t-1)\longrightarrow t}}{\text{College town population}_{(t-2)}}$				0.260*	0.353***	0.365***	
				(0.140)	(0.065)	(0.074)	
						$[0.220, 0.510]^a$	
$\frac{\sum_t \Delta\text{International}_{(t-1)\longrightarrow t}}{\text{College town population}_{t-2}}$							0.324***
							(0.132)
							$[0.064, 0.583]^a$
$t = \{2005, \ldots, 2016\}$ dummies		X	X		X	X	X
State fixed effects		X	X		X	X	X
Controls		X	X		X	X	X
Observations (college towns $\times$ $\sum_t$)	2410	2410	2410	2410	2410	2410	241
R-squared	0.003	0.40	0.40	0.002	0.40	0.40	0.60

Notes: (1) displays OLS results of a model regressing log differences of home prices (FHFA annual index) on the log international student inflows. Column (2) adds year and state fixed effects, as well as unemployment rates and log personal income per capita to (1). (3) is estimated by instrumenting log international student inflows with predicted log inflows using the national-share instrument in equation (4). Columns (4) through (6) re-run these regressions successively by diving the main variable of interest (and predicted changes in enrollment) by lagged local population. (7) uses a long-differences version of our main model. 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 the state level. Regressions are weighted by pre-2005 population.
[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.

increase of international student inflows during 2005-2016 was 111%, implying an increase in home prices in excess of $3,400 relative to the housing boom peak.

Columns (4) and (5) use as the main explanatory variable the share of international inflows to the college town population. Estimated coefficients imply a slightly higher magnitude on average: $4,400. That is consistent with college towns with slower overall population growth disproportionately receiving larger inflows of international students, as we show in Figure (E.1) in the Online Appendix. Since these estimates are not causal, we discuss in detail magnitude assessment and other potential issues after we introduce our instrumental variable strategy below.

6.2 Instrumental Variable Strategy

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

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. In this case, OLS estimates of the international student impact would be upward-biased. Alternatively, foreign-born student inflows could be endogenous if students self-select into college towns where housing costs are increasing more slowly, which produces attenuated estimates. This could be caused by persistent negative shocks to state appropriations vis-à-vis poor local economic conditions, and followed by universities compensating constrained budgets by expanding international enrollment.

In order to identify the causal relationship between the international student enrollment boom and home prices, we first make use of a modified version of the shift-share instrument by Altonji and Card (1991) and widely used in the literature. Later in the paper, we employ the standard version of the shift-share instrument leveraging variation in the country of origin of international students. Both approaches generate international student inflows that are plausibly exogenous to the evolution of house prices and rents in college towns.

We motivate the modified shift-share instrument with the following insight: top destinations for students in the past remain the most internationalized universities decades later. Colleges that become more well-known abroad, either because of more aggressive international outreach or prestige, or due to the establishment of alumni networks persistently receive more foreign students over time. 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 market shares of previous international student enrollment in the US are more likely to receive larger inflows in the future, the historical international presence in a college towns can be used to predict future inflows.

This national-level shift-share is constructed according to each university's historical presence of total foreign students, as of 1996.[13] It uses the total of international students in the US in each year and the historical share of foreign students in a college in 1996 to obtain the shift-share prediction of inflows by college town and year. Total student migration levels in the US are translated into expected migration by city, according to the formula

$$\Delta \widehat{\text{International}}_{k,(t-1)\longrightarrow t} = \left(\frac{\text{International}_{k,1996}}{\sum_k \text{International}_{k,1996}} \right) \sum_k \Delta\text{International}_{k,(t-1)\longrightarrow t} \tag{4}$$

where $\Delta \widehat{\text{International}}_{k,(t-1)\longrightarrow t}$ is the predicted influx of international students into college town k and year t and $\sum_k \Delta\text{International}_{k,(t-1)\longrightarrow t}$ is the total influx of foreign students in the United States in year t. The term in parenthesis represents the share of national foreign student enrollment in college town k in 1996.

Identification. We make two identifying assumptions in (4). First, international student enrollment shares in the base year 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 or rents better than the local market participants. Second, we assume that annual changes in national foreign student inflows are exogenous to

[13]We use 1996 as the base year for the historical share in the instrument as this is the oldest enrollment data available from IPEDS. As Figure (F.5) in the Online Appendix indicates, 1996 was a typical year for international enrollment pre-boom. Using subsequent years as the historical share changes our coefficient estimates only marginally.

the economic conditions in the destination college towns. We assess the plausibility of the first assumption in the Online Appendix (E).

We also use the standard shift-share instrumental variable which exploits variation in the country of origin. Networks are often location-specific, where friends, family, or alumni associations from the same country provide support and information for future prospective students. Indeed, Shih (2017) and Chen (2019) show that school-country specific networks are highly correlated with future international student enrollment. To leverage this variation, we our second instrument is calculated as:

$$\widehat{\text{International}}_{k,(t-1)\longrightarrow t} = \sum_c \frac{\text{International}_{c,k,2005}}{\text{International}_{c,2005}} \times \text{International}_{c,(t-1)\longrightarrow t} \tag{5}$$

where the share component corresponds to the college town k historical share of international students from country c, which allocates current national changes in enrollment from that same country.

Because the implementation of (5) requires variation by university$\times$country of origin, we use the ICE administrative records with annual student counts. Rather than international inflows, the data only enables the computation of changes in enrollment, $\text{International}_{(t-1)\longrightarrow t}$, which may introduce measurement error relative to actual inflows. Because of this potential drawback, we report results for the national-level instrument first and supplement it with the country of origin instrument. Both strategies give similar results.

6.3 Instrumental Variable Results

The first stage of each 2SLS estimate is reported in Table (F.3) in the Online Appendix. We regress the potentially endogenous variable, the international students inflow, 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 as well as the version using international student nationalities as variation, and the effective F-statistics are appropriate. We therefore consider (4) and (5) to be sufficiently strong instruments, and employ standard IV inference. Further, the plausibility test of the identifying assumption in the section below lends further credibility to our IV estimates.

Columns (3) and (6) in Table (II) show 2SLS estimates of the international student impact on home prices using the national-level instrument. Instrumenting international student inflows lead to only slightly increases from OLS point estimates, highlighting the usefulness of our setting to naturally remedy endogeneity concerns pervasive in immigration studies. At the mean, international students caused nominal housing price gains over 2005-2016 of $3,400-$4,600 for the estimated IV coefficients, an average home value in the sample of $155,000 and an average annual share of international inflows to local population of 0.57%. Pooling both estimates imply that about 40% of the average housing return in college towns during the housing bust and recovery was attributed to foreign student inflows, either directly or as consequence of the secondary income impact in local economies.

Column (7) calculates a long-differences version of our baseline model with $\Delta\text{Price}_{2005\longrightarrow 2016}$ as the outcome and the cumulative international student inflow during the period relative to the college town population as the main variable of interest. This allows for potentially slow price adjustment year-over-year, albeit it limits the model's ability to time housing market responses to internationals student inflows. The magnitude of the estimated effect is broadly in line with the firs-difference specifications.

Additional instrumental variable results. Table (III) replicates our previous estimates employing the country-of-origin shift-share instrument and using changes in international enrollment instead of international inflows. First-stage results in Online Appendix Table (F.3) indicate that the use of country-of-origin variation yields an instrument with strong predictive behavior, similarly to the national-share instrument. IV results are in line with our previous estimates on home prices, although here instrumented changes in international enrollment lead to more variation in magnitude between the 2SLS and OLS coefficients. Confidence intervals implied by Adão et al. (2019) standard errors and the two-step weak-instruments-robust confidence set from Andrews (2018) are very similar, lending further credibility to the estimates.

Benchmark elasticities in the literature. How do these estimated effects on home prices compare to previous parameter estimates in the literature? For US MSAs, Saiz (2007) estimates an effect of about 1:1 from immigration to existing population on home prices (i.e., $\beta = 1$

TABLE III

INTERNATIONAL STUDENTS & HOUSE PRICES

COUNTRY-OF-ORIGIN INSTRUMENT

Δ Price$_{t\longrightarrow(t+1)}$	OLS (1)	OLS (2)	IV (3)	OLS (4)	OLS (5)	IV (6)
International$_{(t-1)\longrightarrow t}$	0.004***	0.002**	0.005***			
	(0.001)	(0.001)	(0.002)			
			$[0.002, 0.008]^a$			
$\dfrac{\text{International}_{(t-1)\longrightarrow t}}{\text{College town population}_{(t-2)}}$				0.511*	0.652***	1.760***
				(0.262)	(0.163)	(0.502)
						$[0.776, 2.745]^a$
$t = \{2007, \ldots, 2016\}$ dummies	X	X	X	X	X	X
Adão et al. (2019) (AKM) CI						$[0.860, 2.661]$
State fixed effects		X	X		X	X
Controls		X	X		X	X
Observations (college towns $\times$ $\sum_t$)	1,628	1,628	1,628	1,628	1,628	1,628
R-squared	0.01	0.34	0.33	0.001	0.37	0.37

Notes: (1) displays OLS results of a model regressing log differences of home prices (FHFA annual index) on the log changes in international student enrollment. Column (2) adds year and state fixed effects, as well as unemployment rates and log personal income per capita to (1). (3) is estimated by instrumenting log changes in international student enrollment with predicted log enrollment changes using the country-of-origin instrument in equation (5). Columns (4) through (6) re-run these regressions successively by diving the main variable of interest (and predicted inflows) by lagged local population. 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 the state level. Regressions are weighted by pre-2005 population.

[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.

in equation (3)) while Ottaviano and Peri (2012) recover a long-run elasticity about twice our national-share estimate, 0.68%, and smaller than our estimate with the country-of-origin instrument. Cochrane and Poot (2021) survey the literature findings across eight countries and place housing price elasticities in the range of 1%—2%, despite heterogeneity depending on the context of the underlying immigration flow. This is again largely consistent with our estimates.[14]

6.4 Impact on Rents

Given that more than 95% of international students are renters, the first order impact of international inflows into college town housing markets should occur on rents. We run model (3) substituting log rent changes from 2012 to 2016 for log home price changes, which is when the Zillow.com rental index is available for the most college towns. Table (IV) shows OLS and 2SLS results for both international inflows and inflows relative to the local population in columns (1) through (6). Estimated rent elasticities are close in magnitude to results in Table (II), although OLS estimates now display a slight upward bias.

Column (7) calculates a long-differences version of our baseline model with $\Delta\text{Rent}_{2012\longrightarrow2016}$ as the outcome and the cumulative international student inflow during the period relative to the college town population as the main variable of interest. This specification only considers part of the aggregate international influx (2012 ownward), missing the beginning of the international boom underway since 2005. Similarly, column (8) uses a long-differences model with the Census rents, enabling an estimation period compatible with our analysis for prices (2005 to 2016). Both estimates are consistent in magnitude with the previous elasticities after adjusting column (7) for its lower base value (at the bottom of the housing collapse).

Findings summary. Our estimates show a positive effect on prices and rents caused by an increase in international student enrollment. These effects have important implications for

[14]As we mentioned before, international students do not directly affect the local labor supply while enrolled and likely increase the labor demand through consumption and by potentially subsidizing expanded domestic enrollment (Shih (2016)). Because they move near campus where most residents are other students, countervailing native out-migration flows ("native flight") are also unlikely in college towns, as we only find evidence of nonstudents locating farther away from campus.

TABLE IV

IMPACT OF INTERNATIONAL STUDENTS ON RENTS

	Δ Rent$_{t\longrightarrow(t+1)}$						ΔRent$_{2012\longrightarrow2016}$	ΔRent$_{2005\longrightarrow2016}$
	OLS (1)	OLS (2)	IV (3)	OLS (4)	OLS (5)	IV (6)	IV (7)	IV (8)
ΔInternational$_{(t-1)\longrightarrow t}$	0.003***	0.004***	0.002					
	(0.001)	(0.002)	(0.002)					
			$[-0.001, 0.005]^a$					
$\frac{\Delta\text{International}_{(t-1)\longrightarrow t}}{\text{College town population}_{t-2}}$				0.300**	0.812***	0.448*		
				(0.120)	(0.160)	(0.251)		
						$[-0.045, 0.940]^a$		
$\frac{\sum_t \Delta\text{International}_{(t-1)\longrightarrow t}}{\text{College town population}_{t-2}}$							0.444***	0.163***
							(0.153)	(0.062)
							$[0.143, 0.744]^a$	$[0.040, 0.285]^a$
$t = \{2012, \ldots, 2016\}$ dummies	X	X	X	X	X	X		
State fixed effects	X	X	X	X	X	X	X	X
Controls		X	X		X	X	X	X
Observations (college towns $\times$ T)	880	880	880	880	880	880	880	880
R-squared	0.19	0.19	0.19	0.19	0.19	0.19	0.45	0.36

Notes: (1) displays OLS results of a model regressing log differences of rents (Zillow.com index) on the log inflow of international students. Column (2) adds year and state fixed effects, as well as unemployment rates and log personal income per capita to (1). (3) is estimated by instrumenting log international student inflows with predicted log inflows using the national-share instrument in equation (4). Columns (4) through (6) re-run these regressions successively by diving the main variable of interest (and predicted inflows) by lagged local population. Column (7) uses a long-differences version of our main model and column (8) uses census rents as outcome in another long-differences specifications. 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 the state level. Regressions are weighted by pre-2005 population.

[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.

students and nonstudents. While current homeowners directly benefit from increased housing equity, students who rent are negatively impacted by higher rents.

6.5 Heterogeneity Analysis

To lend further credibility to our results and unveil important sources of heterogeneity in our effects, we conduct in Table (V) three additional analyses. First, we run separate regressions using undergraduate and graduate international inflows to investigate whether the two student subpopulations affect home prices differently. Columns (1) and (2) show that undergraduate inflows have a two-fold effect relative to graduate students. This is consistent with a much more accelerated growth in international undergradudate enrollment relative to international graduate students during 2005-2015 and with the fact that foreign undergrads are more likely to be full paying students and had consistently growing funds (Figure (III)), therefore representing greater income shocks to college towns.

Columns (3) and (4) split the college town sample into cities that only have private institutions and locations with only public schools. The larger effect in college towns home to public schools aligns with the fact that 70% of international student inflows into college towns concentrate at those institution types, which as we discussed in Section 2, increasingly relied on foreign students to offset declining public funding during the Great Recession. Lastly, columns (5) and (6) split college towns into a subsample with high student segregation (i.e., with a dissimilarity index above 0.5) and with low segregation. Stronger price effects in college towns with lower segregation are consistent with the mechanism of single-family home replacement near campus that we show in Section 7.

6.6 Alternative Explanations and Robustness

University dorms. Our analysis thus far leaves the role of university-provided housing in the background. In general, part of student enrollment is also absorbed by university dorms. Figure (F.6) in the Online Appendix shows that college towns have added a total of about 100,000 dorm beds from 2005 to 2015, which at most housed 17% of total enrollment

TABLE V
IMPACT HETEROGENEITY OF INTERNATIONAL STUDENTS ON HOUSE PRICES

	International Inflow		University Control		Student Segregation	
	Undergraduate IV	Graduate IV	Private IV	Public IV	High IV	Low IV
Δ Price$_{t \longrightarrow (t+1)}$	(1)	(2)	(3)	(4)	(5)	(6)
$\frac{\Delta\text{International}_{(t-1)\longrightarrow t}}{\text{College town population}_{(t-2)}}$	0.554**	0.258**	0.360***	0.456**	0.300***	0.479***
	(0.261)	(0.123)	(0.136)	(0.197)	(0.098)	(0.075)
	$[0.151, 1.53]^a$	$[0.039, 0.535]^a$	$[0.093, 0.627]^a$	$[0.071, 0.842]^a$	$[0.108, 0.492]^a$	$[0.332, 0.626]^a$
$t = \{2005, \ldots, 2016\}$ dummies	X	X	X	X	X	X
State fixed effects	X	X	X	X	X	X
Controls	X	X	X	X	X	X
Observations (college towns $\times$ $\sum_t$)	2410	2410	1179	711	1080	1089
R-squared	0.35	0.30	0.34	0.39	0.35	0.41

Notes: (1) regresses log differences of city-level home prices (FHFA annual index) on the international undergraduate inflow share, where we instrument the inflow using using the national-share instrument in equation (4), replacing overall international enrollment with predicted foreign undergraduate flows. (2) runs the same specification using international graduate student inflows. (3) subsamples the full sample of 241 college towns into a group of cities with only private universities, while (4) uses a subsample with only public colleges. (5) and (6) split the college town sample into those locations with high and low student segregation, respectively, where student segregation is measured as described in the main text. College towns are 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 the state level. Regressions are weighted by pre-2005 population.
[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.

and stayed constant during the period. To put the number of 100,000 beds in perspective, this accounts for less than the increase in international enrollment in college towns and is similar to the growth in luxury private housing in only 63 college towns.[15] Thus, the home price and rent effects we find occurred despite of the expansion in university dorms, which could have prevented an ever greater pressure on local housing markets. Column (1) of Table (E.3) in the Online Appendix reproduces our instrumental variable baseline model of the effect on home prices while controlling for local expansion of dorm capacity, which has no effect on the main estimate.

Other checks. We now briefly describe a battery of additional tests to address potential issues with our empirical methodology in the Online Appendix (E). We show that our results are not driven by domestic student enrollment growth, including out-of-state undergraduate students, or local population growth. A placebo exercise where we regress annual home price changes from 1998 to 2004 on foreign student inflows during the 2005-2015 boom shows no significant effects, indicating an absence of price pre-trends in college towns on average.

Online Appendix Table (E.3) further shows that our estimates remain largely unchanged when we: (*i*) use city-level income per capita calculated from 1% ACS annual samples instead of county-level income;[16] (*ii*) further control for the local share of married households; (*iii*) use unweighted regressions; and (*iv*) change the level of standard error clustering. Censoring the horizon of our estimation period in Online Appendix Figure (E.4) indicates strong effects concentrated in "bust-only", implying that college towns receiving larger international student inflows were better able to insulate their housing markets.[17]

[15] According to data manually retrieved from 10-k forms and company online portfolios on projects completed from 2005 to 2017 by the largest student housing developers in the US. These projects are mid- and high-rise buildings located near campus, and include upscale, resort-style amenities.

[16] Note that although this income control tracks the economic conditions of college towns with greater relevance than the county-level measure, which includes other places in the same county, annual samples of the American Community Survey are likely to contain larger measurement and sampling errors than the pooled 5-year samples we use in other sections of the paper.

[17] 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 -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 economic indicators (Online Appendix Table (F.4)).

7 Mechanisms

This sections builds on the stylized facts of housing markets in college towns introduced in Section 5. Because students live near campus, new construction needed to accommodate growing student inflows is likely to take place surrounding the university. Additionally, as most students live in multi-family housing rentals, this construction is likely to comprise apartment buildings. The mechanism we provide evidence for is the replacement of existing single-family units near campus with apartment buildings. This residential development movement pushes up prices near and far from campus, as homeowners leave the university surroundings to relocate in other areas. We first present evidence of the mechanism and rule out the possibility of alternative mechanisms — change in vacancy rates or supply expansion on undeveloped land.

Measuring granular housing density. To verify this mechanism, 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.

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.[18]

In Table (VI), 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.

Column (4) shows a long-difference regression version of the causal effect of international student inflows as in our main model (equation (3)) 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 confirms that college towns receiving larger cumulative inflows of international students 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. Finally,

[18] 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.

TABLE VI

RESIDENTIAL DENSIFICATION IN COLLEGE TOWNS

	% Highly developed land	Δ Highly developed land			
	$<$ 2 miles	$<$ 2 miles	$>$ 2 miles	$<$ 2 miles IV	$<$ 2 miles IV
	(1)	(2)	(3)	(4)	(5)
Log dist. from campus	-0.034***	-0.002***	-0.0004		
	(0.004)	(0.0004)	(0.001)		
$\sum_t \Delta \text{International}_{(t-1)\longrightarrow t}$				0.072***	0.068***
				(0.032)	(0.033)
Full set of controls				X	X
Added controls: population growth, dorm capacity, % college-educated workers					X
College town FE	X	X	X		
R-squared	0.45	0.37	0.21	0.52	0.53
Effective F-statistic				320.23	314.77
Observations	4211	4211	3783	231	231
(Block groups × college towns)	X	X	X		
(College towns)				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 using the national-share instrument and the full set of dynamic controls. (5) replicates the regression in (4) with added controls: population growth rate, change in dorm capacity, and, change in the share of college-educated workers. We report the Montiel Olea and Pflueger (2013) effective F-statistic (critical value at $\alpha = 0.05$ is ≈ 37). 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.

column (5) includes additional location controls and finds an effect of international students on residential densification near campus of similar magnitude.

Vacancy rates remained unchanged. An alternative mechanism that would result in the absorption of increased international student housing demand without new construction is a drop in vacancy rates. That is, previously vacant multi-family rentals become occupied. A simple test for this hypothesis is whether rental vacancy rates near campus have decreased over time. For block groups within 2 miles from the university, 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.[19]

Supply expansion on undeveloped land is unlikely. A second possibility is to build new housing supply on undeveloped land. In this case, the number of owned SFHs would remain constant, and the supply of apartment rentals expand. This is feasible if, first, there is available land near campus, and if it is possible to use the land 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.

Satellite data confirms this conjecture. 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 (e.g., new instructional and academic facilities, dorms) or privately-supplied housing, this advance on undeveloped land was lower than the developed land growth within 2-5 miles farther out: from 68% to 71%. This is consistent with a lower housing supply elasticity near campus. It also

[19] 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.

implies that the conversion of single-family housing into multi-family units occurred at a rate 2:1 relative to construction on undeveloped land near campus.

8 Conclusion

We provide evidence that the international student boom initiated in 2005 made local housing markets in the US more resilient during the Great Recession and led to increases in prices, rents, and residential development. Universities have increasingly turned to foreign students to boost tuition revenue, particularly in 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.

We assemble a comprehensive dataset of local markets around colleges and analyze how exogenous temporary migration inflows impact local housing markets amid economic downturns. College towns are small urban economies rarely studied that host one third of the US 4-year college enrollment. Using shift-share instruments exploiting the historical importance of a location in attracting foreign students and country-of-origin networks, we find 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 existing single-family homes.

Our results show a new dimension of broader effects resulting from the shift toward internationalization in American universities. Larger international student inflows have provided the average homeowner with $4,000 in home equity 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.

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Online Appendix

The Impact of International Students on Housing Markets

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Contents

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). State-of-residence domestic inflows are 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 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 Counts

In Table (B.1), we compare American Community Survey (ACS) 1% samples to official data provided by IPEDS.[1] 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.

TABLE B.1
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.

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)

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

with annual shares of all countries of origin. These data correspond to administrative information and should accurately reflect countries. In Table (B.2), we 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 (B.3)).

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.[2]

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

TABLE B.2

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 B.3
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.

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:

$$p_{k,t} = \alpha_k + \boldsymbol{\beta}'_k \boldsymbol{x}_{k,t-q} + u_{k,t} \tag{1}$$

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 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 (C.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.[3] 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.

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

TABLE C.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)
log Price	0.294	166.04***	−1.648
log Income	0.928	523.35***	−1.796
log Population	0.337	190.03***	−1.621
Δ log Price	0.465	250.04***	−2.776***
Δ log Income	0.514	276.33***	−1.389
Δ log Population	0.025	14.17***	−1.680
Unemployment	0.882	497.44***	−2.098***
Int'l Students Share	0.146	82.49***	−2.274***

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.

D Additional Stylized Facts

This appendix section introduces supportive evidence on the stylized facts of housing markets in college towns we introduce in the main paper, and discuss additional robust patterns. Table (D.1) shows the housing tenure distribution between native students, international students, and non-students in college towns over time.

TABLE D.1
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).

Next, we show that students live near campus and the consequence of this empirical fact on the structure of housing markets in college towns. We run a series of regressions of the form:

$$\text{Outcome}_{g,k} = \theta \times \ln \text{Dist. Campus}_{g,k} + \delta_k + \varepsilon_{g,k} \tag{2}$$

with the following outcomes: (1) share of student population, (2) home ownership, 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 from the US Census through the National Historical Geographic Information System (NHGIS).[4]

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 (D.2). 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

[4]The NHGIS contains block-level averages compiled from individually collected Census responses, therefore providing data that is more spatially granular than the standard decennial Census and American Community Surveys.

TABLE D.2

RELATIONSHIP BETWEEN DISTANCE FROM CAMPUS AND OUTCOMES

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

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. 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.

the opposite direction. Consistent with the fact that students rent MFHs, areas with greater student density also concentrate MFH rentals.

International students pay higher rents than native students. Although international students compete for the same housing stock with domestic students, they pay higher rents for all multi-family rental types (Table (D.3)), 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.[5]

TABLE D.3
RENTS 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).

Rents are higher and appreciate faster near campus. 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.[6] To verify whether rents also increase faster closer to campus, we run model (2) 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 (D.2) shows that rents grew faster in units closer to campus.[7]

Student segregation predates the international student boom. 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%

[5]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.

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

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

to 31% over 2000-2016, the change was mainly driven by increased enrollment, and not necessarily nonstudent population decline. 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, which we confirm later in the paper. 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.

E Detailed Robustness and Sensitivity Checks

One of the identifying assumptions we make in our national-share instrument is that international student enrollment in the base year 1996 is 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 enrollment of international students into the US 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 which channels could be problematic for the exclusion restriction.

TABLE E.1
INSTRUMENT SHARE AND LOCAL CHARACTERISTICS

$\left(\frac{\text{International}_{k,1996}}{\sum_k \text{International}_{k,1996}}\right)$	
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 enrollment of international students in 1996 to college town k divided by the national international student enrollment 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.

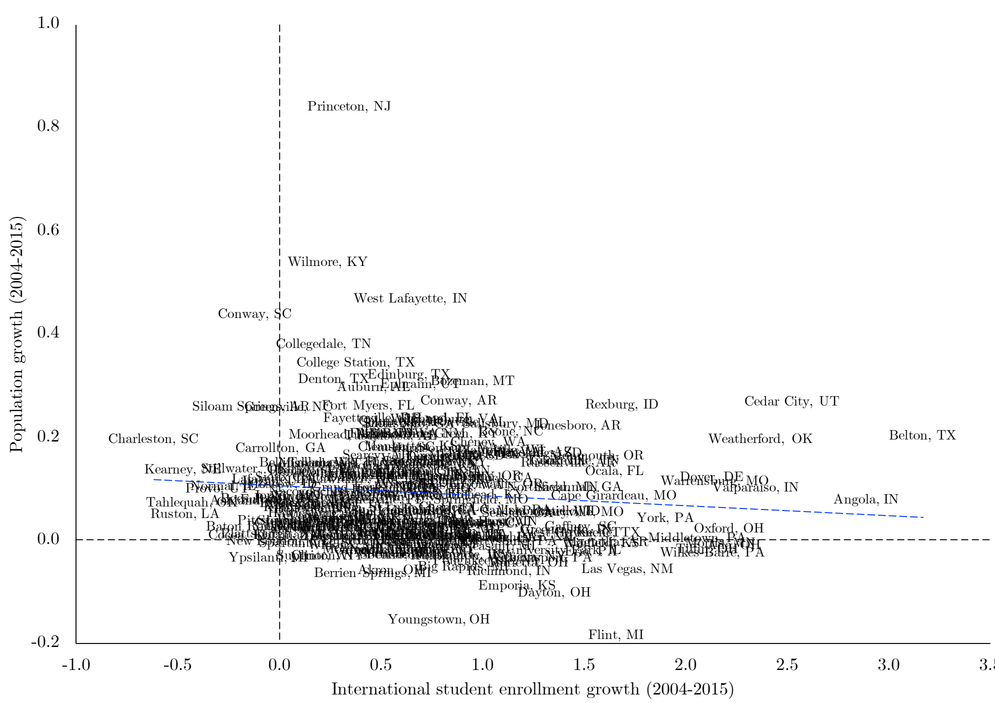
The correlation of the historical share of international students for each college town

$$\left(\frac{\text{International}_{k,1996}}{\sum_k \text{International}_{k,1996}}\right)$$

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 (E.1) shows the relationship between 1996 city characteristics and the city share of international students studying in the US 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.

Robustness. There may exist other reasons contributing to price and rent growth in college towns. For example, universities could respond to falling state appropriations by not only recruiting more foreign students, but also out-of-state candidates who pay higher tuition rates than in-state students. Moreover, unobservable characteristics that may make a certain college town or university more attractive to international students might also be valued by domestic students, driving inflows from within the US and from abroad. Perhaps domestic enrollment increases as a response to higher foreign student enrollment, as in Shih (2017). We bring these alternative explanations to the center of our analysis now and test the robustness of our previous results.

While the growth in international enrollment during the last decade has been unprecedented, one might still worry that our previous estimates may be extraneously picking up growth of domestic students or overall population. Figure (E.2) shows a positive relationship between international and domestic enrollment growth, albeit in the majority of college towns international enrollment grew faster in our study period.



Notes: Data description in Appendix (A).

FIGURE E.1

RELATIONSHIP BETWEEN POPULATION AND INTERNATIONAL ENROLLMENT GROWTH

Following the same approach in our main model (equation (1)), we test how including domestic students, out-of-state undergraduate students, or population growth changes our results. We first construct a domestic student inflow measure and add it to our baseline model. Column (1) of (E.2) shows that the previous estimate of the international inflow impact remains practically unchanged and the coefficient on domestic inflows is not different from zero.

TABLE E.2
FALSIFICATION TESTS
MAIN MODEL

	Δ Price$_{t\longrightarrow(t+1)}$							Δ Price$^{\textbf{Placebo}}_{t\longrightarrow(t+1)}$	
	OLS (1)	OLS (2)	IV (3)	OLS (4)	IV (5)	OLS (6)	IV (7)	OLS (8)	OLS (9)
$\frac{\Delta\text{International}_{(t-1)\longrightarrow t}}{\text{College town population}_{t-2}}$	0.351***	0.332***	0.314***	0.303***	0.311***				0.186
	(0.093)	(0.083)	(0.111)	(0.073)	(0.070)				(0.143)
$\frac{\Delta\text{Domestic}_{(t-1)\longrightarrow t}}{\text{College town population}_{t-2}}$	0.001								
	(0.015)								
$\frac{\Delta\text{Out-of-state}_{(t-1)\longrightarrow t}}{\text{College town population}_{t-2}}$		0.019	0.036						
		(0.035)	(0.055)						
$\Delta\text{International}_{(t-1)\longrightarrow t}$						0.002***	0.002***	0.001	
						(0.001)	(0.001)	(0.001)	
$\Delta\text{Population}_{(t-1)\longrightarrow t}$				X	X	X	X		
$t = \{2007, \ldots, 2016\}$ dummies	X	X	X	X	X	X	X		
$t = \{1998, \ldots, 2005\}$ dummies								X	X
Full set of controls	X	X	X	X	X	X	X	X	X
Year fixed effects	X	X	X	X	X	X	X	X	X
State fixed effects	X	X	X	X	X	X	X	X	X
Observations (College towns $\times$ T)	2410	1205	1205	1205	1205				
R-squared	0.41	0.41	0.48	0.48	0.48	0.41	0.41	0.38	0.36

Notes: (1) reproduces the main model in equation (3) including domestic student inflows. Column (2) uses instead out-of-state undergraduate inflows and (3) instruments both international student inflows with the national-share instrument and out-of-state inflows with a shift-share instrument using state of residence. (4)-(7) control for population growth. Columns (8) and (9) run placebo-type regressions where we regress past price growth prior to the international student boom on future international student flows.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

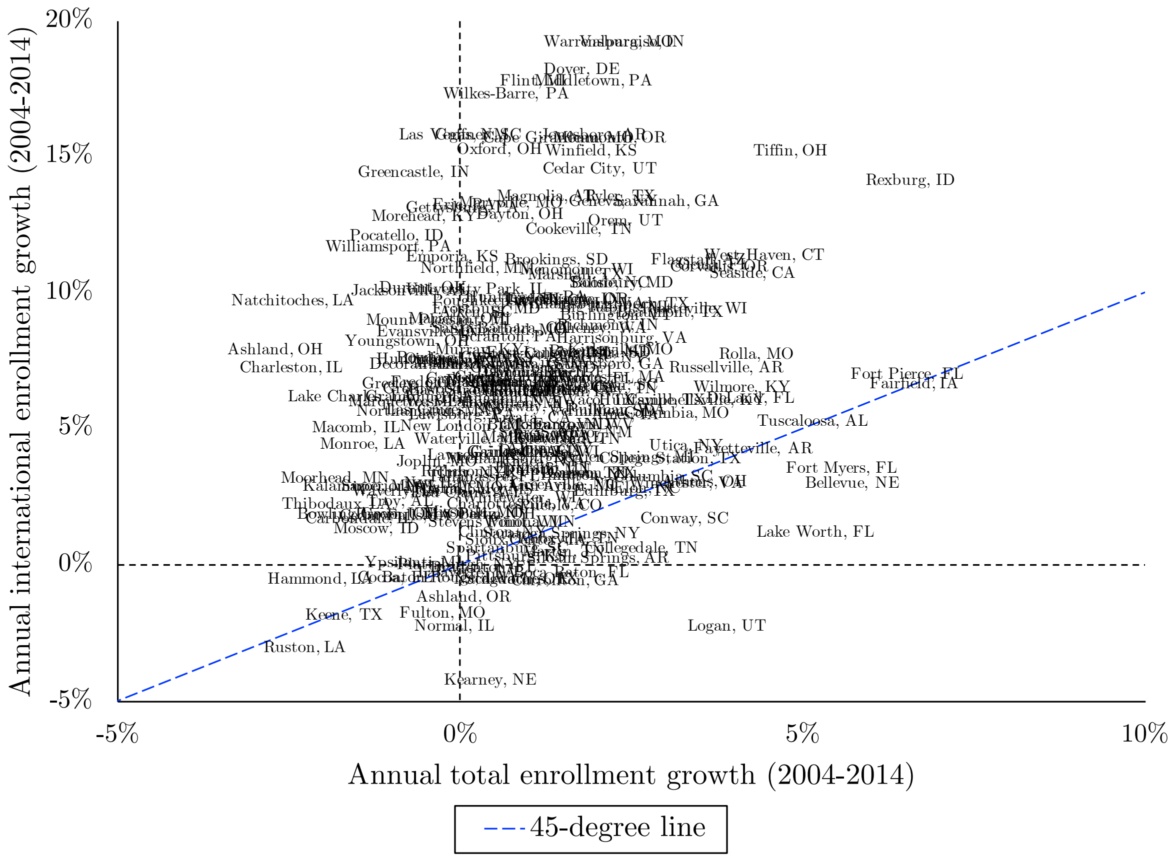
As domestic and international inflows are determined simultaneously, we leverage IPEDS data that allows us to employ a shift-share instrument using variation in the state of residence of freshmen undergraduate students. There is a persistent relationship between students' home state and college choices, beyond obvious patterns of public universities receiving large in-state student contingents.[8] We instrument the domestic undergraduate entry class us-

[8]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.

ing:

$$\Delta\widehat{\text{Out-of-state}}_{k,t} = \sum_{j\neq j(k)} \frac{\text{Out-of-state}_{j\neq j(k),k,1998}}{\text{Out-of-state}_{j\neq j(k),1998}} \times \Delta\text{Out-of-state}_{j\neq j(k),US,t} \tag{3}$$

where $\frac{\text{Out-of-state}_{j\neq j(k),k,1998}}{\text{Out-of-state}_{j\neq j(k),1998}}$ is the share of the freshmen class from state j, other than the college town's own state, $j(k)$, studying in college town k in 1998, and $\text{Out-of-state}_{j\neq j(k),US,t}$ gives out-of-state student inflows from state j into all college towns at t. Column (2) displays OLS estimates for the international inflow share and the out-of-state inflow variable. Once again, the estimated impact of foreign students remains unchanged and the coefficient of out-of-state inflows is zero. Column (3) instruments each student group inflow and returns similar estimates in magnitude and significance.



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

FIGURE E.2
INTERNATIONAL AND OVERALL ENROLLMENT GROWTH

Next, we include annual population growth to our main specification to verify whether overall local population growth could be driving our results. Accordingly, controlling for the variable in columns (4) thorough (7) have almost no impact on our main estimate.

Lastly, we conduct a placebo exercise where we regress annual home price changes from 1998 to 2004 on foreign student inflows during the 2005-2015 boom. If college towns receiving larger international student inflows had already been experiencing more accelerated price growth, this exercise would result in significant estimates and indicate the presence of pre-trends. Columns (8) and (9) show no association between higher international inflows and price growth.

Pre-trends in the outcome. 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 US 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.

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. Our previous placebo exercise does not suggest significant pre-trends, which we confirm again next.

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 (E.3) 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 economic indicators (Table (F.4)).

Alternative specifications & sensitivity. We now conduct additional tests to assess the robustness of our main specification. Table (E.3) replicates the main model with home prices as the outcome by first controlling for dorm capacity expansion (column (1)), then using city-level income instead of the county-level variable in the baseline model (column (2)), and finally by including the share of married households in column (3). Then, the following columns remove regression weights and then clustering standard errors at the college town level instead of state. Reported OLS and national-share IV estimates are stable and very similar in magnitude with

TABLE E.3
ROBUSTNESS CHECKS
MAIN MODEL

Δ Price$_{t\longrightarrow(t+1)}$	IV (1)	IV (2)	IV (3)	OLS (4)	IV (5)	OLS (6)	IV (7)
$\frac{\Delta\text{International}_{(t-1)\longrightarrow t}}{\text{College town population}_{(t-2)}}$	0.314***	0.349***	0.354***	0.330***	0.334***	0.353***	0.365***
	(0.089)	(0.075)	(0.079)	(0.074)	(0.078)	(0.104)	(0.129)
	$[0.138, 0.489]^a$	$[0.201, 0.496]^a$	$[0.199, 0.509]^a$		$[0.180, 0.488]^a$		$[0.112, 0.618]^a$
Dorm capacity	X						
Alternative income control		X					
% married households			X				
$t = \{2005, \ldots, 2016\}$ dummies	X	X	X	X	X	X	X
State fixed effects	X	X	X	X	X	X	X
Controls	X	X	X	X	X	X	X
Observations (college towns $\times$ $\sum_t$)	1975	2410	2410	2410	2410	2410	2410
R-squared	0.37	0.34	0.36	0.40	0.40	0.40	0.40

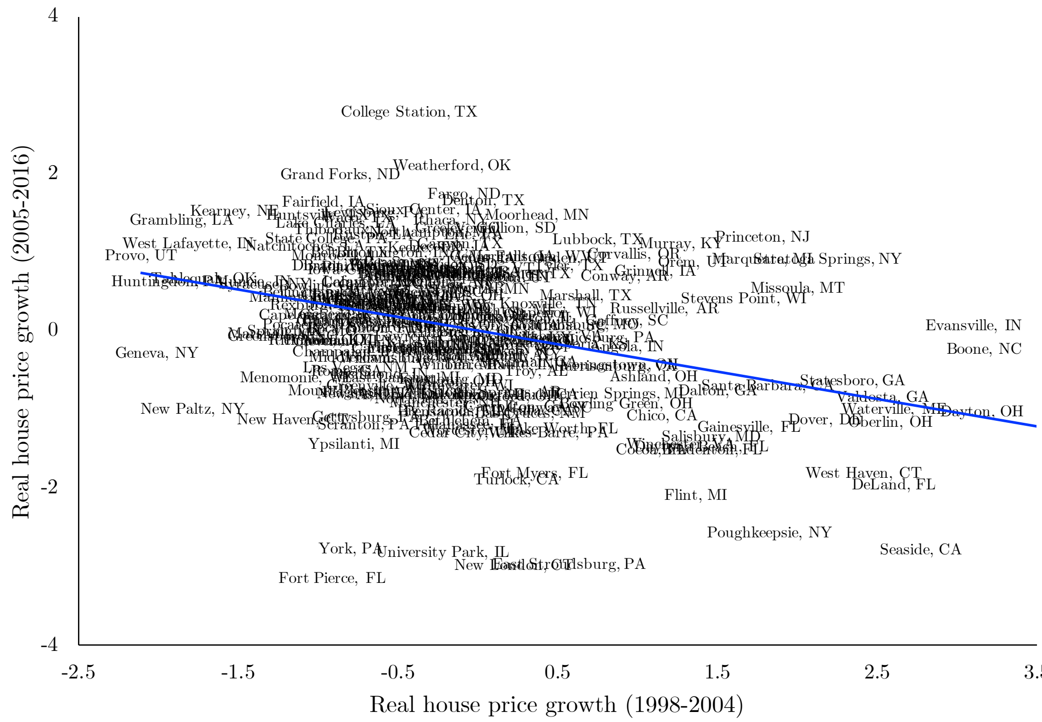
Notes: Column (1) replicates the IV estimator of the impact of international student inflows on home prices with all baseline controls, while including local aggregate annual dormitory capacity. (2) uses city-level income per capita instead of the baseline control county-level income per capita. (3) adds the annual city-level share of married households. (4)—(5) replicates the estimates in Table (II) without weights and (6)—(7) with standard errors clustered at the college town level instead of state level. 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 the state level. International student inflows (normalized by the local population) are instrumented as described in the main text.

[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.



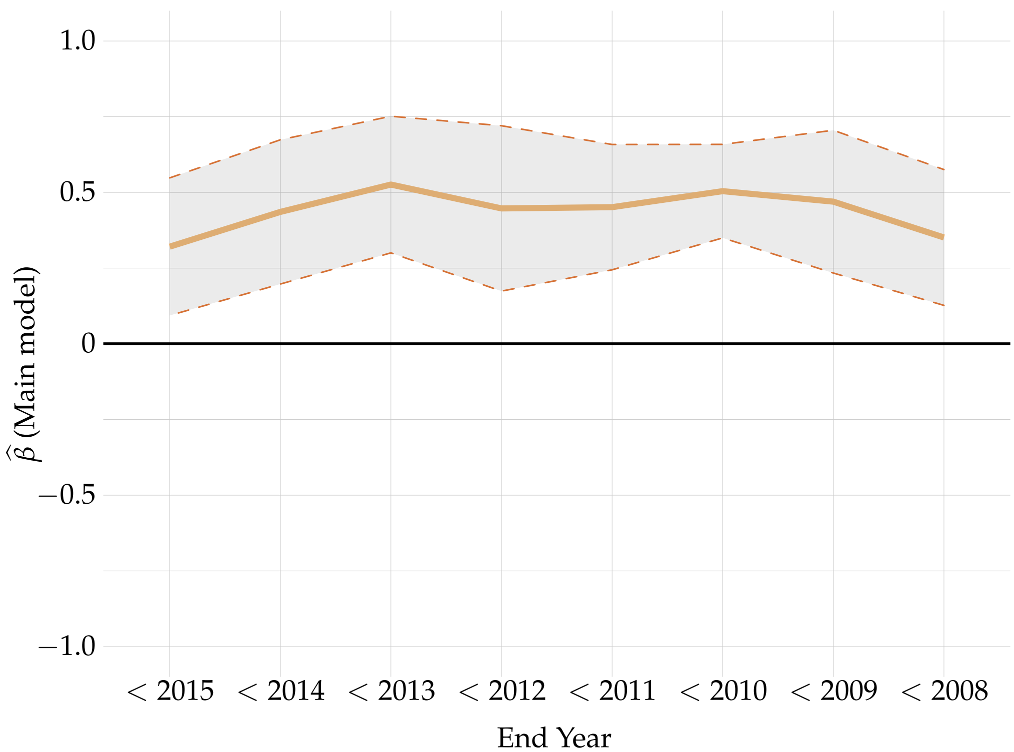
Notes: The figure shows how well the pre-period real price growth (1998-2004) in college towns predicts subsequent real price variation between 2005 and 2016. All variables are normalized to a SD of 1, so that the coefficient of the fitted line $\Delta \widehat{\ln \text{Price}}_{2016-2005} \approx -0.35 \Delta \ln \text{Price}_{2004-1998}$ 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 E.3

CORRELATION BETWEEN HOUSING PRICE PRE-TREND AND IN-PERIOD GROWTH

the effects we obtained in Table (II). The same exercise for changes in international enrollment and the country-of-origin instrument yield similar results.

To conclude, in Figure (E.4), 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 the international student impact at different stages of the housing cycle. Plotted IV estimates of international inflows divided by local population being by discarding data in 2015 and proceeds until leaving only two estimation years, 2006 and 2007. Strong effects concentrated in “bust-only” years imply that college towns receiving larger international student inflows were better able to insulate their housing markets.



Notes: The figure plots IV estimates of the effects of international student inflows on local home prices (baseline model) obtained by progressively discarding the end year of the sample (e.g., < 2015 discards 2015 and runs the model up to 2014) until running only with two years, 2006 and 2007.

FIGURE E.4
RESTRICTING SAMPLE YEARS
MAIN MODEL

F Appendix Figures and Tables

TABLE F.1
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 US. Data come from IPEDS. More details on data processing and samples in the main text.

TABLE F.2
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 F.3

FIRST STAGE OF INSTRUMENTS

	Prices (Table (II))		Rents (Table (IV))		Prices (Table (III))	
	$\Delta\text{International}_{k,(t-1)\longrightarrow t}$	$\frac{\Delta\text{International}_{k,(t-1)\longrightarrow t}}{\text{Population}_{k,(t-2)\longrightarrow(t-1)}}$	$\Delta\text{International}_{k,(t-1)\longrightarrow t}$	$\frac{\Delta\text{International}_{k,(t-1)\longrightarrow t}}{\text{Population}_{k,(t-2)\longrightarrow(t-1)}}$	$\text{International}_{k,(t-1)\longrightarrow t}$	$\frac{\text{International}_{k,(t-1)\longrightarrow t}}{\text{Population}_{k,(t-2)\longrightarrow(t-1)}}$
	(1)	(2)	(3)	(4)	(5)	(6)
$\widehat{\Delta\text{International}}_{k,(t-1)\longrightarrow t}$	0.788***		0.801***			
	(0.037)		(0.050)			
$\frac{\widehat{\Delta\text{International}}_{k,(t-1)\longrightarrow t}}{\text{Population}_{k,(t-2)\longrightarrow(t-1)}}$		0.665***		1.030***		
		(0.122)		(0.120)		
$\widehat{\widehat{\text{International}}}_{k,(t-1)\longrightarrow t}$					0.421***	
					(0.025)	
$\frac{\widehat{\widehat{\text{International}}}_{k,(t-1)\longrightarrow t}}{\text{Population}_{k,(t-2)\longrightarrow(t-1)}}$						0.841***
						(0.111)
Observations ($N \times T$)	2410	2410				
Effective F-statistic	447.87	44.01	402.65	82.04	303.58	64.94
Full set of controls	X	X	X	X	X	X
State fixed effects	X	X	X	X	X	X
Year fixed effects	X	X	X	X	X	X

Notes: First stage results of price and rent regressions using the national-shift share instrument (1)-(4) and the country-of-origin instrument for prices (5) and (6). Values in () are standard errors clustered at the state 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.

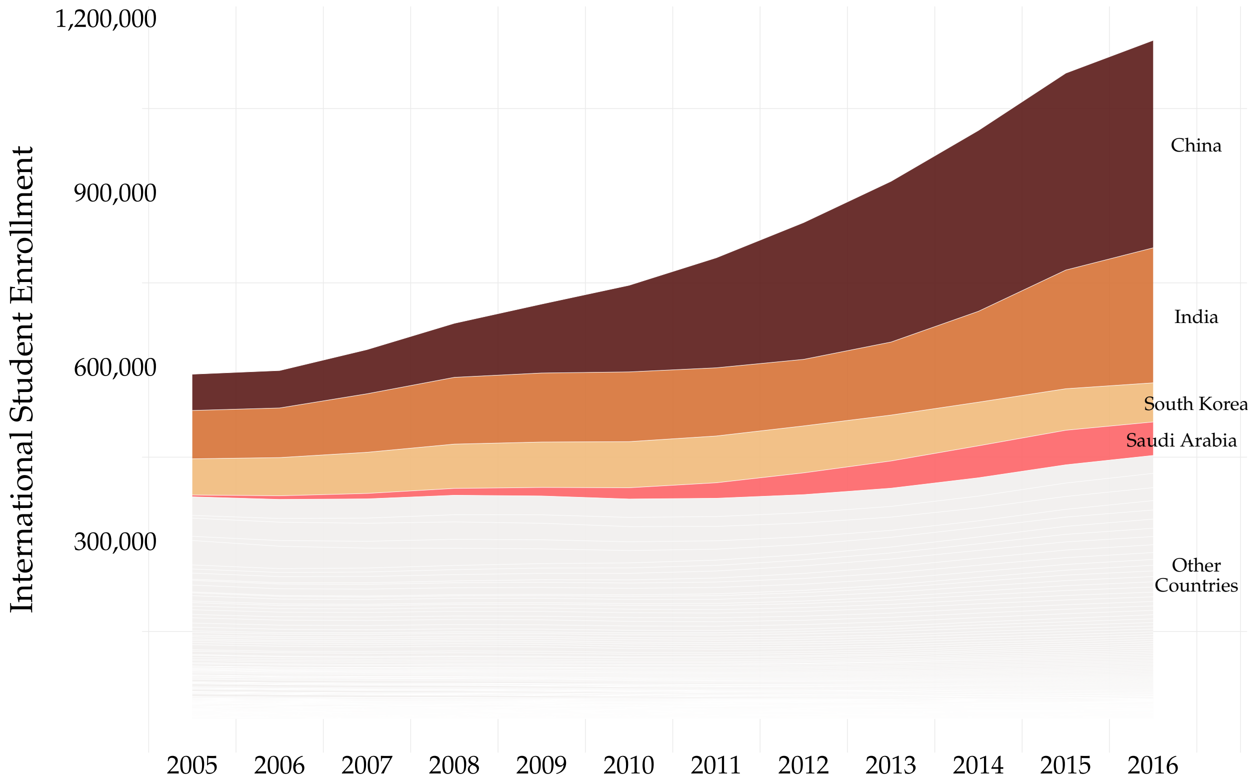
* Significant at the 10 percent level.

TABLE F.4

OBSERVABLE CHARACTERISTICS: TOP AND BOTTOM COLLEGE TOWNS

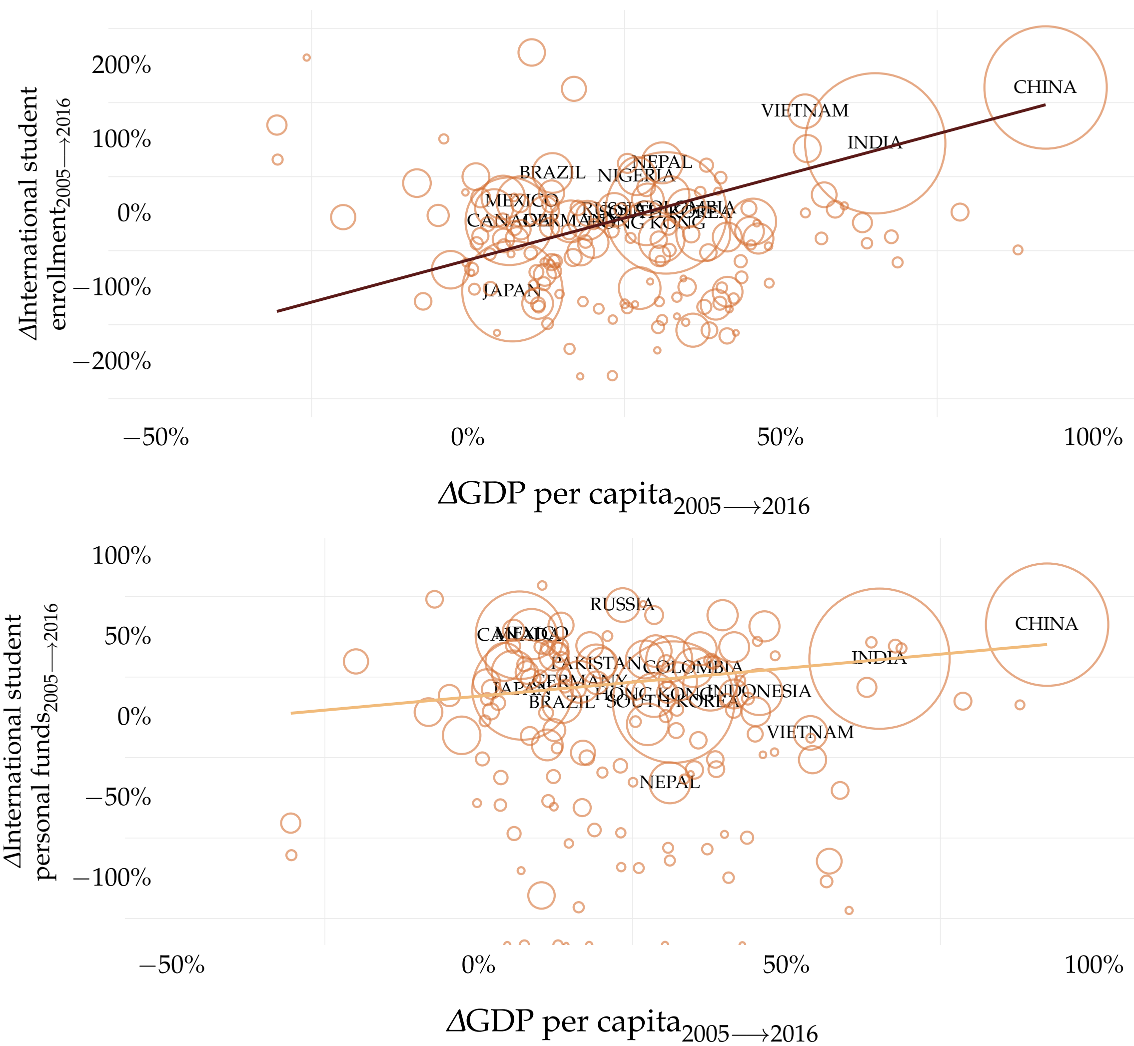
	College towns (Top decile)			College towns (Bottom decile)		
	1996-2001	2001-2005	2006-2016	1996-2001	2001-2005	2006-2016
Income growth	18%	14%	28%	18%	13%	21%
Population growth	23%	3%	13%	17%	4%	3%
Unemployment change (p.p.)	0.9	0.4	0.3	-0.7	0.4	0.5
Cum. int. inflow over total	16%	9%	32%	6%	4%	13%

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.



Notes: This figure plots international enrollment counts by country of origin in US universities from 2005 to 2016. Countries highlighted are the top-4 sending nations. Data come from administrative records obtained from the U.S. Immigration and Custom Enforcement (ICE), from the Department of Homeland Security (DHS).

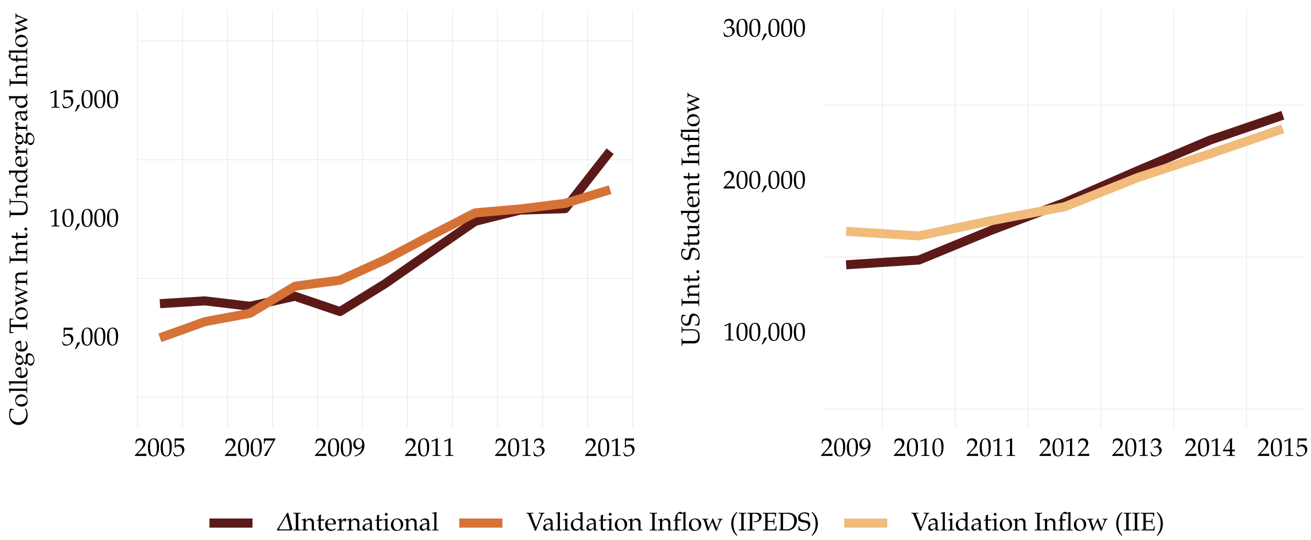
FIGURE F.1
INTERNATIONAL ENROLLMENT IN THE US BY COUNTRY OF ORIGIN



Notes: The top scatterplot compares country-level GDP growth per capita with international students from that country attending US universities during 2005 and 2016. The second figure compares GDP growth per capita to the amount students report to immigration officers upon entry in the US. Data come from administrative records obtained from the U.S. Immigration and Custom Enforcement (ICE), from the Department of Homeland Security (DHS). Circles represent enrollment counts.

FIGURE F.2

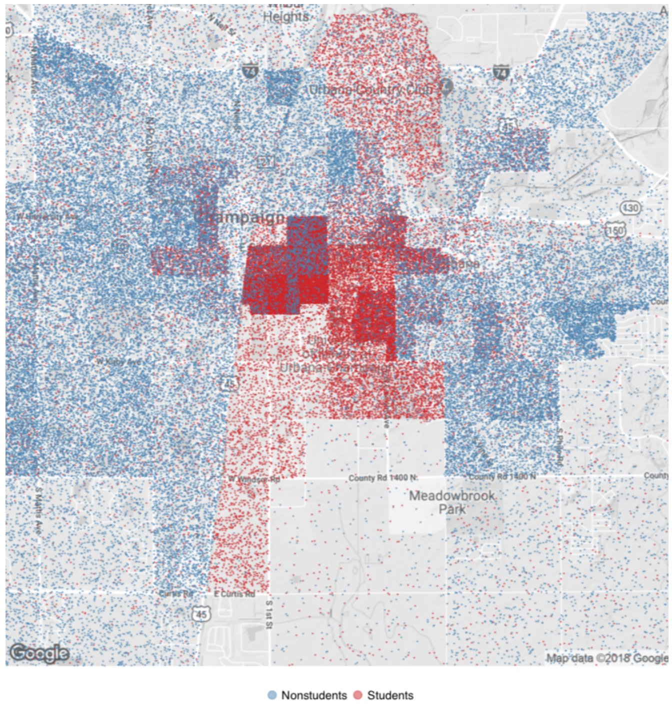
RELATIONSHIP BETWEEN ECONOMIC GROWTH, INTERNATIONAL STUDENT ENROLLMENT AND FUNDS



Notes: The first figure compares a version of our derived international student inflow ΔInternational for first-time degree-seeking freshmen undergraduate international students in college towns to IPEDS new enrollment of the same subgroup of students. The second figure uses our method to all degree-seeking undergraduate and graduate international students enrolled in the US to compare its accuracy with actual new international enrollment available from the IIE.

FIGURE F.3

VALIDATING THE INTERNATIONAL STUDENT INFLOW MEASURE



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 F.4
STUDENT SEGREGATION IN CHAMPAIGN-URBANA, IL

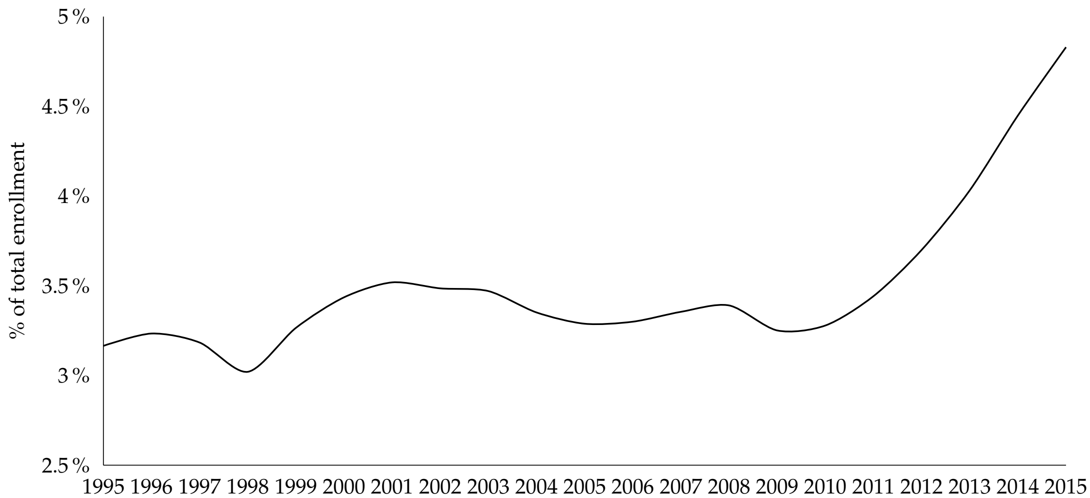


FIGURE F.5

SHARE OF INTERNATIONAL INTERNATIONAL ENROLLMENT US HIGHER EDUCATION

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

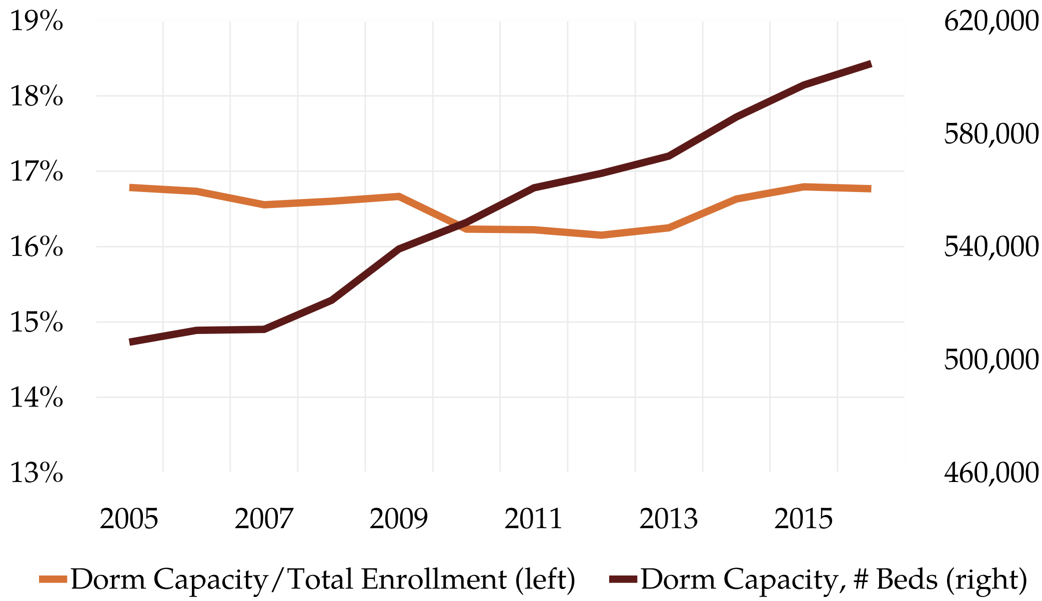


FIGURE F.6
DORM CAPACITY EXPANSION IN COLLEGE TOWNS

Notes: This figure shows the average share of enrollment that dorm capacity in a college town can absorb (on the left) and the total number of beds in college towns over time (on the right).