A PASSAGE TO AMERICA:
UNIVERSITY FUNDING AND INTERNATIONAL STUDENTS

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ABSTRACT

The pool of students in the global economy prepared for higher education and able to pay tuition at U.S. colleges and universities has expanded markedly in the last two decades, with a particularly notable increase among potential undergraduate students from China. Given the concentration of high quality colleges and universities in the U.S., there has been a substantial increase in the demand for enrollment among students from abroad. At the same time, substantial declines in state support, driven by contractions in state budgets, have occurred at public sector universities. For such universities, declines in state appropriations force a choice between increasing tuition levels, cutting expenditures, or enrolling a greater proportion of students paying full out-of-state tuition. In this paper we present evidence showing that a significant set of public universities were able to take advantage of the expanding pool of potential students from abroad to provide a stream of tuition revenue that partially offsets declining state appropriations. Our analysis focuses on the interaction between the type of university experience demanded by students from abroad and the supply-side of the U.S. market. For the period between 1996 and 2012, we estimate that a 10% reduction in state appropriations is associated with an increase in foreign enrollment of 12% at public research universities and about 17% at the most resource-intensive public universities. Our results tell a compelling story about the link between changes in state funding and foreign enrollment in recent years. In the absence of the pool of foreign students, many universities would have faced larger cuts to expenditures and potentially greater increases in in-state tuition charges.

The number of undergraduate students from abroad in the United States has increased markedly since the beginning of the 21st century, rising 67% from 288 thousand students in 2000 to 482 thousand in 2013 (Integrated Postsecondary Education Data System). Increased academic preparation at the secondary level, growth in incomes allowing families to pay for college, and persistently high returns to collegiate attainment are among the international factors affecting this growth. Such changes are particularly marked in developing economies like China where secondary enrollment increased from 64 to 95 million between 1996 and 2012 while GDP per capita (in current US$) increased eightfold from about $707 to $6,264 over this interval (World Bank Development Indicators). Not only is it difficult for home country institutions to expand at this pace, but growth may be particularly constrained at the type of universities with high fixed costs and substantial research infrastructure.

In the United States, there is a large and well-established market for higher education: 4,627 degree-granting institutions enrolled more than 20.6 million students in 2014-15. On a per capita basis, the U.S. leads the world in the supply of collegiate opportunities, and boasts 33 of the 50 most highly ranked universities, as indicated by measures of research productivity (Shanghai Rankings). Institutional diversity and stratification characterizes the market for higher education: market participants include private non-profits, for-profits and public colleges and universities, while instructional resources per student vary dramatically (Winston, 1999 and Bound, Lovenheim, and Turner, 2010). The scale of the public sector is notable as 63% of all BA-level degrees and 64% of all four-year university enrollment are generated by public colleges and universities (IPEDS Fall Enrollment Survey), even as private institutions represent the majority of institutions and include a wide range of missions including internationally acclaimed research universities, liberal arts colleges, institutions with strong religious affiliations and those with particular vocational orientations.

Organized and governed at the state level, public universities typically receive substantial state subsidies and have a mandate to provide collegiate opportunities to in-state students, which is usually fulfilled via below-cost tuition rates and preferential treatment in admissions. State appropriations, however, have not only decreased as a share of the total costs of higher education in recent decades, but have also declined in constant dollars in recent years – falling from $89.7 billion for the 2007-08 academic year to $74.8 billion in 2011-12 (State Higher Education

Executive Officers Association, 2014).[1] For university leaders facing declines in state funding, potential margins for adjustment include raising revenues through increases in tuition, cutting expenditures (and thereby reducing resources per student), or admitting a greater proportion of students paying full out-of-state tuition. The demand from students from different residential locations – in state, other U.S. states, and international – with sufficient academic and financial wherewithal to enroll in a particular public university limits how universities can adjust along these margins, while state-level politics constrain both increases in in-state tuition and decreases in in-state student representation.

The broad hypothesis presented in this paper is that increases in the pool of students from abroad seeking university-level undergraduate education, combined with cuts in state appropriations, have driven the dramatic growth in full-fare paying students from abroad at public research universities. We present empirical evidence consistent with this hypothesis and describe the mechanism in the context of a model of public university behavior.

We begin by demonstrating that the rapid growth in undergraduate enrollment from abroad is largely due to the rise in enrollment from China. This rising demand is driven by improvements in secondary educational attainment in China and the increasing ability of Chinese families to pay for a college education in the U.S. We also show that the matching of students to U.S. colleges and universities varies by country of origin, with students from countries in Western Europe and the U.K. concentrated at the most selective institutions, while students from China and other developing countries enrolled in a broader range of colleges and universities.

We then discuss the sharp declines in state funding faced by public universities and its implications for undergraduate enrollment. While the recent increase in demand among students from China could potentially affect enrollment in all research universities, we hypothesize that public research universities suffering significant state appropriation cuts disproportionately turn to foreign students as a source of tuition revenue. Using an instrumental variables strategy which exploits changes in state-level higher education budgets, we estimate that a 10% reduction in state appropriations is associated with an average increase in foreign enrollment of 12% at public research universities.

We also explore the heterogeneous effects of state appropriation cuts across public universities. We work with the presumption that non-research universities have limited access to

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[1] Constant dollars represented in 2014 units, using the Higher Education Price Index deflator.

international students, so there should be little foreign enrollment response at these institutions. Indeed, our empirical analysis shows that effects of decreases in state appropriations on foreign enrollment do not appear at public institutions outside the research sector, and they are not significant for public universities that had steady access to domestic full-fee paying students.

In turn, increases in the enrollment of foreign students generate substantial gains in university tuition revenues, which partially offset the loss in appropriations. The association between declines in appropriations and increases in foreign enrollment is larger than the association with out-of-state domestic enrollment, which is consistent with the interpretation that the pool of qualified students with the capacity to pay non-resident tuition levels from abroad is substantially larger than the pool of comparably prepared domestic out-of-state students.

Following this framework, in the first section we review trends in international participation in U.S. higher education at the undergraduate level and present evidence on the role of students from China in the recent expansion. In the second section, we outline the institutional features of the U.S. market for higher education and present a conceptual model of public university behavior that considers university resource choice and selection of students. Section three outlines the empirical strategy and sources of data. Section four presents the results and the final section concludes.

Section 1.   The Demand from Abroad and the Role of China

There is a long history of foreign participation in U.S. higher education at both the undergraduate and graduate levels, though the cross-country patterns of flows have changed markedly over time.[2]   In 1993, Japan (with 31,960 students enrolled in the U.S.), Canada (13,149) and South Korea (12,521) were the three largest source countries for enrollment among foreign students at U.S. colleges and universities; but, by 2013, the landscape changed appreciably with Canada falling to fifth, Saudi Arabia[3] jumping to second (26,865) and China leapfrogging ahead of the

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[2] Unlike work visas such as the H-1B, student visas have not been subject to numerical constraints. The process for obtaining a student F visa requires prospective students to receive and accept an offer of admission from a U.S. college or university. More broadly, student visas include the F, M and J visas, which are all "non-immigrant visas" permitting temporary residency. The most common designation is the F-1 visa, which is issued to students admitted to an approved institution of learning. M visas are intended for study in vocational rather than academic programs, while J visas are intended for visitors and require a two-year home residency after the completion of the exchange program before return to the U.S.

[3] The introduction of an explicit government fellowship for study abroad is clearly a contributing factor to the observed increase in enrollments among students from Saudi Arabia (Kurtz, 2012).

others (110,550). Figure 1 illustrates the dramatic increase in students from China, with a sharp shift that begins around 2006. From 1998-2005, the yuan/dollar exchange rate remained effectively constant at 8.28 yuan/USD, but in mid-2005 the Chinese modified their currency valuation policies, allowing the yuan to appreciate. By January 2014, the yuan had appreciated by about 37% to trade at 6.05 yuan/USD. In addition, in June of 2005, Chinese and U.S. authorities extended the terms of student visas to allow for multiple entry 12-month visas, which reduced the administrative hurdles for Chinese students studying in the U.S.[4] Between 2006 and 2013, enrollment of foreign undergraduate students rose 58%, from 234 to 370 thousand students. In academic year 2013-14, China, India, Saudi Arabia and South Korea accounted for more than 50% of foreign undergraduate enrollment, with China alone accounting for 30%. In fact, the growth in undergraduate students from China – from roughly 8 thousand students in 2003-04 to more than 110 thousand in 2013-14 – accounts for 90% of the total increase in foreign undergraduates over this decade (Open Doors, Institute for International Education).

The enrollment demand among students from abroad for U.S. higher education institutions is a function of home country education markets and labor markets (Rosenzweig, 2006). Plausibly, four broad factors affect the demand from abroad to U.S. public universities: the number of students who can afford the cost of pursuing a college degree abroad; the number of students completing secondary education and prepared for post-secondary study; the extent to which home countries are "supply constrained" in the availability of comparable quality higher education; and, in cases where employment opportunities are greater in the U.S. than in the origin country, the extent to which study in the U.S. provides an "option value" to the U.S. labor market.[5]

Capacity to pay for higher education is a potent factor in the flow of students to the U.S. at the undergraduate level. Unlike foreign doctoral students, who commonly receive full support in the form of fellowships, teaching assistantships, and research awards, foreign undergraduates are generally expected to make full tuition payments.

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[4] For more details on the visa policy change, see: https://2001-2009.state.gov/r/pa/prs/ps/2005/47974.htm
[5] Rosenzweig (2006) proposes two models for foreign student mobility: a "constrained domestic schooling model", which leads to the hypothesis that foreign students seek education in the U.S. due to a dearth of home country options; and a "migration model", which points to the hypothesis that foreign students enroll in the U.S. to increase the probability that they will find employment in the U.S. when they graduate. Bound, Demirci, Khanna and Turner (2014) show that a large fraction (at least 70%) of on the graduating class of F-1 visas transition to work visas (H1-Bs or OPTs) within the year after graduation.

A very small number of households in the Chinese population could afford undergraduate education in the U.S. until the late 1990s, when China began to experience rapid economic growth. With an eightfold increase in China's GDP per capita between 1996 and 2012, we calculate that while less than 0.005% of Chinese families had incomes greater than the average charged for out-of-state tuition and room and board by U.S. public universities in the year 2000, by 2009 approximately 0.032% would have had such incomes – a growth that continues exponentially, as by 2013 more than 2% of families were predicted to have such incomes.[6] In Figure 2 we show how this fraction closely tracks the fraction of college-age Chinese students studying in the U.S. While some of the students from China studying in the U.S. are from wealthy families (Liu, 2015; Higgins, 2013; Fischer, 2014), others have parents who invest a large share of household income into their children's education. Many parents in this generation have a single child, reflecting the one child policy in many parts of China, and may concentrate their investments in the single child.

Beyond the obvious observation that China and India are large countries, they are also countries where secondary education has grown dramatically. Between 1996 and 2012, secondary enrollment in India increased 78.8%, from 66.6 million students to 119 million, and in China by 48.9%, from 63.8 million students to 95 million (UNESCO).

Availability of home country higher education options is another factor affecting whether students pursue enrollment in the U.S. Indeed, there are significant differences across countries in measures of supply, defined simply as the number of institutions relative to population. While China has roughly four times the population of the U.S., it has less than half the number of higher education institutions – China has 912 and the U.S. has 2022 institutions listed in the World Higher Education Database. There are also significant differences across countries in the supply of relatively resource intensive universities. The U.K. and Canada have university options comparable in quality and resource intensity to those available in the U.S., except perhaps among the wealthiest private universities and liberal arts colleges.

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[6] Authors' calculations, based on income distribution data from the World Bank and average tuition, room and board charges for out-of-state students at public universities recorded in IPEDS. We derived the income distribution (assumed to be log-normal) following the approach of Pinkovskiy and Sala-i-Martin (2009). With the mean from GDP-per capita, we calibrate the standard deviation using income shares received by each quintile of the income distribution. Using the currency exchange rate, we convert to constant U.S. dollars and compute the expected share of households with incomes greater than the average public tuition, room and board for out-of-state students.

Even as post-secondary options have increased in China and other Asian countries, expansion in enrollment among their top-tier universities has been very limited. Indeed, the selectivity of top universities in India and China – measured by applicants relative to admissions opportunities – is greater than for the most elite private universities in the U.S.[7] These higher education supply constraints motivate foreign students to seek enrollment in the U.S., as well as other countries with well-developed higher education sectors such as the U.K. and Australia.

One implication, which is broadly supported by descriptive tabulations, is that there will be substantial differences across countries in the concentration of students at different types of colleges and universities in the U.S. Students who come from countries that are most supply constrained are likely to consider a much wider range of institutional options in the U.S. than those who come from countries where university options are nearly as diverse and plentiful, as in the U.S.[8] Figure 3 provides an illustrative example, using administrative data on F-1 visa recipients enrolled at U.S. undergraduate institutions from Western Europe and China. For Western Europe, which has a number of universities that are at least as strong as the top-public universities in the U.S., students tend to be concentrated among private, highly-ranked U.S. universities in major cities, while students from China, which has a much more limited relative supply of resource-intensive institutions, attend a much wider range of U.S. universities. Indeed, it is public universities that enroll the bulk of students from China.[9]

The different university destinations also ensure that sources of funding typically differ for students coming from different countries. Using administrative data on F-1 visas, we calculate that for the 2010-5 period, only 3.5% of total funding for students from China was from the U.S. universities they attend.

These trends have ensured that the growth in foreign enrollment is concentrated in public universities. Between 2007 and 2012, public research universities experienced a 112% increase in freshman foreign undergraduate enrollment, while private research universities experienced a

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[7] China's admission process, which relies solely on scores from the *gao kao* exam, is a highly competitive and stressful ordeal for students and parents which results in only 3 in 5 students being admitted to any Chinese college (LaFraniere, 2009).

[8] Bound, Turner and Walsh (2009) largely find this result at the doctorate level, where students from countries like China attended a much broader range of institutions than those from Canada and European countries like the U.K. and France who tended to be concentrated in very top U.S. universities.

[9] Since the late 1990s there has been an expansion in the supply-side of the non-selective universities in China, within which enrollment increased from 3.1 to 20 million in approximately 10 years. Since Chinese students would have opportunities to enroll in comprehensive-level institutions in their home countries at a fraction of the cost, we see almost no Chinese enrollment in non-research U.S. universities.

61% increase. This observation that students from China choose to enroll at the public universities in large numbers motivates our consideration of why these institutions have accommodated the growth in demand from foreign students.

Section 2. Market Structure and Resources for Higher Education in the U.S.

Colleges and universities in the U.S. vary widely in terms of their resources and the extent to which they compete in national (or international markets) for students and faculty. Sources of support differ with institutional control.   While private institutions rely on tuition revenues and (among the elite) endowment returns, public universities draw on state subsidies and tuition revenues with a more modest role for endowment returns. Of the 60 U.S. universities that form the American Association of Universities (AAU), a long-standing organization of leading research universities, 34 are public universities.[10] While some research universities enroll students from across the nation and the world, the majority of public colleges and universities draw students primarily from local or regional markets. In exchange for funds provided by the state government, public universities have a mandate to provide collegiate opportunities to in-state students, which is usually manifested in below-cost tuition rates and preferential treatment in admissions.[11]

Within states, there is significant stratification and specialization among the public institutions. Generally, at least one institution, often referred to as the "flagship university", has a mission which includes research and doctorate education. States also support colleges and universities that are more regional in orientation and focused on providing undergraduate education and professionally-oriented master's programs, often with a vocational and technical orientation that would be atypical at a research university.

2.1 Trends in U.S. Higher Education

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[10] Of the 50 international institutions rated highest in terms of research productivity by the Shanghai Rankings, 33 are located in the U.S., and 17 of these are public universities. In terms of the quality of undergraduate education, five public universities typically appear among the top-30 undergraduate colleges and universities in the U.S. News and World Report rankings; these include the University of California Berkeley, UCLA, University of Michigan-Ann Arbor, University of Virginia and University of North Carolina-Chapel Hill.

[11] Examples of the tuition for in-state versus out-of-state students at three selective public institutions in the 2014-15 academic year include: $13,208 (in-state) vs. $42,394 (out-of-state) at the University of Virginia, $13,486 vs. $41,906 at the University of Michigan and $12,972 vs. $35,852 for the University of California-Berkeley. Notably, the out-of-state tuition charges at these institutions approach those of similarly selective private institutions.

For public universities, the balance between state appropriations and tuition revenues has shifted markedly over time toward greater reliance on tuition revenues. While this shift began in the 1990s, it accelerated with the Great Recession in 2008. Figure 4 shows state appropriations per full-time equivalent (FTE) student at public colleges and universities over the last 30 years. In aggregate, we see the dramatic decline from about $12,000 per FTE in the mid-1980s to less than $7,000 per FTE in the most recent year. The secular decline is punctuated by clear downward cycles following recessions in 1990, 2001, and 2008.

The decline in constant dollar state appropriations led to a marked increase in the share of public universities' total educational revenues covered by net tuition revenue, a share that rose from 29.4% in 2001 to 43.3% in 2011 (Bowen, 2012). Tuition and fees have risen at a much greater rate in recent years for in-state students at public universities than for students at private institutions. For example, between 2008-09 and 2015-16, inflation-adjusted tuition and fees increased by about 20% at private four-year institutions and about 31% at public four-year institutions (College Board, *Trends in College Pricing*, 2015). States with the most severe economic downturns in the 2008 recession were among those in which public institutions raised tuition the most, with in-state tuition increases greatest at the flagship and more selective institutions within each state (Barr and Turner, 2013).

Beyond increasing revenues through raising tuition rates, some public universities may strive to increase the proportion of their student body that pays the full out-of-state tuition rate. Yet, higher education policy experts have recognized that the "demand" from well-qualified domestic out-of-state students is modest, particularly for those public institutions that do not compete with top private universities.[12] At the same time, the pool of well-qualified students from abroad is growing and is increasingly able to afford a U.S. education as incomes in emerging economies have risen. This growing pool would allow some public universities to use

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[12] Indiana University Professor Don Hossler notes: "There cannot possibly be enough students with the means and willingness to travel out-of-state for all the schools that want to tap this market. Institutions seeking to offset enrollment and/or revenue declines with out-of-state students are going to find it a tough road. And to the extent they are successful, they are likely to increasingly find that they have to get into a cycle of ever increasing the dollar value of financial aid awards to achieve their goals" (Hoover and Keller, 2011). There is considerable variation in the extent to which public universities draw domestic students from other states. For example, domestic out-of-state students comprise less than 5% of total domestic enrollment at the University of California-Davis, the University of California-Irvine, and Texas A & M, while they comprise more than 35% of domestic enrollment at the University of Michigan-Ann Arbor, the University of Colorado Boulder, and the University of Iowa.

foreign enrollment as an important tool in recovering lost state appropriations while maintaining admissions criteria.

Indeed, our descriptive evidence presented in Table 1 underscores these basic points about revenue sources and the flow of students from different geographies. We focus our analysis on public universities, and we distinguish universities by the scope and scale of their activities, including doctorate education and sponsored research.[13] The columns of the table present different public university categorizations (Research, Flagship, AAU, and Non-Research), with the AAU set representing the most-resource intensive and selective public universities, while the top and bottom panels show measures for 2007 and 2012, respectively. Across all institutional categories we see a rise in tuition revenue and a decline in state appropriations, with this change largest among the AAU universities. For research universities, appropriations relative to tuition revenue declined from a ratio of 1.28 to 0.75 over the period; while at non-research universities, the ratio falls from 0.74 to 0.47. It is also the case that tuition levels increased, with the greatest percentage change for in-state students. Concurrently, we see dramatic changes in the representation of students from abroad (outside the non-research universities) and largely insignificant changes in the number of domestic out-of-state students. On the other hand, non-research four-year institutions enrolled a small number of foreign students in 2007 with only modest additions by 2012, even as enrollment increased overall.

2.2 A Conceptual Framework of a Public University Decision to Enroll Foreign Students

A full model, detailed in the appendix, describes the behavior of public universities and state legislators, each with different objective functions captured in a principal-agent problem. In our model, the primary concern of universities is with the quality of education they provide, which is a function of the ability of the student body, as well as educational expenditures per student. The university faces a given pool of applicants with heterogeneous abilities from within the state, out-of-state, and from abroad.[14] Public university revenues come from tuitions and state appropriations. In-state students pay in-state tuition and out-of-state and foreign students pay

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[13] Specifically, these are the 138 public doctorate granting universities which are high or very high research activity according to the 2010 Carnegie definition, which includes public universities with substantial federal research support.
[14] The university decisions in our model are related to the framework in Epple, Romano, Sarpça and Sieg (2013) and Epple, Romano and Sieg (2006).

out-of-state tuition. State appropriations are a contract determined by the state legislature as an increasing function of the enrollment of in-state students.

First, state legislatures focus on the number of in-state students enrolled in the public university as well as their capacity to provide other public goods to the rest of the population. In equilibrium, appropriations increase with state revenues – motivating our empirical identification strategy. Then, to maximize the quality of education provided, the public university makes choices on the number of in-state, out-of-state, and foreign students to enroll and how much to invest in education. In equilibrium, public universities enroll foreign students to the extent that they pay higher tuition, effectively increasing the educational subsidy of in-state students. When state appropriations decline, public universities are more likely to admit foreign students because the marginal benefit of additional foreign students (and the associated tuition revenues) increases.[15]

2.3 University Heterogeneity: Research vs Non-Research Universities

Our model explains the heterogeneity in enrollment of foreign students by accounting for systematic differences among universities in the supply of high-quality applicants. In particular, our model predicts that very selective research universities, such as the University of Michigan or UC Berkeley, have access to a substantial pool of high quality out-of-state domestic students. Other research universities, such as Michigan State University or UC Davis, have access to a large pool of high-quality foreign applicants, but face a rapid decrease in out-of-state applicant quality as they expand enrollment. Our model predicts that such universities will not only have high foreign enrollment relative to out-of-state enrollment, but will also adjust to appropriations shocks by further increasing foreign enrollment. Indeed, declines in appropriations in the state of Michigan produce little change in foreign enrollment for the University of Michigan, but a sharp increase at Michigan State (Appendix Figure A1). A similar pattern is observed in California, a state that traditionally had strong support for higher education but recently experienced a substantial decline in appropriations. At UC Berkeley, the rise in out-of-state domestic students is actually somewhat larger than the rise in foreign students, while at UC-Davis the rise in

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[15] As we discuss in the appendix, these results hold even if the university's objective function values enrolling additional in-state students in levels, not just shares.

foreign students far exceeds the rise in out-of-state student. Finally, we expect that smaller, regional, non-research universities, such as Eastern Michigan University, have limited access to out-of-state and foreign student applicants.[16] Across the California state universities, out-of-state domestic enrollment is miniscule (less than 400 students), while enrollment of foreign students is modest (less than 5% of total first-time enrollment).

We test these predictions at the university-level, using the variation from state budgetary shocks. Consistent with the model's results, the empirical analysis shows that the rise in foreign enrollment is indeed driven by falling state appropriations and concentrated in research universities with limited access to out-of-state domestic students.

Section 3. Empirical Framework

Our empirical approach focuses, first, on regressions that show the link between changes in state appropriations and enrollment by domicile, distinguishing in-state students, foreign students and out-of-state students. Our underlying hypothesis is that while the increase in foreign demand for US undergraduate education could affect enrollment in all public research universities, universities suffering appropriation cuts are the ones overwhelmingly enrolling foreign students. Then, we turn to the consideration of how institutional adjustments in finances, including tuition revenues and expenditure categories, adjust to changes in state appropriations. In this setup, we address the concern that institution-level changes in appropriations are endogenous by using an instrumental variables strategy that draws on state budget mechanics. Data used in this analysis come from multiple institutional surveys of colleges and universities, as well as administrative data on foreign students studying in the U.S. with student F-visas.

3.1 Estimation Model

We use a panel of institutional observations for public universities and regress university-level outcomes on appropriations, cohort size, and state economic conditions. Observations are at the level of the university *(i)* and the year *(t)*, and our preferred specification is:

$$y_{it} = \beta_0 + \beta_1 App_{it} + X_{it}\lambda + \gamma_t + \delta_i + \varepsilon_{it} ,$$

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[16] Many of the out of state students at Eastern Michigan University come from northern Ohio, which has a reciprocity agreement with Eastern Michigan University.

where y_{it} is the outcome of interest, App_{it} represents institutional level appropriations, X_{it} are state-level time-varying controls, and γ_t and δ_i are year- and institution-specific fixed effects, respectively. The variation we use is therefore unaffected by secular changes in the entire economy and institution-specific time-invariant characteristics. The year fixed effects control for the overall increase in the demand for a college-education from domestic and foreign applicants, with year fixed effects in specifications for each group of universities accounting for overall changes in demand for universities in the group. Among the state-level controls is a measure of the population at age 18, which may capture institutional capacity.[17] Evidence indicates that college-age populations strongly drive in-state enrollment patterns (Bound and Turner, 2007). We use the basic specification to study the effects of state appropriations on enrollment of foreign, in-state and out-of-state students and the finance variables, such as instructional expenditures and tuition levels. In the specification we report, our institution-year observations are weighted by the undergraduate population at baseline (1996).[18]

There are a few reasons why an OLS regression might not capture the causal effect of state appropriations on the outcomes of interest, particularly foreign enrollment. First, there may be unobserved university characteristics correlated with foreign enrollment and state funding. For instance, a successful university administrator might make qualitative changes (such as a curricular reorganization) that both affect the university's desirability for foreign students and state legislators' willingness to provide state funding to the university. Second, if state legislators punish schools that enroll more foreigners by cutting their funding, there may be a reverse causality a problem. Last, growing universities may see concurrent increases in both their funding and the number of foreign students.

In order to deal with these endogeneity issues, we propose an instrumental variables approach that exploits variations in state appropriations at the *state level*. In other words, we use the funding that state legislators assign to all universities in a state and year, as an instrument for

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[17] State trends in the number of high school graduates and potential college-age students vary widely. Over the last half-century, some states have experienced significant declines while other states have experienced substantial increases in the college-age population. For example, from 1970 to 2004, college-age populations declined in Iowa (-22%), Indiana (-13%), Ohio (-18%), and Michigan (-15%), while they increased substantially in Florida (+99%), Texas (+56%), California (+42%) and Georgia (+41%). States that have experienced declines in the number of potential in-state students over time have particularly strong incentives to draw students from out-of-state, as they will likely have excess capacity in dorms and class offerings. On the other hand, states like Texas and California, which have experienced large-scale population growth since the middle of the 20th century (when many large-scale investments in public higher education were made), are less likely to have excess capacity.

[18] We show in Appendix Table A4 that our results are robust to not weighting the regressions.

state appropriations to a particular university in that state and year. The identification assumption is that the legislators' decision on appropriations for the entire state is orthogonal to idiosyncratic university characteristics.

The natural question is what drives state level higher education funding and whether these factors affect foreign enrollment decisions directly. The higher education budget is often described as a "balance wheel" of state budgets as many states determine the amount of appropriations to colleges and universities by what is left over after other spending priorities (Bell, 2008). This interpretation is consistent with the literature which indicates that a major determinant of state appropriations is the cyclical pressures from federal programs with state-level matching features, like Medicaid (Kane, Orszag and Apostolov, 2005). In this spirit, we explore additional instruments, like a state's disposable revenue (general revenue net of entitlements), and show that our results are similarly strong.

We also worry that state-level appropriations might be endogenous. If, for example, employment growth in a state both boosts state budgets and serves to attract domestic out-of-state students, this might feedback into less need or room for foreign students.[19] We provide some evidence that this is not an issue in our empirical framework. First, we show that foreign students are *no*t more likely to attend private universities in states suffering economic-downturn driven state appropriation cuts. Second, we demonstrate that our main results are unaffected by the inclusions of a rich set of controls: the state unemployment rate, the share of the population below the poverty line, an indicator for whether the governor is a Democrat, the rate of non-farm employment growth, the population at age 18 for all neighboring states, the state level personal income per capita, median wages of employed workers with at least a bachelor degree for ages 23-35, for ages 36-49, and for ages 50-60. Third, we find that in-state and out-of-state enrollment do not respond to changes in state appropriations.

3.2 Data Sources

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[19] McHugh and Morgan (1984) and Kennan (2015) document the migration of domestic students across U.S. states based on employment growth and expected lifetime income, and these time varying controls may help account for changes in state-level economies.

Data on annual enrollments, degrees conferred, and finance variables for each college and university are collected through several sources, the details of which are discussed in the appendix. First, as part of a long-standing federal data collection mandate, the Integrated Postsecondary Education Data System (IPEDS) collects annual data related to different university functions, including enrollment, finances, and degrees awarded. We focus our main analytics on the period from 1996-2012 (where 1996 corresponds to the 1996-97 academic year), as this is the interval in which there is a large, qualified pool of foreign born students considering undergraduate education in the U.S.

We also use data from the Fall Enrollment survey, which records enrollment by level and visa status for each post-secondary institution, distinguishing enrollment by first-time freshmen, all undergraduate students, and graduate students. We focus on first-time freshman enrollment and use the survey distinction between temporary visa holders and U.S. residents to record counts of "Temporary Residents" for each year of our analysis. By definition, any student holding a temporary visa is a foreign-born person who is "*not a citizen or national of the United States and who is in this country on a visa or temporary basis and does not have the right to remain indefinitely.*" Nearly all non-resident students at U.S. colleges and universities hold an F-type ("student") visa.

To distinguish domestic students by in- or out-of-state status, we use data from the American Survey of Colleges (ASC), conducted annually by the College Board. While this source shares many data elements with the IPEDS data collection, the ASC has more detail on the characteristics of admitted and matriculating students.[20] In order to reduce the incidence of missing data, we complement our dataset with enrollment information from the Common Dataset Initiative and the University of California System when this information is missing in the ASC.

In addition, we employ the universe of F-1 visa recipients (2004-2015) which provides individual level data identifying each student's intended degree, subject of study, post-secondary institution in the U.S., city and country of origin, along with variables indicating cost of attendance, financial support, and beginning-end dates of the period of study. These data align well with the IPEDS data and they allow us to distinguish foreign students by country of origin.

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[20] The IPEDS panel also includes a "Residence and Migration" component which provides tallies of enrolled students by permanent address at the time of application, which are available in even-numbered years. These measures are highly correlated, though not identical to the measures we employ.

Section 4. Empirical Results

4.1 Effects of State Appropriations on Enrollment

       The questions motivating our analysis concern how declines in state appropriations are accommodated by changes in the composition of undergraduate enrollment across the public sector given the expansion of the pool of foreign students in recent decades. Institution-level regressions of total first-time foreign enrollment on appropriations, including additional institutional and time-varying effects, are shown in Table 2 for the period 1996-2012. We present these results for four groupings of institutions: public research universities, the AAU subset, flagship universities, and public universities outside the research sector, where the enrollment measures are derived from institution-level surveys from the ASC. Recognizing the concern that appropriations changes may be endogenously related to other institution-level adjustments affecting the composition of enrollment, we focus on the estimates using total state appropriations to higher education as an instrument for the institution-level measure (with the first-stage estimates in the bottom panel). We include the OLS estimates for comparison.

       There is a strong, consistent and negative link between appropriations changes and the enrollment of foreign students at public research universities (but no such link outside this sector during this interval). With a specification in logs, we find that a 10% decline in state appropriations corresponds to an 11.7% increase in the representation of foreign students at the undergraduate level across all research universities, and an increase of about 17% at the more restrictive AAU and Flagship classifications. As a point of reference, the OLS results tell a similar story with somewhat attenuated point estimates (the difference between OLS and IV is never close to statistically significant).

       The graphic presentation over the period from 2006 to 2012 in Figure 5 helps to anchor the negative relationship between total appropriations at the state level and foreign enrollment among public research universities, with a focus on the AAU institutions. While the basic negative relationship for public universities is clear, there is also a significant amount of heterogeneity. For instance, for the same state-level budgetary shock, Michigan State significantly increased foreign enrollment, while the University of Michigan did not. One reason is that the University of Michigan consistently attracts well qualified domestic out-of-state students (around 30% of total freshmen), whereas MSU does not (only 10% of total freshmen).

Also shown in Figure 5 is the specification check provided by the private institutions. If foreign students had state-specific preferences, one might expect to see a parallel response in private peer institutions; yet, what little relationship is visible is of the opposite sign (regression results in Appendix Table A3).

A number of specification alternatives confirm the tenor of these results and, in the interest of parsimony, are presented in the appendix. First, consideration of the dependent variable as either a level (number of students) or as the foreign share among all first-time students also yield the negative relationship between appropriations and enrollment at the research institutions and little measured effect outside this sector (Appendix Table A1). Secondly, we are able to use the micro-data from the F-visa issuances to estimate these specifications with a distinction by country of origin over the shorter interval from 2004 to 2012. Our results are not only remarkably consistent with the baseline results presented in Table 2, but also provide strong confirmation that the role of the expanding pool of Chinese students is central to this adjustment mechanism. The estimated enrollment elasticity for Chinese students is about -2.1 at all research university and indistinguishable from zero at the non-research institutions (Appendix Table A2). Thirdly, we demonstrate that our results are robust to the inclusion of the long list of state level controls discussed in section 3.2, which are correlated with state economic activity, as well as university specific time trends (Appendix Table A4).

Finally, we explore another instrumental variables strategy to solidify our approach. In Appendix Table A5, we use the state's general revenue net of entitlements as an instrument for university-level appropriations, consistent with the notion that state budgetary cycles are driving the variation in question. The higher education appropriations are often described as a "balance wheel" of state budgets and determined by what is left over after other spending necessities (Bell, 2008). State disposable revenues are likely orthogonal to political pressure for increasing in higher education funding, potentially correlated to foreign enrollment. The instrument displays a strong first stage and results consistent with our main specifications.

Overall, these findings are consistent with our underlying hypothesis and conceptual framework: when state appropriations decline, public universities are more likely to admit foreign students because the marginal benefit of adding foreign students (and associated tuition revenues) increases. For non-research colleges and universities (shown in the final column), we continue to estimate essentially no link between changes in state appropriations and foreign

student enrollment, which is consistent with the expectation that non-research universities tend to be more locally focused than the research universities, and have limited capacity to attract foreign students.

In addition to increasing the representation of students from abroad, universities might respond to appropriations changes with other adjustments to undergraduate enrollment on the margins of in-state and out-of-state enrollment. Table 3 considers these specifications in parallel format to Table 2. The overall story line is that there appears to be little adjustment on these margins, with coefficients on appropriations that are statistically indistinguishable from zero and, overall, small in magnitude. The absence of an effect on out-of-state domestic students, another source of revenue from out-of-state tuition, is consistent with the proposition that the supply of academically-qualified, domestic full-pay students at the enrollment margin for most public universities is modest. Also, given these results, we have no reason to expect that any changes in foreign enrollment are driven by changes to domestic enrollment in the wake of falling appropriations.

In order to study what types of public research universities drive these results, we explore heterogeneous effects across three baseline dimensions in Table 4. First, it is clear that public research universities with higher baseline Math SAT scores have the ability to attract qualified students from abroad. Second, universities that spend a larger fraction of their total expenditures on research-related activities, at baseline, also do a better job of accommodating a fall in funds with enrolling more foreign students. Last, we explore heterogeneity along the baseline ability to attract domestic out-of-state students. Here we expect that the universities that most aggressively pursue foreign students will be those outside the very top tier that are capable of attracting a substantial number of domestic out-of-state students. While the contrasts in these last set of columns are not precisely estimated, this is exactly the pattern that emerges. Our interpretation of these results is that universities that have a very low baseline attraction for domestic out-of-state students find it difficult to recruit students from abroad. Consistent with the conceptual framework discussed in section 2.2, those with a very high baseline ability to enroll full paying domestic students find it less necessary to look abroad when they can recruit these students from other states. It is, therefore, in the universities that lie in-between that we see the strongest associations between declining appropriations and rising foreign enrollment.

While a common question that follows from observation of the growth in the enrollment of foreign students is whether these students "crowd out" domestic students (Machin and Murphy, 2015), the declines in the appropriations that are the focus of this analysis affect in-state tuition charges. Thus, any correlational relationship between foreign enrollment and in-state enrollment represents the net effect of changes in tuition charges, institutional resources and other unobserved factors as well as the direct effect of foreign students. With these limitations in mind, in Appendix Table A6, we show a negative association between the number of foreign students enrolled and the number of in-state students enrolled in Research and AAU universities. Two additional foreign students are associated with one less in-state student. While these estimates should not be interpreted as causal, our model suggests that crowd out effects can occur even when university administrators care only about the quantity and quality of the education in state residents obtain.

4.2 State Appropriations and University Finances

Changes in state appropriations directly affect university budget constraints. Absent other channels of adjustment in university revenues, declines in state appropriations would have a negative effect on measures of expenditures – particularly those related to undergraduate education. Our interest is in understanding how such effects may be moderated by other channels of adjustment – either changing the composition of student enrollment by expanding the matriculation of foreign students or increasing the tuition charged.

As shown in the top panel of Table 5, there is a positive relationship between changes in state appropriations and expenditures on instructional activities. While not presented in the tables, we find similar positive but often imprecisely estimated effects of state appropriations on other types of expenditure, such as research spending. Shifting from the expenditures side of the ledger to the revenue side, we consider how the change in the composition of the entering class, combined with changes in tuition, affects tuition revenues across public universities. These results are displayed in the bottom panel of Table 5. In the AAU sample, there is a clear negative relationship between appropriations and tuition revenues, while effects for the other samples are not precisely estimated. We find negative but, with the exception of the AAU sample, not statistically significant effects of appropriations on tuition revenues. These smaller effects can be explained by a decline in full time enrollment associated with appropriations cuts,

as we indeed find a strong negative effect of appropriations on tuition revenue per FTE (not presented in table).

While adding foreign students is one strategy to replace revenue lost from declining state appropriations, an alternative strategy is to increase tuition. As discussed in the earlier sections, we expect universities to have considerably more market power with in-state students than with out-of-state students. To this end, it is not surprising that there is a clear negative link between the in-state price and state appropriations, while there is no clear statistical connection between out-of-state charges and state appropriations, reflecting the constraints of the market. [21]

There is heterogeneity in how universities responded to appropriations cuts; this variation is represented graphically in Figure 6. The figure shows how changes in appropriations over the recession affected total tuition revenues and posted rates across universities. For instance, California and Michigan schools that were especially hurt by budgetary shocks accommodated these reductions by raising tuition revenues, either via enrolling more foreign students (MSU), or raising in-state tuitions (Berkeley).

A different framework for viewing these results is with tuition revenues as the dependent variable and enrollment (in levels) as the key explanatory variable. In effect, this is an accounting exercise in which we would expect changes in enrollment to produce changes in tuition revenue mirroring group-specific prices. We find that foreign undergraduate students generate additional revenue fairly closely aligned with the average "sticker price" of out-of-state tuition (see Appendix Table A7). In contrast, tuition revenues generated by additional out-of-state domestic students are far less than the sticker price, presumably because some discounts – either merit aid or need-based financial aid – are required to attract them.

Importantly, having access to a ready pool of foreign students may mute increases in in-state tuition rates or cuts to expenditures. We show some suggestive evidence in support of this. In times when there were more foreign students who were able to afford tuitions charged by U.S. institutions (2005 onwards), the responsiveness of tuition rates and expenditures to

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[21] The greater changes in in-state relative to out-of-state tuition levels likely reflect the observation that universities have more "market power" with in-state students than out-of-state students who are comparing public universities with private universities across geographic markets. However, it would be incorrect to assert that in-state adjustments are simply an exercise of market power. The magnitude of such adjustments are likely muted by strong political forces and the observation that an institution's net revenue change will be much more modest if financial aid adjusts accordingly or, without such financial aid adjustments, the institution becomes much less affordable to low and moderate income students in the state.

appropriations is smaller (Appendix Table A8). However, since there may be other differences across the two time periods, this type of heterogeneity analysis should be taken to be suggestive rather than conclusive.

4.3 Heterogeneity in Effects and Overall Accommodation of Appropriation Changes

Our results demonstrate the clear link between changes in state appropriations and changes in the flow of students from abroad and the price charged to in-state students as primary channels through which universities moderate changes to state appropriations. The capacity to reduce the impact of appropriation changes varies with an institution's market place: those universities with national and international recognition have the capacity to increase the intake of foreign (and, potentially, out-of-state) students while also potentially increasing tuition charges.

Still, we expect that political considerations which impact appropriations place some limits on how even the strongest universities can maneuver in this space. Local and regional institutions likely have fewer options to the extent that there is little foreign (or out-of-state) demand while comparable within-state alternatives may limit tuition changes.

Just how quantitatively important is this channel of adjustment to different universities? Looking at the period from the pre-Great Recession academic year 2007-08 to 2012-13, we consider the change in tuition revenues per student generated from the following sources: i) the change in the share of foreign undergraduates, ii) the change in the share of out-of-state undergraduates, iii) the change in the tuition charged to foreign and domestic out-of-state students, and iv) the change in tuition charged to in-state students. This decomposition can be expressed as:

$$\Delta \frac{Tuition\ Revenue}{Students} = (\Delta s_o \times \overline{D_t}) + (\Delta s_f \times \overline{D_t}) + (\overline{s_o} \times \Delta D_t) + (\overline{s_f} \times \Delta D_t) + \Delta T_i,$$

where D_t is the difference between in-state and out-of-state tuition, s_o is the domestic out-of-state share of total undergraduate enrollment, s_f is the foreign share of enrollment, $1 - s_o - s_f$ is the in-state share of enrollment, and T_i is in-state tuition. Overbar notation represents an average over two years while delta indicates the change over time. We deflate all monetary variables by the higher education price index (HEPI).

Table 6 shows this decomposition for AAU universities. The first 5 columns show each right-hand side term divided by the total change in tuition revenue per student to show the

percent of the tuition revenue change accounted for by each component. The final two columns show the change in appropriations per undergraduate student and the change in tuition revenue per undergraduate student. Changes in total tuition revenues make up a sizable share of the loss in state appropriations, though somewhat less than 100% at most institutions. In a few cases, such as the University of Illinois and University of Colorado, it would appear that changes in total tuition revenue actually exceeded the negative shock in appropriations.[22]

The measures shown reflect the relative importance of changes in tuition levels for in-state and out-of-state students, along with changes in their representation in the student body. In nearly all cases, the in-state tuition changes form the quantitative majority of revenue changes – on average, such changes account for about 69% of the change in tuition revenues, as show in the fifth column of Table 6. On the other hand, increasing domestic out-of-state enrollment is an important method of adjustment for certain schools like Colorado-Boulder, Oregon and Pittsburgh.

Turning to the role of the change in foreign student enrollment, shown in the first column of Table 6, we find that the increase in foreign students accounts for about 17.4% of the increase in tuition revenues, on average. Notably, for a modest number of universities (such as Minnesota, Purdue and Ohio State) the change in foreign student enrollment accounts for 40% or more of the change in tuition revenues over the interval.

Section 5. Conclusion

Concurrent with the erosion of state support for public higher education (which has occurred to different degrees across the U.S.) there has been a substantial increase in the pool of students from abroad who are academically college-ready and have the financial capacity to enroll. In many developing countries, and most notably China, home country options for post-secondary study at the research university-level are far more limited than student demand. In the aggregate, there is no question that U.S. colleges and universities have absorbed some of this increase in demand with the evident growth in undergraduate enrollment among temporary residents.

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[22] A word of caution is appropriate: Increases in net tuition revenue are often substantially less than changes in gross tuition revenue when institutions are committed to substantial need-based financial aid. A second caution is tied to the observation that our tuition revenue numbers are for all students, not just undergraduate students.

What this analysis demonstrates is that within-state declines in appropriations have affected the accommodation of the expanding pool of foreign students by U.S. colleges and universities. We estimate that a 10% reduction in state appropriations leads to a 12% increase in the enrollment of students from abroad at public research universities and a slightly larger increase of about 17% at the more resource-intensive AAU universities. There is no systematic accommodation at colleges and universities outside the research university sector. Evidence presented in this analysis suggests that expanding foreign enrollment at the undergraduate level is an important channel through which public research universities buffer changes in state appropriations. While additional revenue from in-state tuition increases appears recoup a large fraction of the fall in appropriations, research universities would have had to navigate reductions in resources per student or yet larger increases in in-state tuition in the absence of the large pool of foreign students.

Not only are the results in this analysis consistent with straightforward economic theory, but they also align with the comments of public university administrators. Writing about the circumstances in California, president of the University of California system Janet Napolitano writes:

> "California's situation is not unique. Nearly every state in the nation has faced this Hobson's choice, and they have all reached the same decision: *open doors to out-of-state students in order to keep the doors open for in-state students*." Public letter from Janet Napolitano to Elaine M. Howle, California State Auditor, 2016

The capacity of public universities to use foreign enrollment as a margin of adjustment depends critically on a supply of well-qualified potential undergraduates from abroad with the capacity to pay the tuition charged by U.S. universities. While this supply has been plentiful in the last decade, owing primarily to demographic and economic changes in countries like India and China, this reservoir of talent and resources did not emerge in full force until the millennium. What is more, the supply of such students to U.S. universities is not likely to remain constant in future decades. Growth in home-country institutions of close quality or negative shocks to home-country economies would likely drain this pool of students from abroad.

The dramatic increase in the number foreign undergraduates on U.S. campuses over the past decade raises questions about the impact of this influx. Beyond impacts on the number of in-

state students, the concentration of foreign students in certain majors such as business, engineering, and economics, it is possible that some universities may experience domestic student crowd-out or reductions in per-student instructional resources in these majors. Also, some suggest that the rapid expansion in the number of foreign students has generated institution-level administrative challenges, while others have questioned how well foreign students are integrated in U.S. universities, even as their student bodies are more internationally diverse (Jordan, 2015; Redden, 2014; Gareis, 2012). Nonetheless, our research suggests that in order to provide quality education to in-state students, public universities are turning to high paying foreign students in times of systematic declines in state funding. Finally, the substantial increase in the number of foreign undergraduate students in the U.S. may impact the both domestic and home country economies. While beyond the scope of this paper, these issues are worthy of future investigation.

References

Barr, Andrew and Sarah Turner. 2013. "Expanding Enrollments and Contracting Budgets: The Effect of the Great Recession Higher Education," *The Annals: American Academy of Political and Social Science* Vol. 650 (1):168-193.

Bell, Julie, 2008. "The nuts and bolts of the higher education legislative appropriations process" (Policy Briefs: Getting what you pay for). Retrieved from WICHE website: http://www.wiche.edu/info/gwypf/bell_appropriations.pdf.

Bound, John and Sarah Turner. 2007. "Cohort crowding: How resources affect collegiate attainment," *Journal of Public Economics*, Elsevier, vol. 91(5-6), pages 877-899, June.

Bound, John; Sarah Turner and Patrick Walsh, 2009. "Internationalization of U.S. Doctorate Education," in *Science and Engineering Careers in the United States: An Analysis of Markets and Employment*, National Bureau of Economic Research, Inc. (p. 59-97)

Bound, John; Michael F. Lovenheim and Sarah Turner. 2010. "Why Have College Completion Rates Declined? An Analysis of Changing Student Preparation and Collegiate Resources," *American Economic Journal: Applied Economics*, American Economic Association, vol. 2(3), pages 129-57, July.

Bound, John; Murat Demirci, Gaurav Khanna, and Sarah Turner. 2014. "Finishing Degrees and Finding Jobs: U.S. Higher Education and the Flow of Foreign IT Workers" http://nber.org/confer/2014/IPEs14/bound.pdf

Bowen, William G. 2012. "The 'Cost Disease' in Higher Education: Is Technology the Answer?" ITHAKA, Tanner Lecture I, Stanford University, October 2012 http://www.ithaka.org/sites/default/files/files/ITHAKA-TheCostDiseaseinHigherEducation.pdf

College Board. 2015. *Trends in College Pricing*. College Board: New York.

Deming, David and Chris Walters. 2015. "Should Community College be Free? Supply and Demand in the Market for U.S. Higher Education," paper draft.

Epple, Dennis; Richard Romano, Sinan Sarpça and Holger Sieg. 2013. The US Market for Higher Education: A General Equilibrium Analysis of State and Private Colleges and Public Funding Policies. No. w19298. National Bureau of Economic Research,

Epple, Dennis; Richard Romano and Holger Sieg. 2006. "Admission, tuition, and financial aid policies in the market for higher education." *Econometrica* 74, no. 4: 885-928.

Fischer, Karen. 2014. "Chinese Students Lead Foreign Surge at U.S. Colleges" *New York Times* (November 30).

Gareis, Elizabeth. 2012. "Intercultural friendship: Effects of home region and sojourn location." *Journal of International and Intercultural Communication*, 5, 309-328.

Higgins, Tim. 2013. "Chinese Students Major in Luxury Cars." *Bloomberg Business*. (December 19) http://www.bloomberg.com/bw/articles/2013-12-19/chinese-students-in-u-dot-s-dot-boost-luxury-car-sales

Hoover, Eric and Josh Keller. 2011. "More Students Migrate Away from Home." *The Chronicle of Higher Education* (October 30)

Jordan, Miriam. 2015. "International Students Stream Into U.S. Colleges." Wall Street Journal (March 24) http://www.wsj.com/articles/international-students-stream-into-u-s-colleges-1427248801

Kane, Thomas; Peter Orszag and Emil Apostolov. 2005. "Higher Education Appropriations and Public Universities: Role of Medicaid and the Business Cycle" *Brookings-Wharton Papers on Urban Affairs*, pp. 99-146

Kennan, John. 2015. "Spatial Variation in Higher Education Financing and the Supply of College Graduates," Working Paper, October.

Kurtz, Suzanne. 2012. "Thanks to scholarship, Saudi students return to U.S. in droves." The Washington Diplomat, August 21, 2012.

LaFraniere, Sharon. 2009. "China's college entry test is an obsession." *The New York Times*, June 12, 2009.

Liu, Yi-Ling. 2015. "China's Nouveau Riche Have Landed on America's Campuses" *Foreign Policy* (September 1)

Machin, Stephen and Richard Murphy. 2015. "Paying Out or Crowding Out? The Globalisation of Higher Education." Working Paper.

McHugh, Richard and James N. Morgan. 1984. "The Determinants of Interstate Student Migration: a Place-to-place Analysis," Economics of Education Review, 3, 4, 269-278.

Najar, Nida. 2011. "Squeezed Out in India, Students Turn to U.S." *New York Times,* Asia Pacific section, October 13.

Napolitano, Janet. Janet Napolitano to Ms. Elaine M. Howle. Response to the Audit, March 8, 2016. http://universityofcalifornia.edu/sites/default/files/Howle-Elaine-030816.pdf

Pinkovskiy, Maxim and Xavier Sala-i-Martin. 2009. "Parametric Estimations of the World Distribution of Income" NBER Working Paper No. 15433 (October).

Redden, Elizabeth. 2014. "Integrating International Students; So you have X number of international students on your campus. So what?" *Inside Higher Education* (February 20)

https://www.insidehighered.com/news/2014/02/20/gathering-senior-international-educators-integration-international-students-was

Rosenzweig, Mark. 2006. "Global Wage Differences and International Student Flows." *Brookings Trade Forum*, pp. 57-86.

Shanghai Ranking, Consultancy. 2016. "Academic ranking of world universities-2016." Shanghai: Center for World Class Universities and Institute of Higher Education of Shanghai Jiao Tong University 72.

State Higher Education Executive Officers Association. 2014 "SHEF: FY 2014 State Higher Education Finance." http://www.sheeo.org/projects/shef-%E2%80%94-state-higher-education-finance

UNESCO Institute for Statistics (UIS) database, 2016. http://data.uis.unesco.org/Index.aspx?queryid=128#, November.

Winston, Gordon C. 1999. "Subsidies, Hierarchy and Peers: The Awkward Economics of Higher Education," The Journal of Economics Perspectives, Vol. 13, No. 1 (Winter), pp. 13-36.

World Bank, World Development Indicators. 2016. GDP per capita (current US$), Atlas method [Data file]. Retrieved from http://data.worldbank.org/indicator/NY.GDP.PCAP.CD

Table 1: Summary Statistics, Sample Mean - Selected Years

	Type of Public 4-Year University			
	Research	AAU	Flagships	Non-Research
2007				
1st Undergraduate Enrollment				
# Foreign Students	72	154	87	25
# In-State Students	2,757	3,973	2,845	1,318
# Out-of-State Students	658	1,014	1,098	165
Revenues, 2013 Constant Dollar (Thousands)				
State Appropriations	$241,331	$397,743	$299,145	$57,981
Tuition Revenue	$188,362	$338,900	$245,488	$76,791
Tuition Level, 2013 Constant Dollar				
Out-of-State Tuition	$21,239	$26,329	$22,328	$14,740
In-State Tuition	$7,318	$8,555	$7,521	$5,560
SAT I Verbal - 25th percentile	502	538	515	445
SAT I Math - 25th percentile	522	570	537	451
2012				
1st Undergraduate Enrollment				
# Foreign Students	168	441	217	30
# In-State Students	2,754	3,900	2,882	1,353
# Out-of-State Students	798	1,158	1,289	163
Revenues, 2013 Constant Dollar (Thousands)				
State Appropriations	$189,867	$298,382	$235,151	$47,318
Tuition Revenue	$256,563	$467,993	$329,562	$101,001
Tuition Level, 2013 Constant Dollar				
Out-of-State Tuition	$24,375	$29,576	$25,968	$16,589
In-State Tuition	$8,875	$10,236	$9,014	$6,641
SAT I Verbal - 25th percentile	504	532	517	445
SAT I Math - 25th percentile	527	579	543	457

Note: Data are for 4-year public universities. Monetary variables deflated by the Higher Education Price Index (HEPI) and presented in 2013 dollars. AAU represents American Association of Universities. Research classified based on Carnegie 2010 definitions of high or very high research activity. Non Research includes both Doctoral granting and Masters universities. Enrollment, test scorers and tuition rates data from ASC. Tuition revenue and state appropriations data from IPEDS.

Table 2: Effects of changes in log state appropriations on log first-time foreign enrollment, 1996-2012

Panel A   **Dependent Variable:** Ln Foreign 1st Year Enrollment

Explanatory Variable	Research		AAU		Flagship		Non-Research	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Log(State Appropriations)	-0.617	-1.171	-0.720	-1.704	-0.755	-1.709	0.088	0.557
	(0.180)***	(0.431)***	(0.286)**	(0.703)**	(0.322)**	(0.661)***	(0.156)	(0.380)
Log(Population 18)	0.128	0.329	-1.167	-0.828	-0.032	0.005	0.437	0.306
	(0.323)	(0.431)	(0.716)	(0.647)	(0.485)	(0.455)	(0.422)	(0.704)
R-squared	0.350	0.338	0.634	0.615	0.480	0.450	0.063	0.055

Panel B: First Stage   **Dependent Variable:** Log(State Appropriations)

Explanatory Variable	Research	AAU	Flagship	Non-Research
Log(Total State Appropriations)	0.663	0.613	0.578	0.771
	(0.082)***	(0.119)***	(0.073)***	(0.095)***
R-squared	0.654	0.679	0.655	0.642
Partial R-squared	0.270	0.284	0.280	0.285
F- Statistic	65.55	26.66	63.64	66.04
Observations	2,121	547	791	3,162
Number of Universities	136	34	50	285

Notes: Overall state appropriations to higher education are used as an instrument for institution-level state appropriations in the IV regressions. A levels-log version of this regression exists in the appendix. All regressions include institution and year fixed effects. Institution-year observations are weighted by the undergraduate population at baseline (1996). Robust standard errors reported in parentheses are clustered at the university level in the OLS and at the state level in the IV.

Table 3: Effects of changes in log state appropriations on log first-time in-state and out-of-state undergraduate enrollment, 1996-2012

Panel A	**Dependent Variable**: Ln Out-of-State 1st Year Enrollment							
	Research		AAU		Flagship		Non-Research	
Explanatory Variable	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Log(State Appropriations)	0.045	-0.073	0.095	-0.437	-0.006	0.418	-0.018	-0.467
	(0.135)	(0.218)	(0.256)	(0.413)	(0.210)	(0.282)	(0.134)	(0.255)*
Log(Population 18)	-0.678	-0.635	-0.580	-0.397	-0.830	-0.846	-0.541	-0.416
	(0.233)***	(0.286)**	(0.521)	(0.514)	(0.367)**	(0.351)**	(0.319)*	(0.264)
R-squared	0.248		0.231		0.320		0.041	

Panel B	**Dependent Variable:** Ln In-State 1st Year Enrollment							
	Research		AAU		Flagship		Non-Research	
Explanatory Variable	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Log(State Appropriations)	0.098	0.138	0.053	-0.074	0.019	0.030	0.116	0.054
	(0.052)*	(0.091)	(0.059)	(0.085)	(0.052)	(0.105)	(0.050)**	(0.092)
Log(Population 18)	0.626	0.612	0.509	0.552	0.198	0.198	1.051	1.068
	(0.096)***	(0.113)***	(0.103)***	(0.075)***	(0.140)	(0.138)	(0.151)***	(0.234)***
R-squared	0.397		0.376		0.295		0.336	
Observations	2,121		547		791		3,162	
Number of Universities	136		34		50		285	

Notes: For the first-stage of the IV regression, see Table 2. Overall state appropriations to higher education are used as an instrument for institution-level state appropriations in the IV regressions. All regressions include institution and year fixed effects. Institution-year observations are weighted by the undergraduate population at baseline (1996). Robust standard errors reported in parentheses are clustered at the university level in the OLS and at the state level in the IV.

Table 4: Effects of changes in log state appropriations on log first-time foreign undergraduate enrollment, 1996-2012, Heterogeneous Effects - Instrumental Variable Specification

	Dependent Variable: Ln Foreign 1st Year Enrollment						
	Math SAT 75th Percentile		Fraction of Expenditure for Research		Fraction of Students from Out of State		
Explanatory Variable	High	Low	High	Low	Low	Medium	High
Log(State Appropriations)	-1.737	-0.413	-2.148	0.249	-0.695	-1.915	-1.014
	(0.616)***	(0.284)	(0.573)***	(0.517)	(0.994)	(0.505)***	(0.571)*
Log(Population 18)	0.054	0.060	0.154	-0.210	0.884	0.289	0.246
	(0.843)	(0.399)	(0.575)	(0.540)	(1.024)	(0.804)	(0.319)
Observations	867	906	1,014	958	691	692	718
Number of Universities	55	57	63	63	44	45	45
Partial R-squared	0.325	0.236	0.329	0.222	0.178	0.302	0.348
F- Statistic	49.27	44.90	52.62	38.58	25.83	43.25	56.35

Note: Overall state appropriations to higher education are used as an instrument for institution-level state appropriations. Samples are defined based on baseline (1996) characteristics. High and low are defined by above or below median when sample is split in half. Low, medium and high are define by 33th percentile when sample is split in thirds. All regressions include institution and year fixed effects. Institution-year observations are weighted by the undergraduate population at baseline (1996). Robust standard errors reported in parentheses are clustered at the state level.

Table 5: Estimates of the effect of changes in state appropriations on university financial variables, 1996-2012- Instrumental Variable Specification

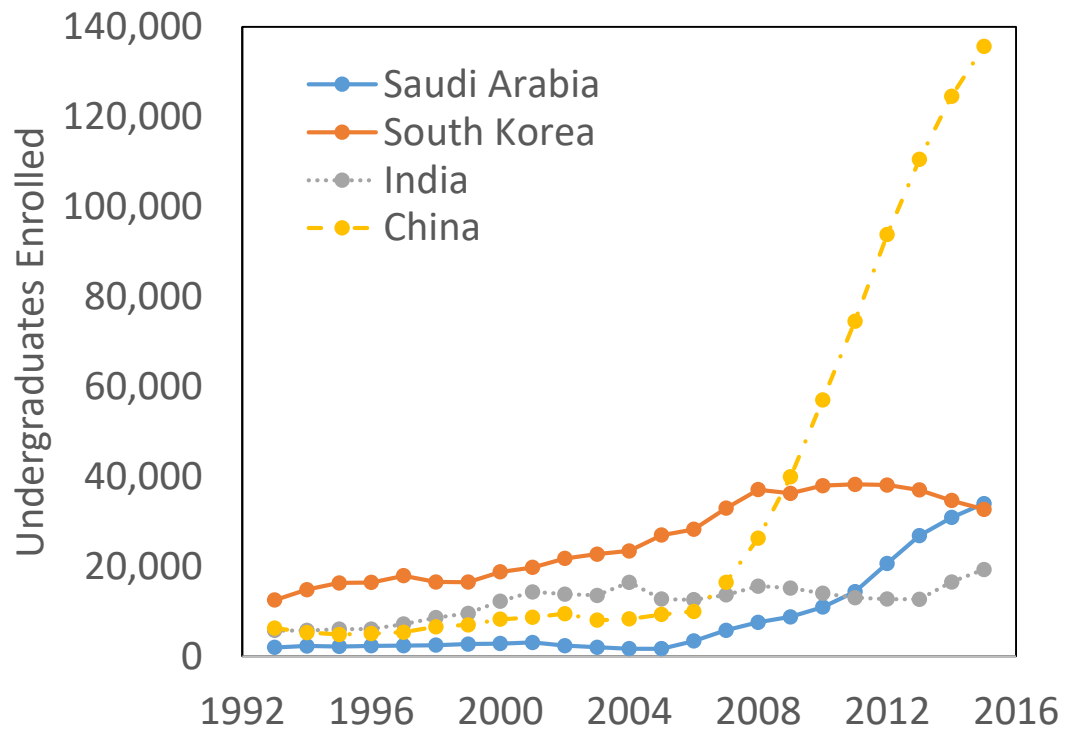| **Expenditure Variable**	Research	AAU	Flagship	Non-Research
Panel A1	Log(Instructional - salaries and wages)			
Log(State Appropriations)	0.210	0.236	0.256	0.254
	(0.065)***	(0.110)**	(0.112)**	(0.126)**
Partial R-squared	0.272	0.311	0.323	0.246
F- Statistic	65.64	30.95	67.45	48.58
Observations	1,717	443	651	3,509
Number of Universities	126	32	47	260
Revenue Variables	Research	AAU	Flagship	Non-Research
Panel B1	Ln (In-State Tuition)			
Log(State Appropriations)	-0.288	-0.416	-0.270	-0.327
	(0.103)***	(0.182)**	(0.117)**	(0.182)*
Panel B2	Ln (Out-of-State Tuition)			
Log(State Appropriations)	0.116	0.307	0.366	-0.020
	(0.117)	(0.209)	(0.165)**	(0.129)
Panel B3	Log(Tuition Revenue)			
Log(State Appropriations)	-0.058	-0.341	-0.060	-0.175
	(0.122)	(0.186)*	(0.155)	(0.218)
Partial R-squared	0.301	0.312	0.295	0.250
F- Statistic	113	40.52	73.76	67.80
Observations	2,172	548	823	4,630
Number of Universities	136	34	50	293

Notes: Overall state appropriations to higher education are used as an instrument for institution-level state appropriations. All regressions include institution and year fixed effects. Institution-year observations are weighted by the undergraduate population at baseline (1996). Robust standard errors reported in parentheses are clustered at the state level.

Table 6: Decomposing per Student Changes in Tuition Revenues, 2007-2012

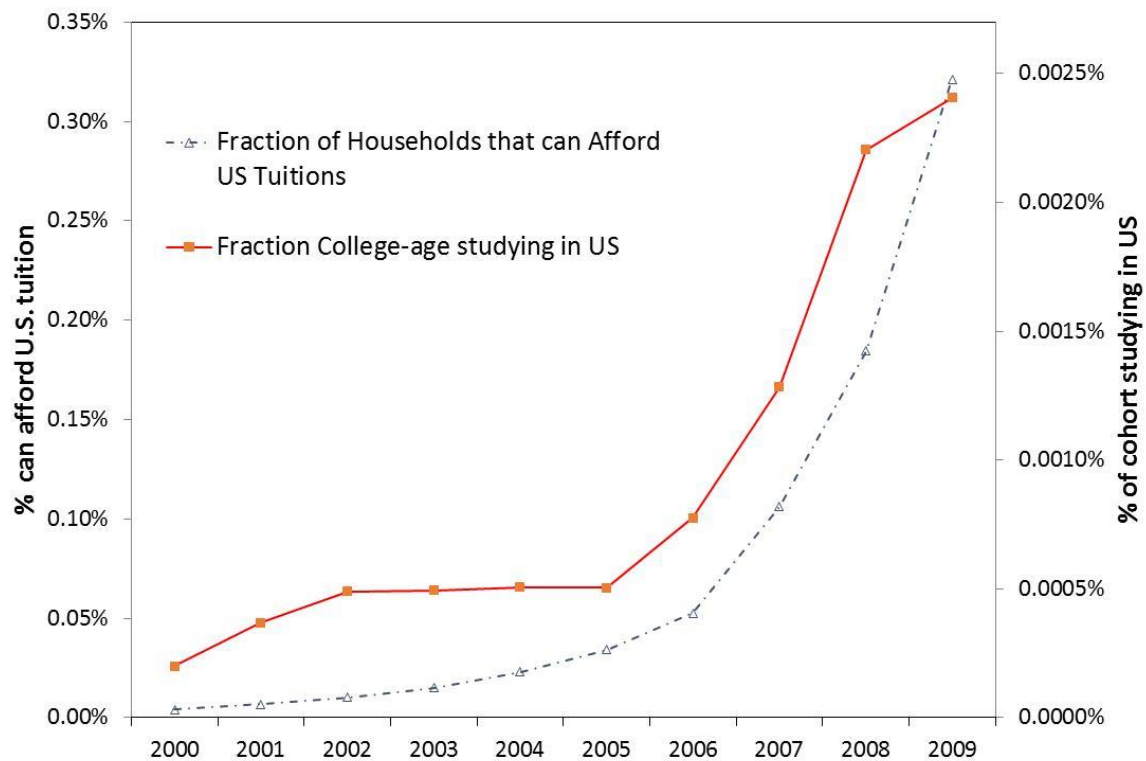| Institution Name	$\Delta s_f * Dt$	$\Delta s_0 * Dt$	$s_f * \Delta Dt$	$s_0 * \Delta Dt$	ΔT	$\Delta\left(\frac{App}{Ugrad}\right)$	$\Delta\left(\frac{Rev}{Ugrad}\right)$
University of Arizona	5.88%	-13.89%	2.46%	19.75%	85.81%	-7,642	5,302
UC-Berkeley	22.65%	0.44%	0.56%	1.19%	75.15%	-11,864	6,686
UC-Davis	8.56%	3.26%	0.29%	0.34%	87.55%	-8,871	5,647
UC-Irvine	12.54%	-3.84%	0.43%	0.34%	90.52%	-2,691	5,329
UC-Los Angeles	17.86%	12.52%	0.58%	0.57%	68.47%	-13,315	7,060
UC-San Diego	18.27%	2.50%	0.37%	0.33%	78.54%	-4,757	6,418
UC-Santa Barbara	6.55%	-0.26%	0.21%	1.47%	92.04%	-5,965	5,429
U Colorado Boulder	7.90%	28.40%	0.63%	11.77%	51.30%	-1,030	4,095
University of Florida	-0.19%	-7.20%	2.16%	9.93%	95.31%	-6,718	2,717
Georgia Tech	15.34%	-7.40%	0.89%	4.98%	86.18%	-8,682	5,004
U Illinois - UC	28.02%	-0.49%	-0.26%	-0.49%	73.22%	-1,593	4,218
Indiana University	32.01%	-35.77%	9.20%	51.53%	43.04%	-1,878	2,930
Iowa State University	24.59%	33.88%	-0.01%	-0.06%	41.60%	-4,924	1,977
University of Iowa	28.40%	8.80%	2.89%	31.62%	28.29%	-6,955	3,582
University of Kansas	12.72%	-7.64%	3.64%	22.99%	68.29%	-948	2,227
University of Maryland	30.87%	-84.28%	17.30%	155.40%	-19.28%	-559	370
University of Michigan	7.36%	6.70%	5.85%	36.07%	44.02%	-3,085	4,875
Michigan State Univ.	26.46%	1.46%	5.30%	9.80%	56.98%	-3,666	3,757
University of Minnesota	85.75%	-35.52%	-32.23%	-244.63%	326.63%	-5,713	848
University of Missouri	10.55%	56.55%	2.48%	20.98%	9.45%	-4,695	1,500
Rutgers University	9.37%	-7.43%	4.75%	17.42%	75.88%	-5,898	1,429
University at Buffalo	27.32%	-1.09%	15.85%	4.98%	52.94%	-5,790	1,947
Stony Brook University	12.09%	11.30%	9.94%	7.74%	58.92%	-8,327	1,903
Univ. North Carolina	8.01%	4.87%	1.70%	20.72%	64.70%	-5,457	2,713
Ohio State University	58.16%	4.45%	4.29%	9.97%	23.13%	-3,173	1,196
University of Oregon	13.07%	24.21%	4.72%	20.10%	37.90%	-2,694	6,931
Pennsylvania State	20.85%	15.84%	0.06%	0.45%	62.81%	-4,110	3,292
University of Pittsburgh	8.36%	27.27%	-0.42%	-5.59%	70.38%	-4,576	3,101
Texas A&M University	0.61%	-22.59%	20.40%	52.21%	49.38%	-2,139	517
U.Texas-Austin	6.23%	-0.31%	10.03%	12.76%	71.29%	-1,922	1,688
University of Virginia	6.88%	-7.11%	5.14%	31.13%	63.96%	-3,871	3,970
U of Washington	20.50%	-2.67%	-0.13%	-0.34%	82.63%	-6,934	6,572
University of Wisconsin	15.45%	4.96%	0.28%	2.21%	77.10%	-2,076	3,102
Purdue University	39.61%	2.97%	4.20%	13.65%	39.58%	-364	4,088
All AAUs	**17.40%**	**2.79%**	**2.04%**	**8.53%**	**69.23%**	**-4,620**	**3,553**

All changes are 2007 to 2012. s_f is share of undergraduate population that is nonresident alien. s_0 is share of undergraduate population that is out of state domestic students. ΔT is the change in in-state tuition rates. Dt is the tuition differential between out-of-state and in-state tuitions. $\Delta\left(\frac{App}{Ugrad}\right)$ is the change in appropriations per undergraduate between 2007 and 2012. $\Delta\left(\frac{Rev}{Ugrad}\right)$ is the change tuition revenues per undergraduate between 2007 and 2012.

Figure 1: Country trends in foreign undergraduate enrollment at U.S. higher education institutions, 1992-2015

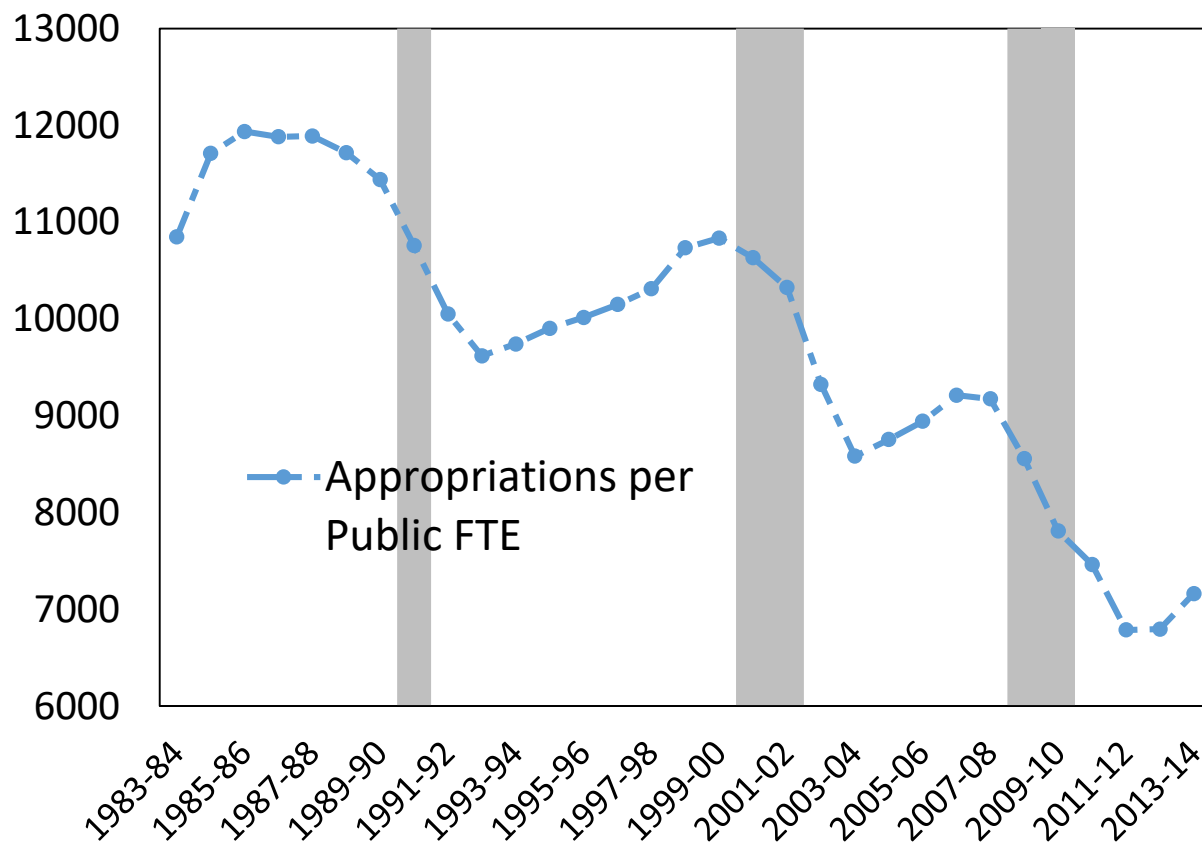Source: *Open Doors*, Institute for International Education, various years.

Figure 2: Fraction of Chinese college-age population studying abroad and financial capacity, 2000-2009

Source: Authors' calculations, based on income distribution data from the World Bank and average tuition, room and board charges for out-of-state students at public universities recorded in IPEDS. We derived the income distribution (assumed to be log-normal) following the approach of Pinkovskiy and Sala-i-Martin (2009). With the mean from GDP-per capita, we calibrate the standard deviation using income shares received by each quintile of the income distribution (available from the World Bank). Using the currency exchange rate, we convert to constant U.S. dollars and compute the expected share of households with incomes greater than the average public tuition, room and board for out-of-state students.

Figure 3: F-1 Visa Recipients for Bachelor's Degrees by Country and University Selectivity (Average 2010-15)

Source: F-1Administrative data

Note: Countries in Western Europe and UK are Austria, Belgium, Denmark, Czech Republic, France, Germany, Greece, Hungary, Ireland, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden and the United Kingdom.
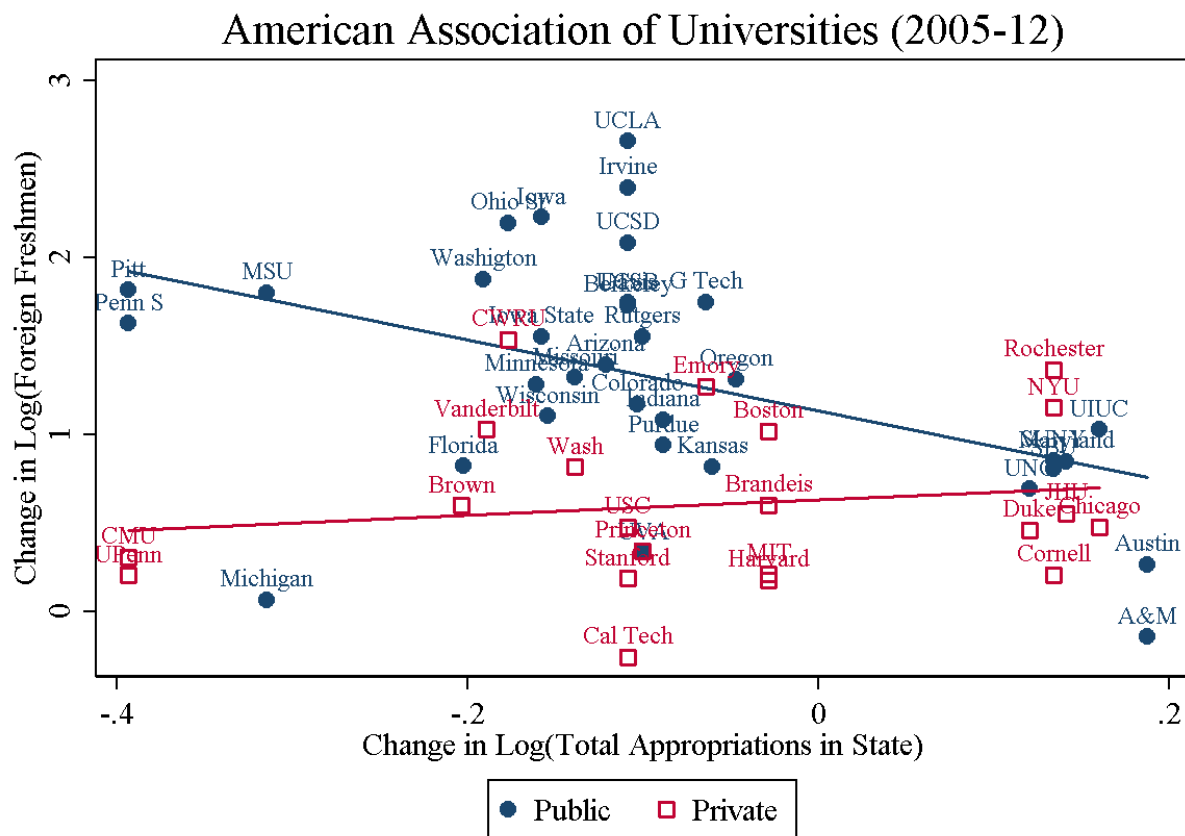
Figure 4: Appropriations per Full-Time Equivalent Student Over Time, 1983-2013

Source: *Trends in College Pricing and Digest of Education Statistics*, various years. Grey bars show US recessions as enumerated by NBER. All figures are deflated by the Higher Education Price Index (HEPI).
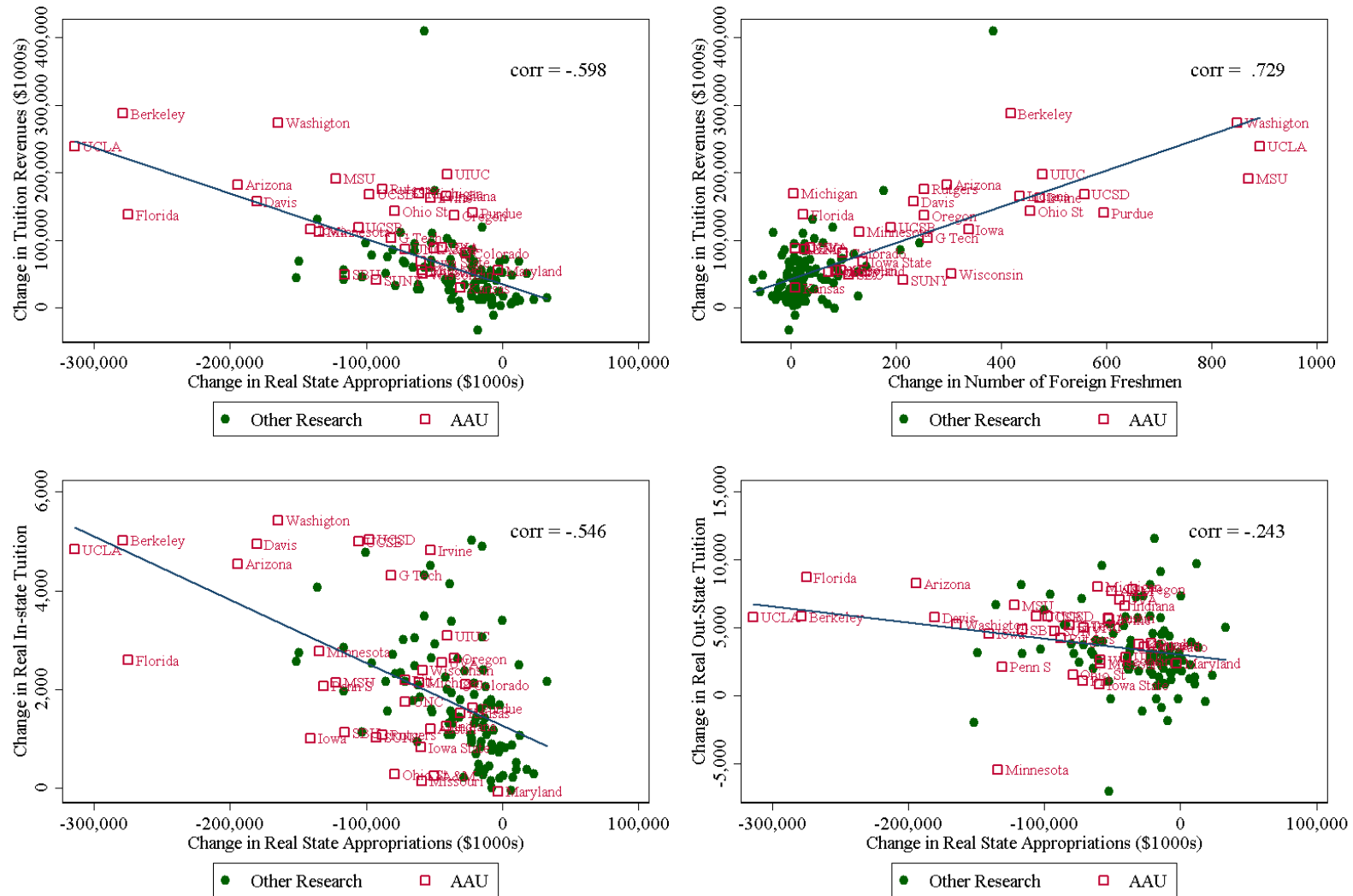
Figure 5: Foreign Enrollment and State Level Appropriations to Higher Education: AAU Private
Universities, 2005-2012

American Association of Universities (2005-12)

Note: Sample of the 60 research universities that are part of the Association of American
Universities (AAUs). Change in Log(Foreign Freshmen) are university-level changes in first-
year students from abroad. Change in Log(Total Appropriations in State) are state level measures
for changes in total appropriations to all public universities in the state between the financial
years 2005-6 and 2012-13. Foreign Freshmen data is from ASC.

Figure 6: Change in Appropriations, Tuition, and Foreign Freshmen - 2007 to 2012

Tuition Revenues and Rates (2007-12)

Note: Changes are defined as the difference between the 2012 value and the 2007 value. All monetary units are deflated by Higher Education Price Index (HEPI) 2012. State appropriations, tuition levels and tuition revenue data from IPEDS, foreign freshmen from ASC.