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International Undergraduate Student Inflows and College Pricing Strategies

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Abstract

This paper examines how growth in international undergraduate enrollment affects both sticker-price and net-price tuition at U.S. PhD-granting institutions. Leveraging the relaxation of U.S. visa policy and the appreciation of the Chinese yuan as natural experiments that drove a rise in Chinese undergraduate enrollment beginning in 2005, I use institution-level panel data from 2000 to 2019 and employ difference-in-differences and instrumental variable approaches to identify the causal effects of rising international undergraduate enrollment on tuition outcomes. I find that increases in international undergraduate enrollment raise out-of-state sticker-price tuition at public PhD-granting universities but reduce it at private PhD-granting institutions. Private PhD-granting institutions with greater exposure to international undergraduate enrollment growth also experience reductions in average net-price tuition, while public PhD-granting institutions show no significant change. These divergent responses highlight differing institutional priorities: private universities appear to prioritize school quality and student subsidization, while public institutions emphasize in-state access and budget stability. The findings suggest that domestic students at private universities benefit more from international undergraduate student growth than their counterparts at public institutions.

JEL Codes: A22, F22, I23

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1 Introduction

Tuition costs in the United States have risen sharply in recent decades. From 2000 to 2019, sticker-price tuition increased substantially across all types of institutions: in real terms, in-state tuition at public institutions rose by approximately 82%, out-of-state tuition by 61.5%, and tuition at private institutions by 50.6% (Figure 1). This rapid escalation in sticker-price tuition has raised concerns about worsening inequality and underscores the importance of understanding the factors driving this growth.

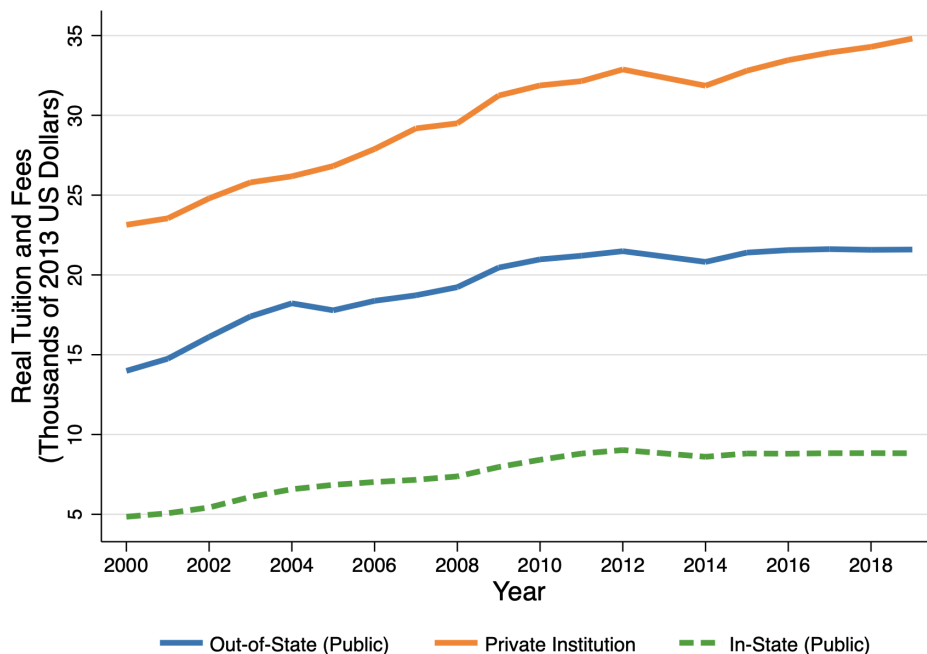
Recent literature has proposed various explanations for tuition increases in the United States. Past studies have focused on rising income inequality (Cai and Heathcote, 2022), improved availability of financial aid (Hedlund and Gordon, 2017), 'cost disease' in the service sector (Archibald and Feldman, 2008; Jones and Yang, 2016), and reductions in state appropriations (Webber, 2017; Koshal and Koshal, 2000; Cook and Turner, 2022). However, most studies in this field have overlooked another major development during this period: the sharp increase in international students from China beginning around 2005. This increase was driven primarily by two policy changes in that year: first, the U.S. government relaxed visa restrictions for Chinese students (U.S. Department of State, 2005), making it easier for them to obtain visas and maintain legal status; second, the Chinese yuan appreciated substantially against the U.S. dollar (Wright, 2025), making U.S. tuition more affordable for Chinese families.¹

These changes led to a rapid rise in the number of Chinese international students since 2005 at all levels. From 2005 to 2015, the number of Chinese students enrolled in U.S. post-secondary institutions increased nearly fivefold, from 62,582 in the 2005–2006 academic year to 304,040 in the 2014–2015 academic year. Because international students typically pay full tuition and receive limited institutional financial aid, this growth in Chinese international students could be another key factor explaining the rapid tuition escalation at U.S. colleges

¹China's accession to the World Trade Organization in 2001 and subsequent economic growth may have also contributed by raising household incomes and making U.S. education more accessible to Chinese families.

and universities.

Figure 1: Trend in Real College Tuition (US \$2013) (2000–2019)



Note: This figure shows the trend in real college tuition adjusted to 2013 dollars using the Consumer Price Index. Tuition data are from the Integrated Postsecondary Education Data System (IPEDS), and price index data are from the Federal Reserve Economic Data (FRED).

In this paper, I examine how the rise in international undergraduate enrollment affects both sticker-price and net-price tuition—the tuition paid by domestic students after grants and financial aid—at U.S. universities, and analyze the differential responses between public and private institutions. I construct an institution-level panel dataset that tracks 258 nonprofit PhD-granting institutions in the United States from 2000 to 2019, providing comprehensive information on undergraduate freshman class composition, sticker-price tuition rates, average net-price tuition by income group, institutional research and instructional spending, and other institutional characteristics.

This paper employs difference-in-differences (DiD) and instrumental variable approaches, leveraging the rise in Chinese undergraduate enrollment following Chinese yuan appreciation and visa policy relaxation in 2005 as a quasi-experimental setting. Following [Card \(2001\)](#)

and [Card \(2009\)](#), the identification strategy exploits the tendency of international students to cluster geographically at institutions with established international student communities due to existing networks and connections. This clustering pattern, combined with the national policy change, creates plausibly exogenous variation in first-time international undergraduate enrollment across U.S. institutions. I apply both discrete- and continuous-treatment DiD specifications to compare tuition outcomes between 2005 and 2019, exploiting cross-institutional variation in exposure to growth in such enrollment. Institutional exposure is measured by each institution’s pre-2005 first-time international undergraduate share. For the instrumental variables approach, I instrument for each institution’s observed first-time international undergraduate share using a predicted value constructed from the interaction of the institution’s baseline (pre-2005) share and the national trend in such enrollment.

The results indicate that growth in first-time international undergraduate enrollment has heterogeneous effects on both sticker-price and net-price tuition at PhD-granting public and private institutions. At public universities, an increase in international enrollment raises out-of-state sticker-price tuition: a 1 percentage point increase in the first-time international undergraduate share leads to a 3.56% increase in out-of-state sticker-price tuition. However, international enrollment growth does not significantly affect in-state tuition at public universities. In contrast, at private universities, increased international enrollment is associated with lower sticker-price tuition, decreasing by 1.58% for each 1 percentage point increase in the first-time international undergraduate share.

For net-price tuition, the effects also differ between public and private PhD-granting institutions. At public universities, growth in first-time international undergraduate enrollment share has no significant impact on the average net-price paid by domestic students. In contrast, at private institutions, increased international undergraduate enrollment share reduces the average net-price paid by low-income domestic students.

These differing responses are consistent with the theory that private and public research universities have different objective functions. Private research universities emphasize insti-

tutional quality and are willing to subsidize tuition to attract high-ability students, whose presence contributes to enhancing institutional quality. In contrast, public research universities are bound by in-state enrollment mandates and state legislation, which lead them to increase out-of-state sticker-price tuition when facing greater international undergraduate enrollment while keeping in-state tuition stable to maintain access for resident students.

Analysis of spending patterns also shows that while both private and public universities increase expenditures in response to growth in first-time international undergraduate enrollment, private institutions experience statistically significant increases in instructional and research expenditures—factors directly affecting institutional quality—supporting the hypothesis that private universities prioritize institutional quality.

This paper intersects with several strands of literature. First, it relates to studies that use structural or empirical methods to understand the rise in college tuition in the United States (Cai and Heathcote, 2022; Hedlund and Gordon, 2017; Archibald and Feldman, 2008; Jones and Yang, 2016; Webber, 2017; Koshal and Koshal, 2000; Cook and Turner, 2022; Bundick and Pollard, 2019; Deming and Walters, 2017; Bound et al., 2020, 2021). For example, Cai and Heathcote (2022) found that rising income inequality increases higher-income families’ willingness to pay for college education, driving tuition increases since college students are predominantly from higher-income families. Meanwhile, Webber (2017), Koshal and Koshal (2000), and Cook and Turner (2022) highlight that reductions in state appropriations force universities to raise tuition to meet budget goals.

A notable exception is the working paper by Shen (2016), which also investigates the impact of international undergraduate enrollment on tuition changes at U.S. higher education institutions. However, this paper differs from Shen (2016) in several important ways. First, I focus on the differential impact of first-time international undergraduate enrollment on tuition outcomes at PhD-granting public versus private institutions, while Shen (2016) examines how increases in international undergraduate enrollment affect R1 and R2 institutions collectively, without differentiating between public and private sectors. Given that

public and private institutions face different objectives and constraints, they may experience divergent responses to changes in international enrollment, and evaluating the impact collectively could obscure heterogeneous effects. Second, I estimate the impact of increased first-time international undergraduate enrollment on net-price tuition—the amount paid by domestic students after receiving financial aid—to better evaluate how this enrollment shift affects the affordability and accessibility of college education for domestic students.

Additionally, this paper contributes to the literature studying crowd-out effects of international students on domestic students (Shen, 2016; Shih, 2017; Tumen, 2021; Khanna et al., 2023; Beine et al., 2023). This literature primarily focuses on whether enrolling international students crowds out or crowds in domestic students and how it affects domestic enrollment levels. The existing evidence is mixed: Shen (2016) finds that international enrollment crowds out domestic enrollment, while Shih (2017) finds that international enrollment cross-subsidizes domestic enrollment. I contribute to this literature by investigating the impact of growth in first-time international undergraduate enrollment on net-price tuition, which more directly captures changes in costs faced by domestic students and provides additional evidence on the nature and extent of cross-subsidization between international and domestic students.

The remainder of this paper is organized as follows: Section 2 provides background on the increase in international undergraduate enrollment during 2000–2019. Section 3 presents the conceptual framework. Section 4 and Section 5 describe the data and identification strategy. Section 6 discusses the main results. Section 7 concludes.

2 Background

Though the first Chinese student came to the U.S. in 1872, Chinese international students remained a small percentage of U.S. higher education enrollment for over a century. The major change occurred after China resumed diplomatic relations with the U.S. in the late

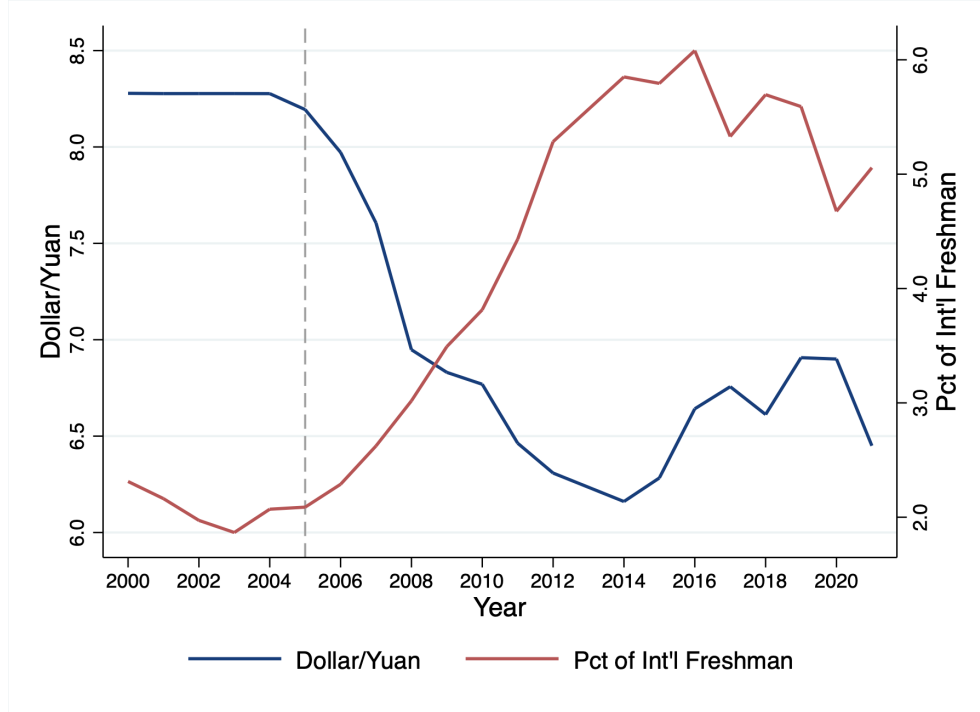
1970s. Chinese leader Deng Xiaoping encouraged Chinese students to study in the U.S. as part of China's modernization efforts. Since then, the number of Chinese students steadily grew to represent around 10% of all international students between 1979 and 1989. However, the growth in international students during this period consisted mainly of doctoral students, which had very limited impact on tuition revenue at U.S. higher education institutions.

After China joined the World Trade Organization (WTO) in 2001, the country became significantly more integrated into the global market. This integration set the stage for more Chinese students to pursue higher education in the United States. However, following the 9/11 terrorist attacks in the same year, the U.S. government tightened visa restrictions, temporarily hindering the ability of Chinese students to come to the United States.

The largest increase in Chinese student enrollment in the United States occurred after 2005, primarily driven by two factors. First, China abandoned its fixed exchange rate policy, which had previously pegged the yuan at approximately 8.28 yuan per U.S. dollar to promote exports. As a result, the exchange rate gradually declined to 6.09 yuan per U.S. dollar by 2014, significantly reducing the cost of attending U.S. postsecondary institutions for Chinese students. Due to the appreciation of the yuan, the same tuition rates became 26% cheaper for Chinese families. As Figure 2 indicates, the sharp appreciation of the Chinese yuan coincided with the rapid growth in international undergraduate student enrollment in the United States.

Second, the United States relaxed its visa policies, making it easier for Chinese students to obtain student visas and study in the United States. More specifically, on June 15, 2005, the U.S. government announced extended visa validity starting from June 20, 2005. The extended visa validity allowed Chinese students under F-1 (student visa), J-1 (exchange visitor visa), and M-1 (vocational student visa) to have their visa validity increased from 6 months to 12 months and from 2 entries per year to multiple entries each year, which gave Chinese international students more flexibility in attending U.S. colleges. Another major change that accompanied the extended visa validity was the increased visa approval rate.

Figure 2: Exchange Rate (Dollar/Yuan) and International Undergraduate Student Enrollment



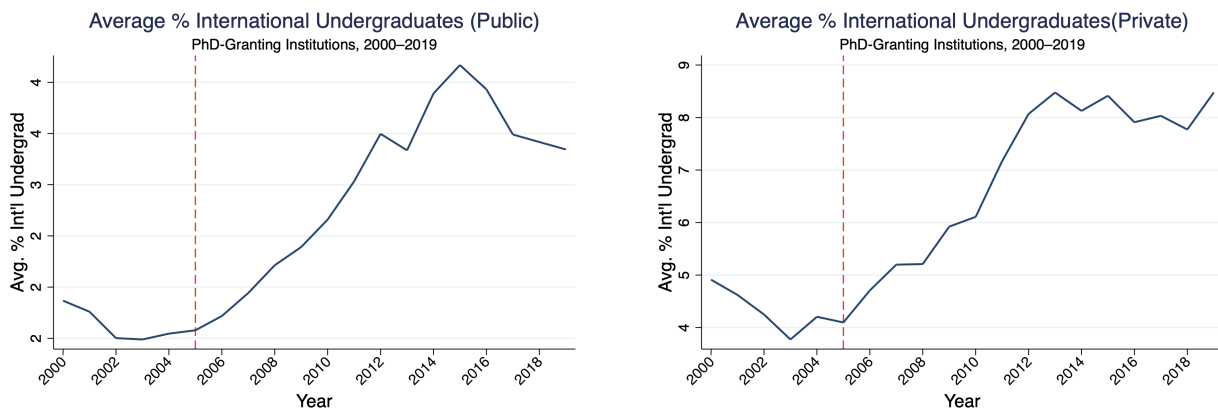
Notes: This figure displays the exchange rate between the U.S. dollar and Chinese yuan alongside the trend in international undergraduate student enrollment from 2000 to 2019. Exchange rate data are from the Federal Reserve Economic Data (FRED). International student enrollment data are from the Integrated Postsecondary Education Data System (IPEDS).

The approval rate for F-1 visas increased from 55% during 2000–2004 to 76% in 2006, and subsequently to 90% by 2010 (Shen, 2016). This change also greatly reduced the difficulty and uncertainty for Chinese students seeking to obtain student visas. The appreciation of the Chinese yuan relative to the dollar, combined with the major changes in visa policies for Chinese students—both of which occurred in 2005—fueled the sharp increase in Chinese student enrollment in the United States after 2005. Between 2005 and 2015, the number of Chinese international students in the United States increased from 62,582 to 304,040, representing an approximately 386% rise. Moreover, the proportion of Chinese students among all international students in the United States rose from 11.1% to 31.2%.

Figure 3 shows the growth in the share of first-time international undergraduate students among PhD-granting public and private institutions in the United States. The left panel

shows the change in share for PhD-granting public institutions between 2000–2019, while the right panel shows the change at PhD-granting private institutions between 2000–2019. At both types of institutions, the share of international undergraduate students experienced significant growth after 2005 and nearly doubled between 2005 and 2019. Considering that most international undergraduate students pay full tuition, this substantial rise in Chinese student enrollment has likely had a pronounced impact on the American higher education market, particularly in terms of tuition revenue and institutional financial planning.

Figure 3: Average Share of International First-Time Undergraduate Enrollment (2000–2019)



Notes: This figure displays the average share of international first-time undergraduate students at PhD-granting public institutions (left panel) and PhD-granting private institutions (right panel) from 2000 to 2019. Data are from the Integrated Postsecondary Education Data System (IPEDS).

3 Conceptual Framework

In this section, I discuss a framework for understanding how the rise in international undergraduate enrollment affects sticker-price and net-price tuition outcomes at public and private research institutions in the U.S. The increase in international undergraduate enrollment can impact tuition outcomes through various channels. Under a simple supply and demand framework, the rise in international undergraduate students shifts the demand curve for U.S. college education outward. Since universities face capacity constraints and can only

adjust available enrollment slots gradually, the supply response is likely to be limited in the short run. In this scenario, profit-maximizing universities would respond to increased demand by raising tuition rates.

However, the situation for research universities is more nuanced. These institutions pursue objectives beyond profit maximization, such as providing public benefits, enhancing educational quality, and advancing research. Additionally, private and public universities typically serve distinct student populations and operate under different constraints; consequently, their responses to rising international enrollment may differ substantially. To understand these differential responses, I draw upon the theoretical frameworks presented in [Hoxby \(2003\)](#), [Epple et al. \(2004\)](#), [Epple et al. \(2006\)](#), [Epple et al. \(2019\)](#), and [Epple et al. \(2017\)](#), which analyze the varied objectives of research universities and examine the differences in mission, function, and constraints between public and private institutions.

3.1 Setup

For higher education institutions, profit maximization is unlikely to be the primary objective. Building on this assumption, [Epple et al. \(2017\)](#) posit that institutional quality is a central component of the objective function for both public and private institutions. In their framework, university quality (q) is modeled as a function of average student ability (θ) and per-student expenditure (E). Under this setup, the cost of admitting a student comprises two components: (1) the direct resource cost, and (2) the school quality cost. Enrollment of high-ability students raises average student ability, which in turn positively affects school quality. Consequently, institutions experience a negative school quality cost—that is, a benefit—from admitting high-ability students. Because high-ability students both contribute tuition revenue and enhance the average quality of the student body (a key determinant of overall institutional quality), universities have strong incentives to offer financial subsidies to attract and enroll them.

Furthermore, [Epple et al. \(2017\)](#) emphasize that private institutions primarily focus on

institutional reputation, while public institutions are bound by state mandates to provide affordable education to in-state students. In-state tuition and financial aid policies are typically controlled by state legislation, over which public institutions have limited discretion.

Under these conditions, the model assumes that private universities aim to maximize institutional quality ($q(\theta, E)$). Under this setup, the effective marginal cost of enrolling each student constitutes two parts: the marginal resource cost and the marginal school quality cost. A private institution j will only admit a student if the tuition that student pays exceeds this effective marginal cost.

Hence, for a student with ability b , where that student's ability is higher than the average student ability at institution j ($b > \theta_j$), the school quality cost of enrollment is negative, thereby reducing the effective marginal cost. In this case, private institutions have an incentive to provide subsidies to attract such high-ability students. For domestic students, this occurs through higher financial aid packages. For international students, who are more likely to pay sticker-price tuition, this could result in reduced sticker prices to attract high-ability applicants, as international students constitute the majority of those paying full tuition.

In contrast to private universities, public universities aim to optimize the aggregate achievement of in-state students, defined as the number of in-state students enrolled (N_{is}) multiplied by the average achievement of these students, which is a function of university quality. The objective function for public universities is defined as: $a(q(\theta, E), b) \cdot N_{is}$, where $a(\cdot)$ represents the achievement function for each student and b is each in-state student's ability. Therefore, public universities are incentivized to enroll a substantial number of in-state students. Moreover, as financial aid is bound by state legislation, these policies are unlikely to change in response to international student enrollment. However, since the average achievement of in-state students depends on overall college quality—which, in turn, is affected by the average ability of the entire student body—public universities cannot focus solely on in-state enrollments. They must also consider the composition and ability of the overall student body, including out-of-state and international students, to optimize their

objective function.

Like private institutions, public institutions admit out-of-state and international students based on their contributions to both tuition revenue and average school quality. [Epple et al. \(2017\)](#) empirically demonstrate that out-of-state students contribute by paying higher tuition rates. However, whether international students contribute more through tuition revenue or through improvements in school quality remains an empirical question.

3.2 Impact of International Students on Tuition

The rise of international students provides private universities with a new pool of high-ability applicants. Additionally, since most international students do not receive financial aid or merit scholarships from universities, enrolling them serves as a direct source of revenue. Given that private universities aim to maximize overall institutional quality—which depends heavily on average student ability—they have strong incentives to attract and enroll high-ability international students. The additional revenue generated from increased international enrollment, combined with the typically higher tuition rates these students pay, enhances budgetary flexibility. Consequently, research-oriented private universities may be more willing to subsidize tuition costs for a portion of their students, particularly high-achieving domestic students through more generous financial aid packages and high-ability international students through reduced sticker-price tuition.

Although public universities also face a larger pool of high-ability international students, their state education obligations and objective of maximizing aggregate in-state student achievement may limit their incentive to aggressively recruit these students. Under these constraints, and given that in-state tuition and financial aid policies are bound by state legislation, the rise of international students will likely have limited impact on in-state tuition or financial aid policies.

Regarding out-of-state sticker-price tuition at public universities, the theoretical impact is ambiguous. While [Epple et al. \(2017\)](#) empirically demonstrate that out-of-state students

contribute to public universities primarily through higher tuition revenue rather than positive school quality effects, how international students contribute remains an open empirical question. If international students contribute primarily through revenue generation, increased international demand would drive tuition higher. Conversely, if international students contribute more through positive school quality effects, their tuition could decrease.

The impact on out-of-state tuition depends critically on the nature of international students' contributions. Given that out-of-state students contribute through revenue generation and that international students constitute the majority of those paying sticker-price tuition, two scenarios emerge. If international students contribute primarily through positive school quality effects, increased international enrollment could reduce out-of-state tuition. However, if international students, like out-of-state students, contribute primarily through revenue generation, increased international enrollment would increase out-of-state sticker-price tuition. Therefore, the theoretical impact of international student enrollment on out-of-state tuition at public universities is ambiguous and requires empirical analysis.

4 Data

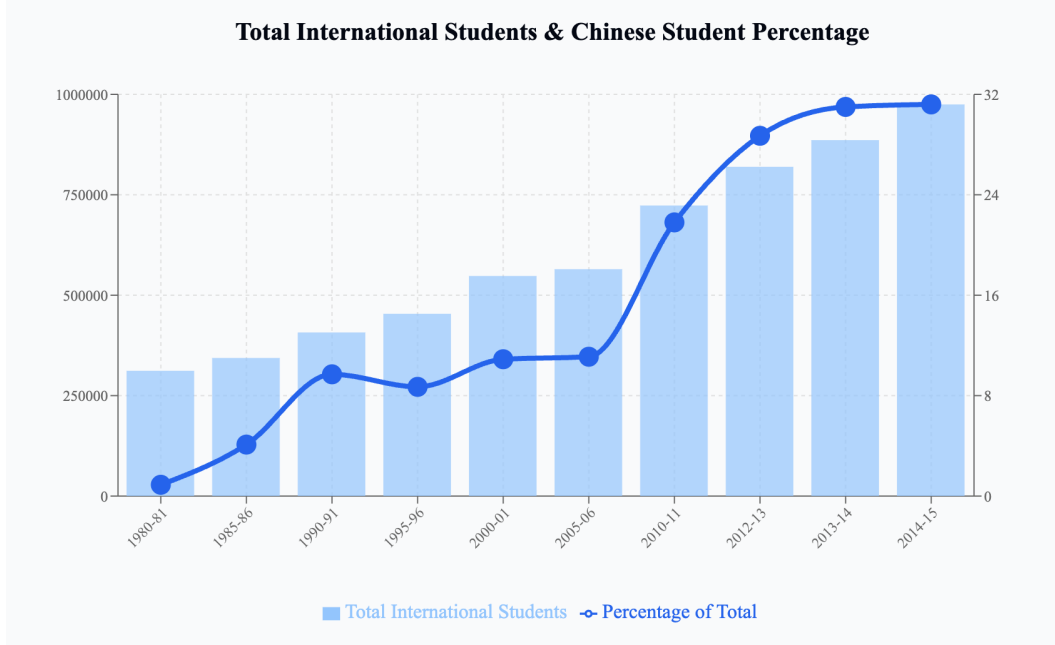
This paper draws on two primary data sources. The first is the Integrated Postsecondary Education Data System (IPEDS) from 2000–2019. IPEDS, an annual survey conducted by the National Center for Education Statistics (NCES), contains rich institutional characteristics for every college, university, and technical and vocational institution that participates in federal student financial aid programs. It covers more than 7,000 institutions in the U.S. and includes up to 250 variables. From IPEDS, I compile information on sticker-price tuition rates, average net-price tuition rates by income group, first-time undergraduate enrollment by residency, institutional expenditures, and additional characteristics including total enrollment, research intensity (proxied by Carnegie classification), AAU membership, average financial aid and grant amounts, average student loan amounts, and average SAT scores of

enrolled students.

The analysis focuses on the effect of international undergraduate enrollment on tuition at public and private universities. Ideally, the number of Chinese undergraduate students would serve as the key explanatory variable. However, since IPEDS does not disaggregate international undergraduate enrollment by country of origin, I use the total number of first-time international undergraduate students to evaluate the effects on tuition rates at U.S. higher education institutions. Figure 4 shows the growth of international students between 1980 and 2015. First, it is clear that the major increase in international students occurred in 2005, marking the beginning of significant international student growth. Moreover, between 2005 and 2010, Chinese students rapidly grew from below 10% to approximately 24% of total international students. Furthermore, international student enrollment increased from 564,766 to 819,644, while Chinese student enrollment increased from 62,582 to 235,597 between 2005 and 2012. This means that approximately 73.6% of the growth in international students can be explained by the growth of Chinese students. Additionally, Chinese undergraduate students increased from 9,304 (16% of all Chinese international students) to 148,880 (52.6% of all Chinese international students) between 2005 and 2012, which also indicates that Chinese undergraduate students were the major driver of Chinese student growth in the U.S. since 2005. Hence, combining these two pieces of information, total international undergraduate student enrollment serves as a good proxy for the increase in Chinese undergraduate student enrollment in the U.S.

Moreover, as shown in Figure 5, the increase in international undergraduate students is concentrated among PhD-granting institutions. On average, PhD-granting institutions experienced growth in the first-time international undergraduate enrollment share from 3% to 6%, while the first-time international undergraduate enrollment share at Master's-granting institutions remained below 3%. Moreover, as Master's-granting and PhD-granting institutions may differ in other characteristics that could cause them to have divergent trends in tuition growth, the sample is restricted to PhD-granting universities for the period 2000–2019.

Figure 4: Growth of Chinese Students Among International Students (1980–2015)

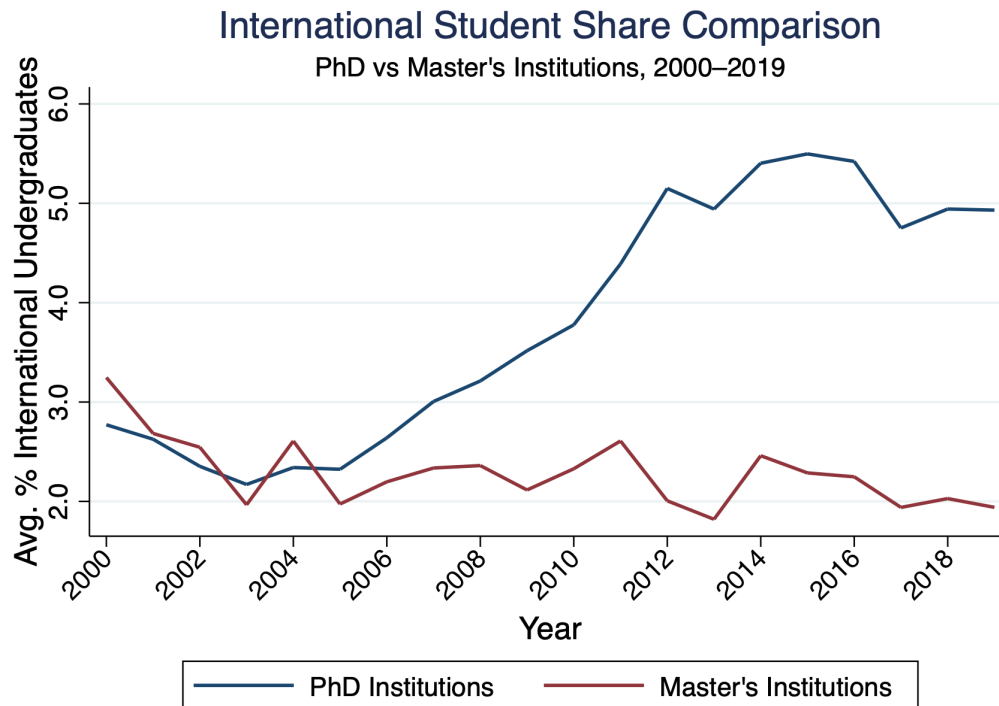


Notes: This figure displays the growth of Chinese students as a share of total international students in the United States from 1980 to 2015. Data are from the National Center for Education Statistics (NCES), Digest of Education Statistics 2015, Table 310.20.

Furthermore, a key assumption of the identification strategy, following [Card \(2001\)](#) and [Card \(2009\)](#), is that like immigrants, international students are more likely to choose schools with higher shares of international students due to existing networks and connections. To provide additional evidence for this assumption, I plot the average share of international undergraduate students at the institution level before (2000–2004) and after (2005–2019) the shock in international undergraduate enrollment. As [Figure 6](#) shows, at the institution level, there is a high correlation (0.7) between the share of international undergraduate students before and after the shock, which supports the network and connection assumption.

Local economic conditions and job opportunities can be another factor that explains the flow of international students ([James-MacEachern and Yun, 2017](#)). To account for variations in local economic conditions, I supplement the IPEDS data with state-level unemployment rates from 2000–2019 from the Bureau of Labor Statistics (BLS). These data serve as a proxy for economic conditions that may affect student demand for higher education and the

Figure 5: Trend in Percentage of International Students by Type of Institution (2000–2019)



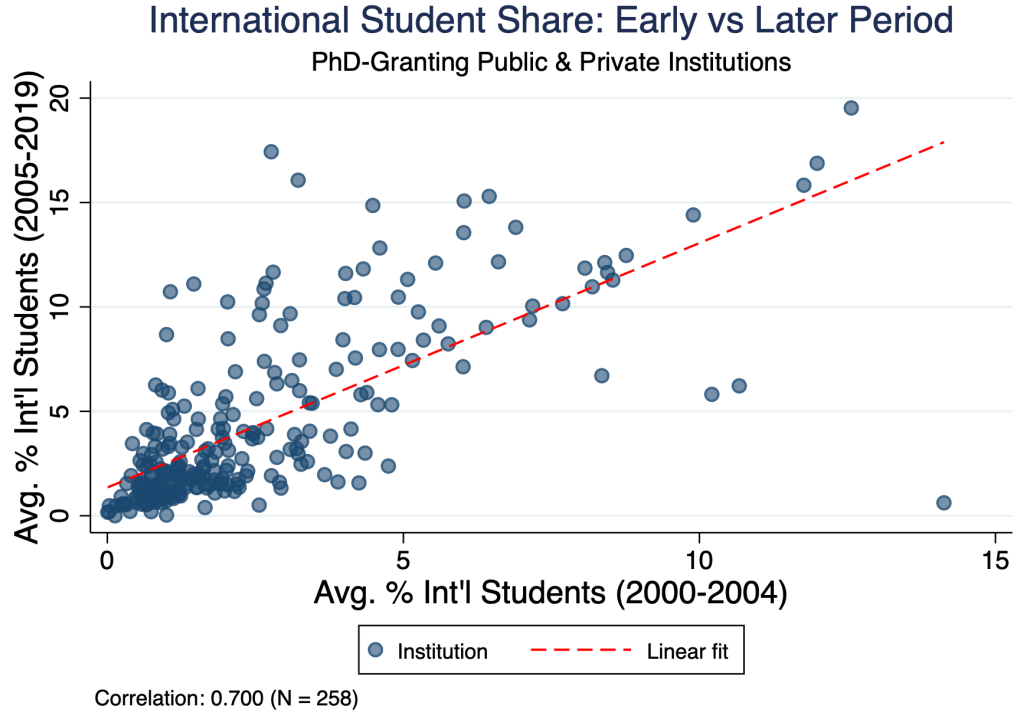
Notes: This figure displays the trend in the share of first-time international undergraduate students at PhD-granting institutions and Master's-granting institutions from 2000 to 2019. Data are from the Integrated Postsecondary Education Data System (IPEDS).

tuition-setting behavior of universities.

The final sample consists of 5,126 observations from 258 institutions between 2000 and 2019. Each observation includes an institution's sticker-price tuition (published tuition before discounts), net-price tuition (average cost after grants and scholarships), international and total first-time undergraduate enrollment, and institutional characteristics including school size, average grant amount, average aid amount, average loan amount, location, and the relevant state unemployment rate. Combining these sources allows the analysis to control for both institutional features and local economic conditions that may influence tuition-setting decisions.

Tables 1 and 2 present a comparison of key characteristics between institutions with above-median and below-median pre-shock shares of international undergraduate students

Figure 6: International Undergraduate Student Share:
Before-Shock (2000–2004) vs After-Shock (2005–2019)



Notes: This figure plots the average share of international undergraduate students at the institution level before the shock (2000–2004) against the average share after the shock (2005–2019). Each point represents a PhD-granting institution. The high correlation (0.7) between pre-shock and post-shock shares supports the identification assumption that international students tend to enroll at institutions with established international student communities. Data are from the Integrated Postsecondary Education Data System (IPEDS).

for public and private institutions, respectively.

As Table 1 shows, PhD-granting public institutions with above-median and below-median pre-shock (pre-2005) shares of international undergraduate students are similar in most characteristics. The main differences exist in R1 indicators, total enrollment, and the share of students receiving grants. Public institutions with above-median international student shares are significantly more likely to be R1 universities, have larger enrollments, and have fewer students receiving grants.

However, PhD-granting private institutions exhibit greater variation across characteristics when comparing those with different levels of pre-shock international undergraduate

Table 1: Summary Statistics by Initial Rate Group for Baseline Characteristics
(Public PhD-Granting Institutions)

Variable	Below Median Initial Rate		Above Median Initial Rate		Mean Difference (Above–Below)
	<i>N</i>	Mean	<i>N</i>	Mean	
R1 indicator	406	0.372	405	0.494	-0.122***
Enrollment (1,000s)	406	19.70	405	22.04	-2.34***
Average loan (1,000s)	239	3.45	242	3.43	0.02
Average aid (1,000s)	239	2.09	242	2.18	-0.09
Share receiving grants (%)	239	36.97	242	30.52	6.45***
Tuition (1,000s)	406	12.59	405	12.94	-0.35
Unemployment rate (%)	406	5.16	405	5.03	0.13

Notes: This table reports summary statistics for baseline characteristics (2000–2004) of public PhD-granting institutions, comparing those with above-median and below-median pre-shock shares of international undergraduate enrollment. The median pre-shock international undergraduate share for public institutions is 1.205%. Stars indicate statistical significance of mean differences based on two-sample t-tests: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Data are from IPEDS.

student shares, as shown in Table 2. The differences extend to more characteristics, including R1 indicators, total enrollment, share of students receiving grants, sticker-price tuition, and unemployment rates in their locations.

Table 2: Summary Statistics by Initial Rate Group for Baseline Characteristics
(Private PhD-Granting Institutions)

Variable	Below Median Initial Rate		Above Median Initial Rate		Mean Difference (Above–Below)
	<i>N</i>	Mean	<i>N</i>	Mean	
R1 indicator	215	0.140	210	0.595	-0.456***
Enrollment (1,000s)	215	9.14	210	10.91	-1.78**
Average loan (1,000s)	128	4.59	126	4.45	0.13
Average aid (1,000s)	129	3.53	126	3.47	0.06
Share receiving grants (%)	129	32.57	126	23.57	8.99***
Tuition (1,000s)	212	19.44	200	24.10	-4.67***
Unemployment rate (%)	215	5.33	210	5.04	0.28***

Notes: This table reports summary statistics for baseline characteristics (2000–2004) of private PhD-granting institutions, comparing those with above-median and below-median pre-shock shares of international undergraduate enrollment. The median pre-shock international undergraduate share for public institutions is 1.205%. Stars indicate statistical significance of mean differences based on two-sample t-tests: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Data are from IPEDS.

5 Empirical Methodology

5.1 Difference-in-Differences Approach

I employ a difference-in-differences strategy to identify the causal effect of rising international undergraduate enrollment on tuition outcomes at PhD-granting institutions in the U.S. The identification strategy exploits cross-institutional variation in exposure to the national growth in international undergraduate enrollment that began in 2005. I measure institutional exposure using each institution’s pre-2005 share of first-time international undergraduate students, which proxies for how sensitive the institution was to subsequent enrollment growth.

The identifying assumption is that tuition outcomes at institutions with higher pre-shock shares of international undergraduate students would have followed similar trends to those at institutions with lower pre-shock shares in the absence of the shock. Under this assumption, the strategy identifies the causal impact of international undergraduate student enrollment on tuition outcomes at U.S. PhD-granting institutions.

Specifically, I estimate the following equation:

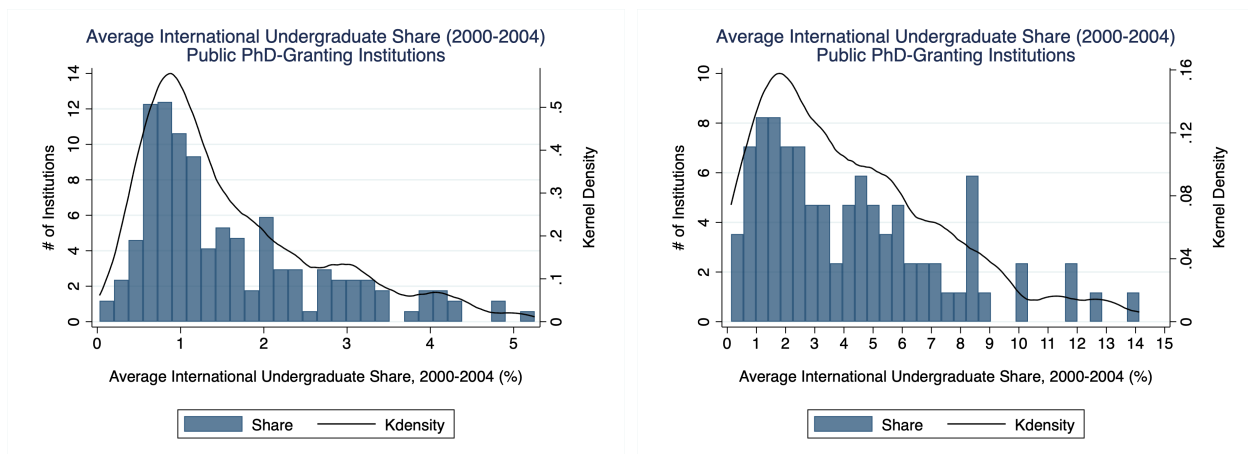
$$Y_{ist} = \beta_1 \text{InitialRate}_i \times \text{Post2005}_t + \delta_i + \eta_t + \beta_2 X_{st} + \epsilon_{ist}, \quad (1)$$

where Y_{ist} denotes the outcome of interest, which includes logged out-of-state and in-state sticker-price tuition at public university i in state s in year t , as well as logged sticker-price tuition at private institution i in state s in year t . InitialRate_i is the pre-shock (pre-2005) share of international undergraduate student enrollment. Post2005_t represents a dummy variable that equals one starting in 2005. I also include year fixed effects, η_t , to control for unobservable factors that vary across time but are invariant across institutions, and institution fixed effects, δ_i , to control for time-invariant unobservable factors that vary across institutions. ϵ_{ist} is the error term. I additionally control for the state-level unemployment

rate, X_{st} , as a proxy for local economic conditions. Standard errors are clustered at the institution level in all specifications. The parameter of interest is β_1 , which measures the differential change in tuition outcomes after the rise in international undergraduate students beginning in 2005.

I also specify exposure to international undergraduate enrollment using an alternative discrete measure. In this specification, I replace the continuous treatment variable (InitialRate_i) with a binary indicator (HighExposure_i) that equals one for institutions with above-median pre-2005 international undergraduate enrollment shares and zero otherwise. This alternative specification is motivated by the highly skewed distribution of international student enrollment shown in Figure 7. Approximately 40% of public institutions and 13% of private institutions have pre-2005 average international student shares below 1%. While effects at such low exposure levels are possible, we would expect effect sizes to increase with exposure intensity. The binary specification therefore compares institutions with above-median exposure (1.205% for public institutions and 3.46% for private institutions) to those with below-median exposure, providing a clearer contrast between high- and low-exposure groups.

Figure 7: Average International Undergraduate Share (2000–2004)



Notes: This figure displays the distribution of average pre-shock (2000–2004) international undergraduate enrollment shares for PhD-granting public institutions (left panel) and PhD-granting private institutions (right panel). The median pre-shock share is 1.205% for public institutions and 3.46% for private institutions. Data are from the Integrated Postsecondary Education Data System (IPEDS).

Identification of the causal effect of international undergraduate student enrollment on the growth in tuition outcomes relies on several key assumptions. First, I assume that in the absence of the rise in international undergraduate student enrollment since 2005, all PhD-granting institutions would have experienced the same growth in tuition outcomes, regardless of their pre-shock share of international undergraduate student enrollment. However, since the parallel trends assumption is not testable, I also adopt an event-study specification to evaluate the pre-trends in outcomes to provide supportive evidence for the parallel trends assumption. Specifically, the estimation equation is:

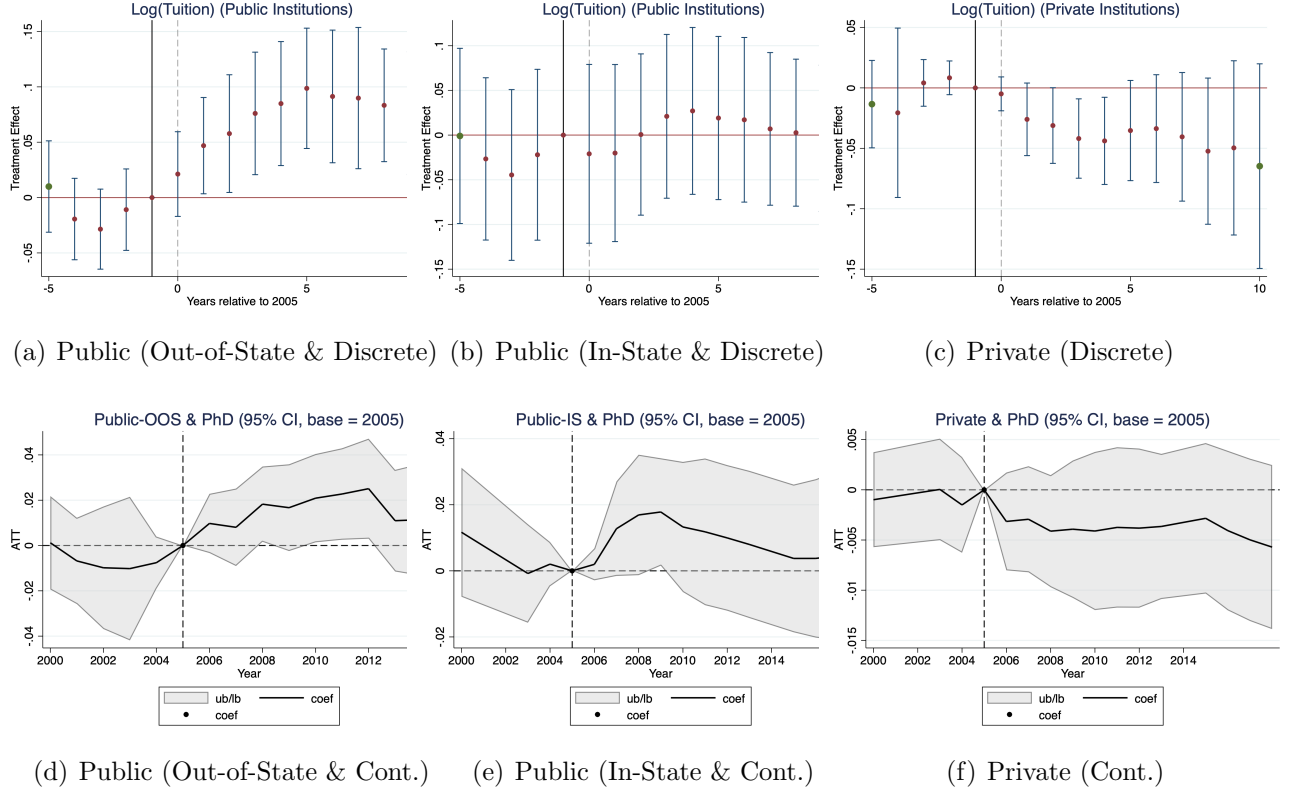
$$Y_{ist} = \sum_{t=2000, t \neq 2005}^{2019} \gamma_t \mathbf{1}(\text{year} = t) \times \text{InitialRate}_i + \delta_i + \eta_t + \beta X_{st} + \epsilon_{ist}, \quad (2)$$

where I replace the interaction between the pre-shock share of international undergraduate student enrollment and the indicator for post-2005 with a set of interactions between the pre-shock share of international undergraduate student enrollment and each year. I leave out 2005 so that all coefficients are measured with respect to the first year that the rise in international undergraduate student enrollment occurred. If there were no differential pre-trends in the tuition outcomes observed in PhD-granting institutions with high and low pre-shock shares of international undergraduate student enrollment, then the coefficient estimates on the interaction terms before 2005 should not be statistically different from zero.

The event study estimates are presented in Figure 8, where panels (a)–(c) show the estimated coefficients (γ_j) with the discrete treatment HighExposure_i , while panels (d)–(f) show the estimated results with the continuous treatment InitialRate_i . For all outcomes under both treatment specifications, the results show no evidence of pre-trends, which provides credibility for the parallel trends assumption.

My specification is a continuous-treatment difference-in-differences, which exploits the difference between high and low shares of international enrollment. [Callaway et al. \(2024\)](#) shows that for continuous-treatment difference-in-differences specifications, an additional

Figure 8: Event-Study Estimates of Treatment Effects on Sticker-Price Tuition Outcomes

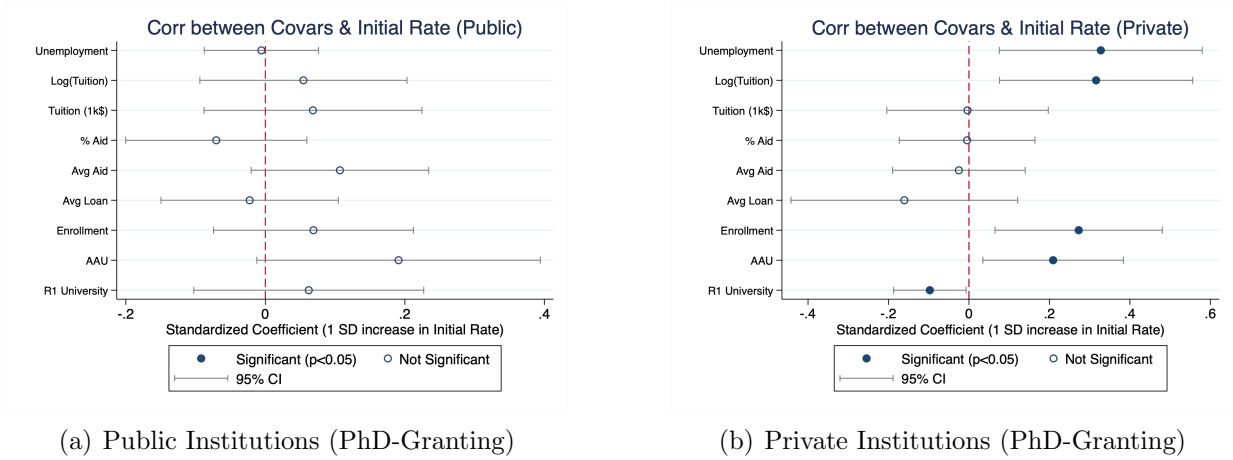


Notes: This figure displays event-study coefficient estimates from the difference-in-differences specification. Panels (a)–(c) show results using the discrete treatment variable (HighExposure_i), comparing institutions with above-median versus below-median pre-shock international undergraduate shares. Panels (d)–(f) show results using the continuous treatment variable (InitialRate_i), which measures the pre-shock share of international undergraduate enrollment. Vertical bars represent 95% confidence intervals. Standard errors are clustered at the institution level.

assumption is the homogeneous treatment effect assumption: if schools that received few international undergraduate students had received many international undergraduate students, the effects of receiving international undergraduate students would have been the same as in the schools that actually received many international undergraduate students. This is because in this type of specification, low-dosage units are used as the counterfactual to high-dosage units. Hence, we need to assume that low-dosage units would have had a similar treatment effect to the high-dosage units if they had received high dosage. As this assumption is also not directly testable, one potential way to provide supportive evidence is to show that dosage is uncorrelated with the observables. Figure 9 shows the results of a

balance test that examines the correlation between baseline observables and the pre-shock share of international undergraduate student enrollment. Each row displays the estimate from a separate regression of the standardized share of international undergraduate students on the standardized regressor defined along the horizontal axis. The coefficient estimates show that for PhD-granting public institutions, there is no significant correlation between the observables and the share. However, for PhD-granting private institutions, there are significant correlations between local unemployment rate, tuition, total enrollment, AAU indicator, R1 indicator, and the pre-shock international share. To account for the differences in the baseline characteristics, I additionally control for the interaction between the baseline characteristics and the year dummies ($X_i \times \eta_t$) as a robustness check to account for the variations created by the differences in baseline characteristics.

Figure 9: Correlation Between Baseline Institutional Characteristics and Initial Rate



Notes: This figure displays results from a balance test examining the correlation between baseline institutional characteristics (2000–2004) and the pre-shock share of international undergraduate enrollment. Each row shows the coefficient estimate from a separate regression of the standardized pre-shock international undergraduate share on the standardized characteristic listed on the horizontal axis. For public institutions (left panel), there is no significant correlation between observables and the pre-shock international share. For private institutions (right panel), significant correlations exist for unemployment rate, log tuition, total enrollment, AAU indicator, and R1 indicator. Horizontal bars represent 95% confidence intervals.

5.2 Instrumental Variable Approach

While the difference-in-differences approach allows me to estimate the effect of international undergraduate enrollment on tuition year by year, each year involves different growth rates and varying numbers of arriving students. To aggregate these effects over time and obtain a weighted average treatment effect, I employ a shift-share instrumental variable approach that instruments the percentage of international first-time undergraduate enrollment using a shift-share instrument constructed from national trends and institutional baseline shares.

Formally, the first stage predicts institutional-level international enrollment as follows:

$$\text{Predicted Pct Foreign}_{it} = \frac{\sum_{t=2000}^{2004} \text{Pct Foreign}_{it}}{n} \times (1 + g_t), \quad (3)$$

where g_t is the percentage point change in first-time international undergraduate enrollment at the national level, and n ranges from 1 to 5 to account for institutions with missing values between 2000 and 2004.

The second stage estimates:

$$Y_{ist} = \beta_0 + \beta_1 \text{Pct Foreign}_{it-1} + \delta_i + \eta_t + \epsilon_{ist}, \quad (4)$$

where Y_{ist} denotes the outcome of interest for institution i in state s in year t . In addition to sticker-price tuition outcomes, Y_{ist} also includes average net-price tuition rates by income group. I include net-price outcomes in this specification because the net-price data begin in 2009, making the difference-in-differences approach infeasible for these outcomes due to the limited pre-treatment period.

Recent econometric literature has formalized the identification assumptions underlying the shift-share IV framework ([Borusyak et al., 2022](#); [Goldsmith-Pinkham et al., 2020](#)). Following [Goldsmith-Pinkham et al. \(2020\)](#), I argue that identification in my setting arises from the exogeneity of institutions' initial shares of international freshmen—the so-called "exoge-

nous shares” assumption. Under this approach, the identification assumption is conceptually similar to that of the difference-in-differences framework: an institution’s initial share of international freshmen is assumed to be uncorrelated with unobserved factors that influence its subsequent tuition trajectory. This assumption is supported by the parallel pre-trends documented in the event-study results shown in Figure 8.

6 Results

6.1 Sticker-Price Tuition Outcomes

The results estimated from the difference-in-differences approach are presented in Tables 3 and 4. In Table 3, columns (1)–(3) present the results for out-of-state sticker-price tuition at PhD-granting public institutions, in-state sticker-price tuition at PhD-granting public institutions, and sticker-price tuition at private institutions with the discrete treatment HighExposure_{it} , while columns (4)–(6) show the same results under the continuous treatment InitialRate_{it} . All columns include institution fixed effects and year fixed effects, and the standard errors are clustered at the institution level.

Columns (1) and (4) of Table 3 present the impact on sticker-price out-of-state tuition at PhD-granting public institutions. In column (1), the coefficient of 0.0843 indicates that institutions with above-median pre-shock exposure experienced an 8.43% increase in out-of-state sticker-price tuition compared to institutions with below-median exposure. In column (4), the estimated coefficient implies that each 1 percentage point increase in the pre-shock share of international undergraduate enrollment is associated with a 2.66% increase in sticker-price out-of-state tuition at PhD-granting public institutions.

To contextualize the magnitude of these effects, consider that the average PhD-granting public institution experienced a 2.5 percentage point increase in international undergraduate enrollment share between 2005 and 2019, and the average baseline tuition for these institutions was \$12,940 between 2000 and 2004. The 8.43% increase translates to approximately

\$1,091 in additional out-of-state tuition revenue per student at PhD-granting public institutions. These results are not directly comparable to Shen (2016), as that study estimates the combined impact on public out-of-state and private tuition using a dollar-per-student measure. However, the positive sign of the estimated effect aligns with Shen (2016), which finds a positive impact on public out-of-state and private tuition jointly.

Columns (2) and (5) of Table 3 show the estimated coefficients for sticker-price in-state tuition rates at PhD-granting public institutions. Although the estimated coefficients are positive, they are not statistically significant. This result aligns with the key assumptions in Epple et al. (2019), which highlight that in-state tuition is frequently constrained by additional factors, such as state regulations and political considerations, making it less responsive to demand from international students. However, this finding contradicts Shen (2016), who reports a positive and statistically significant effect on sticker-price in-state tuition rates.

Finally, columns (3) and (6) of Table 3 present the impact on sticker-price tuition at private institutions. The estimated coefficients indicate that treated private institutions experienced a 4.4% reduction in sticker-price tuition compared to untreated institutions during 2005–2019. Alternatively, the continuous specification in column (6) shows that each 1 percentage point increase in the pre-shock share of international undergraduate enrollment is associated with a 0.598% reduction in sticker-price tuition at PhD-granting private institutions.

To contextualize this effect, consider that the average PhD-granting private institution experienced a 4.5 percentage point increase in international undergraduate enrollment share between 2005 and 2019, and the baseline average tuition was approximately \$24,100. This translates to a \$4,772 reduction in sticker-price tuition at PhD-granting private institutions attributable to the increase in international undergraduate enrollment during this period.

These results highlight a critical limitation of jointly evaluating sticker-price tuition at public and private institutions: the same increase in international undergraduate enrollment has divergent effects on these two types of institutions. While public institutions raise

out-of-state tuition, private institutions reduce tuition, suggesting that joint estimation may mask these differential responses and obscure important heterogeneity in institutional pricing strategies.

Table 3: Diff-in-Diffs Results for Sticker-Price Tuition (PhD-granting institutions)

Tuition Category	(1) Public-OOS log(Tuition)	(2) Public-IS log(Tuition)	(3) Private log(Tuition)	(4) Public-OOS log(Tuition)	(5) Public-IS log(Tuition)	(6) Private log(Tuition)
HighExposure $\times$ Post2005	0.0843*** (0.0219)	0.0273 (0.0233)	-0.0404** (0.0164)			
InitialRate $\times$ Post2005				0.0266*** (0.00938)	0.00703 (0.0103)	-0.00598** (0.00269)
Treatment type	Discrete	Discrete	Discrete	Continuous	Continuous	Continuous
Institution FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Observations	3,439	3,429	1,687	3,439	3,429	1,687
R^2	0.925	0.951	0.986	0.924	0.951	0.986

Notes: This table reports difference-in-differences estimates of the impact of international undergraduate enrollment on sticker-price tuition at PhD-granting institutions. Columns (1)–(3) use the discrete treatment variable (HighExposure_i), which equals one for institutions with above-median pre-shock (2000–2004) international undergraduate shares. Columns (4)–(6) use the continuous treatment variable (InitialRate_i), which measures the pre-shock share of international undergraduate enrollment. All specifications include institution and year fixed effects, control for state-level unemployment rates, and include interactions between baseline institutional characteristics and year dummies. OOS = out-of-state tuition; IS = in-state tuition. The sample includes 173 public and 85 private PhD-granting institutions observed from 2000–2019. Robust standard errors clustered at the institution level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In Table 4, I report results from a robustness check that additionally controls for interactions between baseline institutional characteristics and year dummies. This specification addresses concerns that institutions with different baseline characteristics may have experienced differential trends during 2005–2019, or that differences in baseline characteristics may have persistent effects on tuition-setting strategies. Similar to Table 3, I present results under both the discrete treatment specification (HighExposure_{it}) and the continuous treatment specification (InitialRate_{it}).

For public institutions, shown in columns (1), (2), (4), and (5) of Table 4, the estimated impacts on out-of-state and in-state sticker-price tuition remain largely consistent with those in Table 3. However, for private institutions, the results differ. Although the estimated coefficients on sticker-price tuition at PhD-granting private institutions retain their negative

sign, as shown in columns (3) and (6) of Table 4, they are no longer statistically significant.

Table 4: Diff-in-Diffs Results for Sticker-Price Tuition (PhD-granting institutions)

Tuition Category	Public-OOS log(Tuition)	Public-IS log(Tuition)	Private log(Tuition)	Public-OOS log(Tuition)	Public-IS log(Tuition)	Private log(Tuition)
HighExposure $\times$ Post2005	0.0829*** (0.0236)	0.0223 (0.0233)	-0.0202 (0.0201)			
InitialRate $\times$ Post2005				0.0223** (0.00971)	0.00358 (0.0103)	-0.00359 (0.00264)
Treatment type	Discrete	Discrete	Discrete	Continuous	Continuous	Continuous
Baseline $\times$ Year Dummy	✓	✓	✓	✓	✓	✓
Institution FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Observations	3,439	3,429	1,687	3,439	3,429	1,687
R^2	0.931	0.957	0.988	0.930	0.957	0.988

Notes: This table reports robustness checks for the difference-in-differences estimates shown in Table 3. The specification additionally controls for interactions between baseline institutional characteristics (R1 indicator, total enrollment, average loan amount, average aid amount, share receiving grants, and baseline tuition) and year dummies to account for differential trends across institutions with different baseline characteristics. Columns (1)–(3) use the discrete treatment variable (HighExposure_{*i*}), while columns (4)–(6) use the continuous treatment variable (InitialRate_{*i*}). All specifications include institution and year fixed effects and control for state-level unemployment rates. OOS = out-of-state tuition; IS = in-state tuition. The sample includes 173 public and 85 private PhD-granting institutions observed from 2000–2019. Robust standard errors clustered at the institution level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Finally, Table 5 presents results from the shift-share instrumental variables regression, which provides a more policy-relevant estimate of the aggregate effect of rising international undergraduate enrollment between 2005 and 2019. Column (1) of Table 5 reports the effect of international student enrollment on sticker-price tuition at private doctoral-granting institutions. A 1 percentage point increase in the share of international freshmen in year $t - 1$ is associated with a 1.44% reduction in sticker-price tuition. Column (2) presents the effect on in-state tuition at public institutions, which is both small in magnitude and statistically insignificant. Column (3) shows the corresponding effect on out-of-state tuition at public PhD-granting institutions: a 1 percentage point increase in the lagged share of international freshmen leads to a 3.76% increase in out-of-state tuition.

Overall, the results across all identification strategies are consistent. Increases in international undergraduate enrollment are associated with (i) higher sticker-price out-of-state tuition at public PhD-granting institutions, (ii) lower sticker-price tuition at private PhD-

granting institutions, and (iii) no statistically significant effect on in-state tuition at public PhD-granting institutions.

Table 5: IV Regression Results for Sticker Price Tuition of Public and Private Institutions (PhD-granting Institution)

Tuition Type	Public(OS) Log(Tuition)	Public(IS) Log(Tuition)	Private Log(Tuition)
Pct Foreign _{it}	0.0355** (0.0152)	0.0135 (0.0142)	-0.0158** (0.00652)
Mean Tuition	19,639	7,650	33,236
Observations	3,116	3,107	1,385
F-Test(1st Stage)	109.161	203.105	111.013
Kleibergen-Paap LM	14.019	9.581	6.339
Kleibergen-Paap p-value	0.0002	0.0020	0.0118
Year FE	✓	✓	✓
Institution FE	✓	✓	✓
State Control	✓	✓	✓
Baseline Interactions	✓	✓	✓

Notes: This table reports shift-share instrumental variable estimates of the impact of international undergraduate enrollment on sticker-price tuition at PhD-granting institutions. The endogenous variable is the lagged percentage of international first-time undergraduate enrollment (Pct Foreign_{it-1}). The instrument is constructed using each institution’s average pre-shock (2000–2004) international undergraduate share interacted with the national growth rate in international undergraduate enrollment. All specifications include institution and year fixed effects, control for state-level unemployment rates, and include interactions between baseline institutional characteristics and year dummies. IS = in-state tuition; OOS = out-of-state tuition. Mean tuition is calculated over the sample period. The sample includes 85 private and 173 public PhD-granting institutions observed from 2000–2019. Robust standard errors clustered at the institution level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6.2 Net-Price Tuition Rates for Domestic Students

As 72% of undergraduate students in the U.S. received some form of financial aid during 2019–2020, changes in sticker-price tuition affect only a small percentage of students from high-income families who do not receive aid. Therefore, net-price tuition rates—the tuition paid by domestic students after financial aid—are more relevant for analyzing how the increase in international undergraduate enrollment affects college affordability for domestic

students.

To further evaluate the impact of rising international undergraduate enrollment on domestic students in the U.S., I examine average net-price tuition by income group, which represents the average tuition paid by domestic students after receiving financial aid and grants. However, because data on average net-price tuition begin in 2009—four years after the surge in international undergraduate enrollment began in 2005—the difference-in-differences approach would have an insufficient pre-treatment period. I therefore rely primarily on the shift-share IV regression to analyze these impacts, which compares net-price tuition outcomes across institutions with different pre-shock shares of international undergraduate students.

Tables 6 and 7 present the estimated coefficients for the impact on average net-price tuition rates at PhD-granting public and private institutions, respectively. Columns (1) through (5) in Table 6 present the estimated impacts on average net-price tuition for students from families with annual incomes ranging from \$0 to \$30,000 up to students from families with incomes of \$110,000 or more at public institutions. As Table 6 shows, although most estimated coefficients are negative, none are statistically significant.

Table 6: IV Regression Results for Average Net Price of PhD-granting Public Institutions

	(1)	(2)	(3)	(4)	(5)
	log(Net Price)	log(Net Price)	log(Net Price)	log(Net Price)	log(Net Price)
	Inc: 0k – 30k	Inc: 30k – 48k	Inc: 48k – 75k	Inc: 75k – 110k	Inc: $\geq$ 110k
Pct Foreign _{it-1}	0.00542 (0.0716)	-0.0222 (0.0468)	-0.0671* (0.0383)	-0.0321 (0.0214)	-0.0129 (0.0172)
Observations	1,274	1,274	1,272	1,271	1,268
Year FE	✓	✓	✓	✓	✓
Institution FE	✓	✓	✓	✓	✓

Notes: This table reports shift-share instrumental variable estimates of the impact of international undergraduate enrollment on average net-price tuition (tuition after financial aid and grant) by family income group at public PhD-granting institutions. The endogenous variable is the lagged percentage of international first-time undergraduate enrollment (Pct Foreign_{it-1}). Income groups represent annual family income in thousands of dollars. All specifications include institution and year fixed effects and control for state-level unemployment rates. The sample includes 173 public PhD-granting institutions observed from 2009–2019. Robust standard errors clustered at the institution level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Columns (1) through (6) in Table 7 show the estimated impact on net-price tuition outcomes at private institutions. Compared to PhD-granting public institutions, net-price tuition rates at PhD-granting private institutions experienced statistically significant reductions for students from nearly all income groups. For example, column (2) in Table 7 shows that each 1 percentage point increase in the lagged predicted share of international undergraduate students is associated with a 5.73% reduction in net-price tuition for students from families with annual incomes between \$30,001 and \$48,000.

Table 7: IV Regression Results for Average Net Price of PhD-granting Private Institutions

	(1)	(2)	(3)	(4)	(5)
	log(Net Price)	log(Net Price)	log(Net Price)	log(Net Price)	log(Net Price)
	Inc: 0k – 30k	Inc: 31k – 48k	Inc: 49k – 75k	Inc: 76k – 110k	Inc: $\geq$ 111k
Pct Foreign _{<i>it-1</i>}	-0.0430*	-0.0573**	-0.0368*	-0.0153*	0.0114**
	(0.0224)	(0.0211)	(0.0187)	(0.00836)	(0.00422)
Observations	732	736	737	735	735
Year FE	✓	✓	✓	✓	✓
Institution FE	✓	✓	✓	✓	✓

Notes: This table reports shift-share instrumental variable estimates of the impact of international undergraduate enrollment on average net-price tuition (tuition after financial aid and grant) by family income group at private PhD-granting institutions. The endogenous variable is the lagged percentage of international first-time undergraduate enrollment (Pct Foreign_{*it-1*}). Income groups represent annual family income in thousands of dollars. All specifications include institution and year fixed effects and control for state-level unemployment rates. The sample includes 85 public PhD-granting institutions observed from 2009–2019. Robust standard errors clustered at the institution level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6.3 Student Quality and Institutional Expenditures

If universities indeed prioritize institutional quality, then the rise of international students—who expand the pool of highly qualified applicants—should increase the overall academic ability of enrolled students. To test this mechanism, I examine how international undergraduate enrollment affects average student ability, as measured by SAT scores.

Table 8 reports the impact on the 75th percentile SAT math and verbal scores of first-time

undergraduates at PhD-granting institutions. Columns (1) and (2) present results for public institutions, while columns (3) and (4) present results for private institutions. Consistent with the quality investment hypothesis, the 75th percentile SAT verbal and math scores increase at both public and private institutions, indicating that universities leverage the expanded international applicant pool to admit academically stronger students.

Table 8: IV Regression Results for SAT Score of Public and Private Institutions
(PhD-granting Institution)

	(1)	(2)	(3)	(4)
	log(SAT Math 75th %)	log(SAT Verbal 75th %)	log(SAT Math 75th %)	log(SAT Verbal 75th %)
Pct Foreign _{it-1}	0.00668** (0.00300)	0.00629* (0.00357)	0.00389 (0.00238)	0.00219 (0.00254)
Observations	1,403	1,393	704	702
R-squared	-0.051	-0.095	-0.034	-0.040
Institution Type	Public	Public	Private	Private
Year FE	✓	✓	✓	✓
Institution FE	✓	✓	✓	✓

Notes: This table reports shift-share instrumental variable estimates of the impact of international undergraduate enrollment on the 75th percentile SAT math and verbal scores of first-time undergraduate students. The endogenous variable is the lagged percentage of international first-time undergraduate enrollment (Pct Foreign_{it-1}). The instrument is constructed using each institution’s average pre-shock (2000–2004) international undergraduate share interacted with the national growth rate in international undergraduate enrollment. Columns (1)–(2) show results for public institutions, while columns (3)–(4) show results for private institutions. All specifications include institution and year fixed effects and control for state-level unemployment rates. The sample includes 173 public and 85 private PhD-granting institutions observed from 2000–2019. Robust standard errors clustered at the institution level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Additionally, Table 9 examines the impact on institutional spending patterns. Columns (1), (2), and (3) present estimates for public institutions, while columns (4), (5), and (6) show results for private institutions. The results are statistically significant only for private institutions. For each 1 percentage point increase in the share of international undergraduates, instructional spending increases by \$69,610 and research spending increases by \$53,080 at private institutions. Because all three spending categories are strongly associated with educational quality, these substantial increases suggest that private institutions prioritize quality investments when enrolling more international students.

Table 9: IV Regression Results for Expenditure of Public and Private Institutions
(PhD-granting Institution)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(Instructional)	Instructional	log(Research)	Research	log(Instructional)	Instructional	log(Research)	Research
Pct Foreign _{it-1}	0.0226 (0.0242)	83.09 (52.24)	-0.0431 (0.0581)	62.56 (41.76)	0.0398* (0.0207)	69.61*** (25.88)	0.00240 (0.0396)	53.08** (24.81)
Observations	1,649	1,649	1,649	1,649	733	733	647	647
R-squared	-0.001	-3.680	-0.017	-3.564	-0.250	-2.509	0.000	2.964
Institution Type	Public	Public	Public	Public	Private	Private	Private	Private
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Institution FE	✓	✓	✓	✓	✓	✓	✓	✓

Notes: This table reports shift-share instrumental variable estimates of the impact of international undergraduate enrollment on institutional spending per student (in thousands of 2013 dollars). The endogenous variable is the lagged percentage of international first-time undergraduate enrollment (Pct Foreign_{it-1}). The instrument is constructed using each institution's average pre-shock (2000–2004) international undergraduate share interacted with the national growth rate in international undergraduate enrollment. Columns (1)–(3) show results for public institutions, while columns (4)–(6) show results for private institutions. All specifications include institution and year fixed effects and control for state-level unemployment rates. The sample includes up to 173 public and 85 private PhD-granting institutions observed from 2000–2019. Robust standard errors clustered at the institution level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

7 Conclusion

This paper examines the causal impact of rising international undergraduate enrollment on both sticker-price and net-price tuition outcomes at PhD-granting universities in the United States. Leveraging difference-in-differences and instrumental variable approaches with panel data from IPEDS covering 2000–2019, I find that increased international undergraduate enrollment has divergent effects across institutional types: it raises out-of-state sticker-price tuition at public universities while reducing sticker-price tuition at private institutions. Specifically, a 1 percentage point increase in the pre-shock share of international undergraduate enrollment is associated with a 3.56% increase in out-of-state sticker-price tuition at public universities and a 1.58% decrease in sticker-price tuition at private universities. Moreover, net-price tuition declines at private institutions, with statistically significant decreases across nearly all income groups, while public institutions show no significant changes in net-price tuition.

These differential responses suggest that private and public universities pursue distinct institutional objectives in response to international enrollment growth. Private universities appear to prioritize institutional quality and student subsidization, using revenue from international students to reduce net prices for domestic students and enhance institutional resources. In contrast, public institutions emphasize maintaining in-state access while using international enrollment to offset budget pressures, leading to higher out-of-state tuition

without commensurate reductions in domestic student costs. Analysis of institutional expenditure patterns supports this interpretation: private universities significantly increase spending on instruction and research following international enrollment growth, while public universities show no statistically significant changes in these quality-related expenditures.

These findings have important implications for higher education policy. The evidence suggests that domestic students at private universities benefit substantially from international enrollment growth through lower net prices and enhanced educational resources, whereas domestic students at public institutions experience more limited gains, primarily through modest improvements in average student quality. These results have important implications for higher education policy, particularly regarding the role of international students in financing American universities and promoting educational access.

References

- Archibald, R. B. and Feldman, D. H. (2008). Explaining increases in higher education costs. *The Journal of Higher Education*, 79(3):268–295.
- Beine, M., Peri, G., and Raux, M. (2023). International college students’ impact on the us skilled labor supply. *Journal of Public Economics*, 223:104917.
- Borusyak, K., Hull, P., and Jaravel, X. (2022). Quasi-experimental shift-share research designs. *The Review of Economic Studies*, 89(1):181–213.
- Bound, J., Braga, B., Khanna, G., and Turner, S. (2020). A passage to america: University funding and international students. *American Economic Journal: Economic Policy*, 12(1):97–126.
- Bound, J., Braga, B., Khanna, G., and Turner, S. (2021). The globalization of postsecondary education: The role of international students in the us higher education system. *Journal of Economic Perspectives*, 35(1):163–184.
- Bundick, B. and Pollard, E. (2019). The rise and fall of college tuition inflation. *Economic Review*, 104(1):1–19.
- Cai, Z. and Heathcote, J. (2022). College tuition and income inequality. *American Economic Review*, 112(1):81–121.
- Callaway, B., Goodman-Bacon, A., and Sant’Anna, P. H. (2024). Difference-in-differences with a continuous treatment. Technical report, National Bureau of Economic Research.
- Card, D. (2001). Immigrant inflows, native outflows, and the local labor market impacts of higher immigration. *Journal of labor economics*, 19(1):22–64.
- Card, D. (2009). Immigration and inequality. *American Economic Review*, 99(2):1–21.
- Cook, E. E. and Turner, S. (2022). Progressivity of pricing at us public universities. *Economics of Education Review*, 88:102239.
- Deming, D. J. and Walters, C. R. (2017). The impact of price caps and spending cuts on us postsecondary attainment. Technical report, National Bureau of Economic Research.
- Epple, D., Figlio, D., and Romano, R. (2004). Competition between private and public

- schools: testing stratification and pricing predictions. *Journal of public Economics*, 88(7-8):1215–1245.
- Epple, D., Romano, R., Sarpça, S., and Sieg, H. (2017). A general equilibrium analysis of state and private colleges and access to higher education in the us. *Journal of Public Economics*, 155:164–178.
- Epple, D., Romano, R., Sarpça, S., Sieg, H., and Zaber, M. (2019). Market power and price discrimination in the us market for higher education. *The RAND Journal of Economics*, 50(1):201–225.
- Epple, D., Romano, R., and Sieg, H. (2006). Admission, tuition, and financial aid policies in the market for higher education. *Econometrica*, 74(4):885–928.
- Federal Reserve Bank of St. Louis (2025). Chinese yuan renminbi to u.s. dollar spot exchange rate (dexchus). FRED, Federal Reserve Bank of St. Louis. Accessed: October 10, 2025.
- Goldsmith-Pinkham, P., Sorkin, I., and Swift, H. (2020). Bartik instruments: What, when, why, and how. *American Economic Review*, 110(8):2586–2624.
- Hedlund, A. and Gordon, G. (2017). Accounting for tuition increases at us colleges. In *2017 Meeting Papers*, number 1550. Society for Economic Dynamics.
- Hoxby, C. M. (2003). School choice and school productivity. could school choice be a tide that lifts all boats? In *The economics of school choice*, pages 287–342. University of Chicago Press.
- Institute of International Education (2023). International students: All places of origin, 2022/23 academic year. Open Doors Report on International Educational Exchange. Accessed: October 13, 2025.
- James-MacEachern, M. and Yun, D. (2017). Exploring factors influencing international students’ decision to choose a higher education institution: A comparison between chinese and other students. *International Journal of Educational Management*, 31(3):343–363.
- Jones, J. B. and Yang, F. (2016). Skill-biased technical change and the cost of higher education. *Journal of Labor Economics*, 34(3):621–662.

- Khanna, G., Shih, K., Weinberger, A., Xu, M., and Yu, M. (2023). Trade liberalization and chinese students in us higher education. *Review of Economics and Statistics*, pages 1–46.
- Koshal, R. K. and Koshal, M. (2000). State appropriation and higher education tuition: What is the relationship? *Education Economics*, 8(1):81–89.
- National Center for Education Statistics (2016). Foreign students enrolled in institutions of higher education in the united states, by continent, region, and selected countries of origin: Selected years, 1980-81 through 2014-15. Digest of Education Statistics, Table 310.20. Accessed: October 13, 2025.
- National Center for Education Statistics (2025). Integrated postsecondary education data system (ipeds). Database.
- Shen, Y. (2016). The impacts of the influx of new foreign undergraduate students on u.s. higher education. Unpublished manuscript, University of Notre Dame.
- Shih, K. (2017). Do international students crowd-out or cross-subsidize americans in higher education? *Journal of Public Economics*, 156:170–184.
- Tumen, S. (2021). The effect of refugees on native adolescents’ test scores: Quasi-experimental evidence from pisa. *Journal of Development Economics*, 150:102633.
- U.S. Bureau of Labor Statistics (2025). Consumer price index for all urban consumers: All items in u.s. city average [cpiaucsl]. Retrieved from FRED, Federal Reserve Bank of St. Louis. Seasonally Adjusted.
- U.S. Department of State (2005). U.s. extends visa validity for chinese students and exchange visitors. Media Note. Press Release 2005/619.
- Webber, D. A. (2017). State divestment and tuition at public institutions. *Economics of Education Review*, 60:1–4.
- Wright, L. (2025). 20 years of missed opportunities in china’s exchange rate policy. Research report, Rhodium Group, New York, NY.

A Appendix

Table A1: Reduced Form: Effect of Shift-Share Instrument on Tuition
(PhD-granting Institutions)

Tuition Type	Public (OOS) Log(Tuition)	Public (IS) Log(Tuition)	Private Log(Tuition)
Predicted Rate $_{it-1}$	0.0222*** (0.00669)	0.00706 (0.00736)	-0.00556*** (0.00163)
Mean Tuition	19,639	7,650	33,236
Observations	3,262	3,253	1,444
R-squared	0.926	0.952	0.986
Year FE	✓	✓	✓
Institution FE	✓	✓	✓
State Controls	✓	✓	✓
Baseline Interactions	✓	✓	✓

Notes: This table reports reduced form estimates of the relationship between the shift-share instrument and log sticker-price tuition at PhD-granting institutions. The shift-share instrument is constructed using each institution's average pre-shock (2000–2004) international undergraduate share interacted with the national growth rate in international undergraduate enrollment. All specifications include institution and year fixed effects, control for state-level unemployment rates, and include interactions between baseline institutional characteristics and year dummies. IS = in-state tuition; OOS = out-of-state tuition. Mean tuition is calculated over the sample period in 2019 dollars. The sample includes 85 private and 173 public PhD-granting institutions observed from 2000–2019. Robust standard errors clustered at the institution level are reported in parentheses. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table A2: Reduced Form Regression Results for SAT Scores (PhD-granting Institution)

	(1)	(2)	(3)	(4)
	log(SAT Math 75th %)	log(SAT Verbal 75th %)	log(SAT Math 75th %)	log(SAT Verbal 75th %)
Predicted Rate _{it-1}	0.00562*** (0.00197)	0.00523** (0.00201)	0.00199** (0.000892)	0.00264** (0.00122)
Observations	1,443	1,431	800	798
R-squared	0.938	0.922	0.960	0.956
Institution Type	Public	Public	Private	Private
Year FE	✓	✓	✓	✓
Institution FE	✓	✓	✓	✓

Notes: This table reports reduced form estimates of the impact of the predicted rate on the 75th percentile SAT math and verbal scores of first-time undergraduate students. The instrument is constructed using each institution's average pre-shock (2000–2004) international undergraduate share interacted with the national growth rate in international undergraduate enrollment. Columns (1)–(2) show results for public institutions, while columns (3)–(4) show results for private institutions. All specifications include institution and year fixed effects and control for state-level unemployment rates. The sample includes 173 public and 85 private PhD-granting institutions observed from 2000–2019. Robust standard errors clustered at the institution level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3: Reduced Form Regression Results for Expenditure of Public and Private Institutions (PhD-granting Institution)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(Instructional)	Instructional	log(Research)	Research	log(Instructional)	Instructional	log(Research)	Research
Predicted Rate _{it-1}	0.0222 (0.0237)	39.28*** (12.98)	-0.0243 (0.0293)	25.26*** (7.530)	0.0120* (0.00672)	23.23*** (6.290)	-0.0339 (0.0285)	15.65*** (4.818)
Observations	1,716	1,716	1,716	1,716	850	850	712	712
R-squared	0.017	0.089	0.005	0.082	0.011	0.160	0.003	0.144
Institution Type	Public	Public	Public	Public	Private	Private	Private	Private
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Institution FE	✓	✓	✓	✓	✓	✓	✓	✓

Notes: This table reports reduced-form estimates of the impact of international undergraduate enrollment on institutional spending per student. The endogenous variable is the lagged percentage of international first-time undergraduate enrollment (Pct Foreign_{it-1}). The instrument is constructed using each institution's average pre-shock (2000–2004) international undergraduate share interacted with the national growth rate in international undergraduate enrollment. Columns (1)–(3) show results for public institutions, while columns (4)–(6) show results for private institutions. All specifications include institution and year fixed effects and control for state-level unemployment rates. The sample includes up to 173 public and 85 private PhD-granting institutions observed from 2000–2019. Robust standard errors clustered at the institution level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.