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Disinvesting in the Future? A Comprehensive Examination of the Effects of State Appropriations for Public Higher Education

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Abstract:
In aggregate, state appropriations are the largest revenue source for public higher education in the United States. However, these appropriations have significantly declined over past decades, drawing serious concerns about the potential negative impact on schools and students. This paper provides a more comprehensive study of the effects of state appropriations than previous research, while explicitly exploring and testing the heterogeneity of the effects by institutional type. It finds strong evidence of the negative effects of state appropriation cuts in the areas of tuition and fees, student financial aid, instructional and other school expenditures, and degree completion. Community colleges, which serve the most undergraduates but have not been well studied by past research, are shown to be particularly vulnerable to the negative effects of state funding cuts.

Keywords: state appropriations, public higher education, community colleges, state funding cuts

JEL Classifications: H2, H4, H7, I2

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1 Introduction

State colleges and universities play a crucial role in providing higher education in the United States. In fall 2010, 76 percent of undergraduate students attended public degree-granting institutions, while only 15 and 10 percent of undergraduate students attended private nonprofit and for-profit institutions, respectively (National Center for Education Statistics 2012).

State governments support public higher education for reasons of efficiency and equity. In terms of efficiency, higher education generates many social and fiscal benefits. For example, there are positive spillovers from college graduates on wages and productivity (Glaeser and Saez 2004, Moretti 2004a, Moretti 2004b, Rosenthal and Strange 2008). Human capital spillovers are generated likely via the sharing of knowledge and skills among workers and are geographically localized. Higher education also generates long-term local economic growth. Simon (1998), Simon and Nardinelli (2002), and Shapiro (2006) show that metropolitan areas with a higher percentage of college-educated residents experience faster employment growth. Moreover, universities' research activities create positive externalities to industries (Jaffe 1989; Bania, Eberts, and Fogarty 1993; Mansfield 1995; Mansfield and Lee 1996; Anselin, Varga, and Acs 1997; Adams 2002; Zheng and Slaper 2016). These research activities particularly benefit companies located near the universities because the spillovers are often concentrated in a small geographic area. Higher education lowers crime rates as well. Lochner (2004) finds that college education has a strong negative impact on both property and violent crime. Further, higher education improves civic engagement. Dee (2004) shows that higher educational attainment increases voter participation, support for free speech, and the quality of civic knowledge. In addition, higher education generates net fiscal benefits. Trostel (2010) estimates that states receive a significant amount of direct extra tax revenues from college graduates, who tend to

earn higher incomes than non-college graduates, and of direct savings in post-college government expenditures. Thompson (1993) and Landon (2006) show that welfare recipients are more likely to find a job and get off public assistance after receiving postsecondary education.

Governments also support public higher education to improve social and economic equity. Since public institutions in general charge less for tuition than their private counterparts do, they reduce barriers for low-income students to access higher education and related post-college benefits such as higher wages and better health and marriage outcomes (Oreopoulos and Salvanes 2011; Heckman, Humphries, and Veramend 2016).[1] Public higher education can also help promote intergenerational mobility. Torche (2011) finds that intergenerational association in terms of class, occupational status, earnings, and household income is lower among bachelor's degree recipients than among those with lower educational attainment. Chetty, Friedman, Saez, Turner, and Yagan (2017) suggest that many public colleges (such as the City University of New York and the California State University System) are potential engines of upward intergenerational mobility.

In addition, benefit leakage from public higher education across states is relatively small. Benefit leakage occurs when a person received subsidized public higher education in one state and then moved to another state to work and live after graduation. The first state thus did not receive the full social and fiscal benefits from educating this person, even though it provided the subsidy for his or her postsecondary education. Because graduates from public higher education institutions tend to stay in the institutions' states, state and local governments, businesses, and in-state individuals can reap most of the benefits associated with their own states' public higher education. For example, 76.5 percent, 71.1 percent, and 65.4 percent of undergraduates who

[1] Even community college education is economically beneficial to students. Kane and Rouse (1995) and Kolesnikova (2010) find that people who attended community colleges even without completing an associate's degree subsequently experienced higher earnings than those without any higher education.

received their bachelor's degrees from public four-year institutions in 1993 still resided in the same state as the degree-granting institutions in 1994, 1997, and 2003, respectively (Perry 2001; Bradburn, Nevill, Cataldi, and Perry 2006).[2] In comparison, 63.1 percent, 57.6 percent, and 53.4 percent of undergraduates who received their bachelor's degrees from private nonprofit four-year institutions in 1993 still resided in the same state as the degree-granting institutions in 1994, 1997, and 2003, respectively. The lower percentages for private institutions partly reflect the fact that more students enrolled in private institutions come from out of state.

State governments play a critical role in funding public higher education. In aggregate, state appropriations are the largest funding source for public colleges and universities. State appropriations are more than double the expenditures on federal Pell Grants and are comparable to federal spending on student loans (Long 2016). However, state investment in public higher education has declined substantially in recent decades. The real value of state appropriations per full-time equivalent student (hereafter, FTE) decreased 44 percent over the 2001–2013 period across the United States (Figure 1). Long (2016) shows that regardless of the type and home state, all public higher education institutions have suffered from reductions in state appropriations.

State appropriations have not declined due to decreased demand for higher education. In fact, according to the National Center for Education Statistics (NCES), the immediate college enrollment rate for high school graduates increased from 63 percent in 2000 to 69 percent in 2015.[3] There are both long- and short-term reasons for the so-called state disinvestment in public

[2] 74.0 percent of undergraduates who received their bachelor's degrees from public four-year institutions in 2000 still resided in the same state as the degree-granting institutions in 2001 (Bradburn, Berger, Li, Peter, Rooney, and Griffith 2003). 75.0 percent of undergraduates who received their bachelor's degrees from public four-year institutions in 2008 still resided in the same state as the degree-granting institutions in 2009 (National Center for Education Statistics 2012).
[3] See https://nces.ed.gov/programs/coe/indicator_cpa.asp.

higher education. In the short term, state governments experienced two severe fiscal crises caused by the 2001 and 2007–2009 recessions; to address large budget gaps they had to significantly cut spending, particularly higher education funding as part of discretionary spending (Mitchell and Leachman 2015, Mitchell, Leachman, and Masterson 2016). Even though the economy has now fully recovered, states have not replenished funding for higher education back to pre-recession levels (Mitchell, Leachman, and Masterson 2016, State Higher Education Executive Officers Association 2017). Over the long term, state appropriations for higher education have been crowded out by growing Medicaid spending (Kane, Orszag, and Gunter 2003, Okunade 2004, and Kane, Orszag, and Apostolov 2005). States have also had to dedicate more resources to unfunded public pension liabilities (Novy-Marx and Rauh 2014).

This paper examines the effects of state appropriations for public higher education on students and public universities. Using an integrated framework, I examine four important areas: tuition and fees, student financial aid, school expenditures, and degree completion. Based on the results, the paper discusses the implications of state funding cuts.

Existing literature on the effects of state appropriations for public higher education is surprisingly thin and sometimes inconclusive. Previous research has examined the role of state appropriations in five areas: tuition and fees, school expenditures, enrollment patterns, student financial aid, and school educational and research outputs. While using different regression techniques and data, six studies find that an increase in tuition and fees at public higher education institutions is associated with a decline in state appropriations. Among four papers using cross-sectional ordinary least squares analyses (OLS), Lowry (2001a and 2001b) and Kim and Ko (2015) use institutional-level data from public four-year universities, while Koshal and Koshal (2000) study state-level data of all public institutions. Applying a fixed-effects panel data

model, Rizzo and Ehrenberg (2004) use institutional-level data of public research or flagship universities while Goodman and Henriques (2015) focus on state-level analysis of all public institutions.[4] These studies also examine different measures of tuition and fees. Lowry (2001a and 2001b) use net tuition and fees (gross tuition and fees net of institutional grant aid). Goodman and Henriques (2015) study the sticker price[5] and gross tuition and fees of all public institutions, community colleges, or flagship institutions within states. Rizzo and Ehrenberg (2004) separate in-state tuition from out-of-state tuition.[6]

Previous studies show that state funding cuts result in reductions in instructional and other school expenditures, with mixed evidence regarding instructional and research expenditures.[7] Lowry (2001b) and Goodman and Henriques (2015) find that public institutions' academic support and student services expenditures fall after states scale back appropriations for higher education. Goodman and Henriques (2015) and Zhao (2017) show that cuts in state appropriations result in an increased percentage of part-time faculty and a lower ratio of full-time faculty to students, respectively. In addition, Lowry (2001a and 2001b) and Husted and Kenny (2015) suggest that reducing state appropriations has a negative impact on public service expenditures, plant operations and maintenance expenditures, and the salaries of full professors of public universities, respectively. However, there are some conflicting results regarding other expenditure functions. While Lowry (2001b) indicates a positive relationship between state

[4] The IPEDS Delta Cost Project data use the definition of flagship institutions provided by Gerald and Haycock (2006), who define a flagship institution as the oldest, largest, or best-known campus in a public state higher education system. Based on this definition, each state has only one flagship institution. Other sources have assigned more than one flagship university to certain states.

[5] Sticker price is a fixed amount of money charged to a full-time student by an institution that covers tuition and required fees for an academic year. It is also called published price because schools often list it in their brochures.

[6] It is unclear which tuition and fees measure (sticker price, gross tuition and fees, or net tuition and fees) Koshal and Koshal (2000), Rizzo and Ehrenberg (2004), and Kim and Ko (2015) use.

[7] Instructional expenditures include expenses on general academic instruction, occupational and vocational instruction, community education, preparatory and adult basic education, and regular, special, and extension sessions.

appropriations and public universities' spending on instruction, Goodman and Henriques (2015) find no significant effects of state appropriations on instructional expenditures. Lowry (2001a) shows that there is no relationship between state appropriations and research expenditures, likely because his data include many non-research universities and the analysis is based on cross-sectional OLS.[8] In contrast, Zhao (2017) finds that state appropriation cuts result in lower public research universities' research expenditures, especially research expenditures on salaries and wages.

Existing evidence on the effects of state appropriations on enrollment patterns is mixed. Using student-level data and a cross-sectional multinomial logit, Perna and Titus (2004) find that lower state appropriations lead to a higher likelihood of a high school graduate attending an out-of-state institution but do not affect the likelihood of a high school graduate attending an in-state institution. Using state-level data and a fixed-effects panel data model, Toutkoushian and Hillman (2012) find the opposite: lower state appropriations reduce the percentage of high school graduates attending in-state postsecondary institutions but have no impact on out-of-state college-going rates. There are also conflicting results regarding the effects of state appropriations on nonresident enrollment at public institutions. Using 1979–1998 data from public research or flagship universities, Rizzo and Ehrenberg (2004) find no evidence that these universities increase nonresident freshman enrollment to offset state funding cuts. However, Jaquette and Curs (2015), based on 2003–2013 data of public four-year universities, show a negative relationship between state appropriations and nonresident freshman enrollment; the relationship

[8] Research universities are also called doctoral universities. According to the Carnegie Classification of Institutions of Higher Education, a research/doctoral institution awards at least 20 research/scholarship doctoral degrees a year. See http://carnegieclassifications.iu.edu/classification_descriptions/basic.php.

is even stronger at public research universities than at public master's or bachelor's institutions.[9] In addition, Goodman and Henriques (2015) find that lower state appropriations result in an enrollment shift from public higher education institutions to private for-profit institutions.

Little is known about the impact of state appropriations on student financial aid. Rizzo and Ehrenberg (2004) find that state need-based grant aid increases with state appropriations for public research or flagship universities. They speculate that the two forms of state funding are complementary, even though both may be correlated with the same omitted variables. Goodman and Henriques (2015) show that cuts in state appropriations have no effects on student loan amounts at public institutions but result in more student borrowing at private for-profit institutions.

Little research exists as well on the effects of state appropriations on public higher education institutions' educational and research outputs. Using 1992–1999 institutional-level data and a panel data model with institution fixed effects, Zhang (2009) finds that graduation rates at public four-year universities increase with state appropriations. However, this relationship is sensitive to the inclusion of time fixed effects. Zhao (2017) and Husted and Kenny (2015) show that a decline in state appropriations results in a decrease in granted patents and in the number of pages published in the top 50 economic journals, respectively.

This paper examines the effects of state appropriations for public higher education more comprehensively than in previous studies. It investigates four areas that state appropriations may affect: tuition and fees, student financial aid, school expenditures, and degree completion.[10] Aside from Rizzo and Ehrenberg (2004) and Goodman and Henriques (2015), previous studies

[9] According to the Carnegie Classification of Institutions of Higher Education, a master's institution awards at least 50 master's degrees and fewer than 20 doctoral degrees a year. A bachelor's institution awards degrees which at least half of should be baccalaureate or higher degrees.

[10] I also examined the percentage of freshman undergraduates that are out-of-state. Results are included in a later footnote.

look at only one or two areas. This paper also has a more extensive list of dependent variables within each study area; it includes many dependent variables that have not previously been examined, particularly in the areas of student financial aid and degree completion. This paper examines nine measures of tuition and fees defined along three dimensions: (1) sticker price, average tuition, or net tuition and fees, (2) in-state or out-of-state, and (3) undergraduate or graduate. Most previous studies only use net tuition and fees—none examine graduate tuition and fees separately. In terms of school expenditures, this paper adds instructional faculty and a broader category called education and related expenditures to other expenditure variables examined in previous studies.[11] In addition, this paper includes four measures of student financial need: amount of institutional grants; percentage of full-time, first-time undergraduates receiving federal grants; amount of Pell Grants; and percentage of full-time, first-time undergraduates receiving student loans. It also includes four measures of degree completion: doctoral degrees granted, master's degrees granted, bachelor's degrees granted, and associate's degrees granted.[12] To my knowledge, this is the first paper to systematically examine these variables of student financial aid and degree completions.

This paper explores and tests the heterogeneity of the state funding effects on different types of public higher education institutions more explicitly, systematically, and in-depth than previous studies do. It recognizes that different types of public institutions have different missions and objectives, and as such may have different cost structures and production functions. Therefore, it runs separate regressions for each type of public institution to fully allow for the heterogeneity. In contrast, previous studies either lump together either two- and four-year public

[11] Education and related expenditures refer to total spending on direct educational costs, including spending on instruction, student services, and the education share of spending on central academic and administrative support, operations, and maintenance.

[12] I examined student loan amounts, certificates and awards granted, and graduation rates as well. Results are reported in later footnotes.

institutions) or all public four-year institutions (doctoral, master's, and bachelor's institutions), or they focus on one specific type of public institution, either research/doctoral institutions or flagship institutions.

Previous studies shed little light on the effects of state appropriations on community colleges.[13] They either completely ignore community colleges or combine them with other types of public institutions in the data. In fact, community colleges are the largest provider of undergraduate education in the United States. In fall 2010, 39.9 percent of all undergraduates were enrolled in public two-year institutions, compared with 35.9 percent and 14.5 percent of all undergraduates enrolled in public and private four-year institutions, respectively (National Center for Education Statistics 2012). This paper adds a significant finding to the literature—that community colleges indeed experience different effects of state appropriations than other types of public institutions (particularly public research/doctoral institutions) and therefore may deserve different policy considerations.

In addition, this paper uses an integrated, consistent conceptual and empirical framework to examine various dependent variables and aligns the data period within each broad study area. Doing so facilities comparisons across dependent variables and analyzes results systematically. Part of the difficulty in synthesizing the existing literature and reconciling the mixed evidence is that previous studies often use different models, regression techniques, and data with different levels and/or periods.

2 Conceptual Framework and Hypotheses

[13] Community colleges are also called associate's institutions. According to the Carnegie Classification of Institutions of Higher Education, the highest-level degree awarded at associate's institutions is an associate's degree.

The literature often assumes that a public higher education institution aims to fulfill its mission and maximize its prestige, subject to a balanced budget constraint (Garvin 1980, Ehrenberg and Sherman 1984, Ehrenberg 2000, and Rizzo and Ehrenberg 2004). Public universities' core mission is to educate students, produce research (as research/doctoral institutions), and provide public service to the general society. A university's prestige can be measured based on its three products: educational output, research output, and public service. In addition, the public higher education institution is indirectly subject to a student household budget constraint; it cannot set tuition and fees so high that students cannot afford attending even after pooling family resources and financial aid.

Put simply, I assume that a public university seeks to solve the following optimization problem: [14]

$$\underset{q_1,q_2,q_3}{Max} U(q_1, q_2, q_3)$$

$$s.t. E(q_1, q_2, q_3) = R$$

$$TF + C = Y + A$$

Here U represents university prestige or utility, which is a function of educational output (q_1), research output (q_2), and public service (q_3). E is the amount of expenditures needed to produce the bundle of university products (q_1, q_2, q_3). R is a university's total revenue. *TF* is tuition and fees paid by a representative student family. *C* is the cost of non-higher education goods and services consumed by the student's family. *Y* is the family income. *A* is the financial aid that the student receives.

Total revenue consists of tuition and fees (R_1), state appropriations (R_2), and other revenues (R_3). That is, $R = R_1 + R_2 + R_3$. Other revenues (R_3) include federal grants and

[14] For simplicity, this is a static model, ignoring university saving and borrowing behavior.

contracts; private gifts, grants, and contracts; federal appropriations; local appropriations; state grants and contracts; investment return; et cetera.[15] These other revenues are a small portion of total revenue and do not change much over time (Goodman and Henriques 2015). Unlike state appropriations and tuition and fees mostly serving as general purpose revenues, other revenues are often earmarked for specific projects, such as contracted training programs, research, public service, scholarships, or facilities.

States historically use enrollment-based funding models for public higher education (National Conference of State Legislatures 2005). Thus, state appropriations per FTE student in real value is more commonly used by researchers, practitioners, and policymakers than the aggregate nominal value of state appropriations to compare state higher education funding across states or institutions and over time (see, for example, Schuster 2016). It is important to scale state appropriations by enrollment, given that college-going rates have significantly increased over past decades (Goodman and Henriques 2015). It is also common practice for researchers to scale dependent variables to make them more comparable across states or institutions and over time. For example, one of the dependent variables in Rizzo and Ehrenberg (2004) is state need-based grant aid per student. Desrochers and Hurlburt (2014) measure the number of degrees awarded per FTE student. Accordingly, this paper uses a revised model in per-FTE-student terms with *S* representing the number of FTE students:

$$\frac{E(q_1,\ q_2,\ q_3)}{S} = \frac{R_1}{S} + \frac{R_2}{S} + \frac{R_3}{S}$$

$$\frac{R_1}{S} + C = Y + A$$

[15] Federal grants and contracts are awarded to universities by federal governmental agencies for contracted training programs, research, or public service activities. Pell grants are removed if universities reported them as federal grants in the survey. Private gifts, grants, and contracts are revenues received from private donors and from private contracts for specific goods and services provided to the funder. State grants and contracts are awarded by state government agencies mostly for contracted training programs.

$U(q_1, q_2, q_3) = S * \frac{U(q_1, q_2, q_3)}{S}$, with an assumption of

$$\frac{U(q_1, q_2, q_3)}{S} = U\left(\frac{q_1}{S}, \frac{q_2}{S}, \frac{q_3}{S}\right).$$

2.1 Hypotheses on Effects of State Appropriations on Tuition and Fees

Given school budget constraint ($\frac{E}{S} = \frac{R_1}{S} + \frac{R_2}{S} + \frac{R_3}{S}$), and holding other revenues ($\frac{R_3}{S}$) constant, when states cut appropriations ($\frac{R_2}{S}$), public universities have an incentive to raise tuition and fees ($\frac{R_1}{S}$) in order to reduce total revenue loss and to smooth expenditures.

However, it is unlikely that public universities can fully compensate lower state appropriations through raising tuition and fees because they face multiple constraints. First, it is politically unpopular and risky for public universities to initiate a large increase in tuition and fees for in-state students, especially during economic recessions when student families are facing lower incomes and higher unemployment. Raising tuition and fees could erode public trust at the exact time when public universities need stronger support from voters to put pressure on policymakers. Second, the governing structure of the public higher education system determines that public universities in many states have limited control over setting tuition. In most states, tuition-setting involves many parties and the primary tuition-setting authority often does not reside with individual institutions. According to a 2010–2011 survey by the State Higher Education Executive Officers Association, the state legislature or the statewide coordinating governing agency has the primary tuition-setting authority in 14 states, and the coordinating/governing boards for institutional systems have the primary tuition-setting authority in 19 states (Bell, Carnahan, and L'Orange 2011). Dictated by their own political interests, the state legislatures and the centralized governing boards/agencies have an incentive to maintain

low tuition. Even when individual institutions have the primary authority in setting their own tuition levels, they often have to follow state guidelines and also face potential penalties from state governments for raising the tuition too much (Kim and Ko 2015). Third, some states directly intervene in tuition-setting by imposing ad hoc tuition caps, curbs, or freezes (Boatman and L'Orange 2006, Kim and Ko 2015). For example, Massachusetts instituted a two-year tuition freeze in the mid–2010s, after the state cut higher education funding in the aftermath of the Great Recession (Murray 2017). Fourth, competition in the higher education market may force many public universities to limit the increase of tuition and fees so that they can maintain or increase enrollment. For example, the president of the University of Massachusetts System recently stated that the system has a lower tuition increase for the academic year 2018 than in previous years in order to compete with the state's many public and private institutions (Murry 2017).

There is heterogeneity among different types of public higher education institutions, in terms of their market power and the price elasticity of demand (PED) for their educational service. Therefore, they may have different abilities to raise tuition and fees when facing the same cuts in state appropriations. For example, public research/doctoral universities, especially flagship campuses, are more selective in admission and have greater market power in their states or regions than other types of public higher education institutions (Povich 2015). Their current and prospective students are also more likely to come from higher-income families and are on average less price sensitive than students attending other public institutions. Therefore, public research/doctoral universities may be able to raise tuition and fees more than other types of public higher education institutions. In line with this hypothesis, the president of the Public Affairs Research Council of Louisiana stated in early 2015 that the flagship school of the state (Louisiana State University) can afford to keep tuition increases in response to state budget cuts,

without losing many students, unlike the state's smaller schools (Povich 2015). On the other end of the public higher education spectrum, community colleges serve primarily low-income students, who tend to be price-sensitive. Many community colleges also have an open access policy and avoid creating a high price barrier. Therefore, we can expect a smaller (or no) adjustment in tuition and fees from community colleges than from other types of public higher education institutions in response to the same cuts in state appropriations.

In addition, public universities facing state funding cuts have an incentive to raise out-of-state tuition and fees more than they raise in-state tuition and fees, for several reasons.[16] First, it is politically less risky and more convenient because it will export more cost burden to non-residents who are not in-state voters. Second, unlike in-state tuition increases that are subject to state legislative approval or state- or system-wide governing boards, individual institutions have full autonomy over setting out-of-state tuition (Jaquette and Curs 2015). Third, out-of-state students' PED is on average lower than that of in-state students, which alleviates public universities' concerns about higher tuition and fees deterring out-of-state enrollment (Mixon and Hsing 1994, Mak and Moncur 2003, Rizzo and Ehrenberg 2004, Dotterweich and Baryla 2005, Zhang 2007, Adkisson and Peach 2008).

2.2 Hypotheses on Effects of State Appropriations on Student Financial Aid

Student families face their own budget constraints, which can be rearranged into $A = \frac{R_1}{S} - (Y - C)$. Therefore, if tuition and fees increase ($\frac{R_1}{S}$) in response to state funding cuts ($\frac{R_2}{S}$), students, particularly those from lower-income families, will have a greater need for financial aid (A).

[16] Knight and Schift (2016) show that public universities' charging residents and nonresidents a different amount of tuition results in economic inefficiencies from a national perspective.

There are three main forms of student financial aid: government grants, student loans, and institutional grants (fellowships and scholarships awarded by universities). The largest need-based government grant program for undergraduate students is the federal Pell Grant. To be eligible for a Pell Grant, a student must demonstrate financial need, which is defined as the difference between the cost of attendance at the school where the student is enrolled or accepted and expected family contribution calculated based on income and assets.[17] The size of the demonstrated financial need, along with other considerations, for example, full-time or part-time student status, determines the amount of Pell Grant awarded for each eligible applicant, up to a cap. The maximum Pell Grant awarded for 2017–2018 is $5,920. Because of the slow growth of the Pell Grant cap, the real value of Pell Grants has declined over time while that of tuition and fees has risen.

If state appropriation cuts lead to hikes in tuition and fees, the cost of attendance increases. Accordingly, student financial need increases, holding the expected family contribution constant. As a result, more students would be eligible to apply for federal Pell Grants and would likely receive a greater amount of federal grants.

Student loans play a larger role than government grants in student financial aid packages. Pell Grants mostly serve low-income students due to eligibility considerations. Even if a student receives the maximum Pell Grant amount, it is still much lower than tuition and fees in most public universities. Therefore, many students need loans to meet their financial needs and to ease their credit constraints. Therefore, if state appropriation cuts result in increases in tuition and fees, more students will need loans.

In addition, public universities may offer more fellowships and scholarships to students after raising tuition and fees for two reasons. First, some states have a policy directly and

[17] See https://studentaid.ed.gov/sa/types/grants-scholarships/pell.

positively linking tuition to public universities' fellowships/scholarships (Boatman and L'Orange 2006). The percentage of revenue from tuition increases that is earmarked for student financial aid varies widely across states—from 1 percent in Alaska to 30 percent in Arkansas (Kim and Ko 2015). Also, public universities may decide to provide more institutional grants in order to attract and retain talented students on the enrollment margin. Therefore, public universities are likely to provide more institutional grants per FTE student if they raise tuition and fees following state funding cuts.

2.3 Hypotheses on Effects of State Appropriations on School Expenditures

Based on school budget constraint($\frac{E}{S} = \frac{R_1}{S} + \frac{R_2}{S} + \frac{R_3}{S}$), a decline in state appropriations could lead to smaller total revenues and expenditures, even after potential adjustments in tuition and fees. Since state appropriations are general-purpose revenue that is not earmarked and supports all expenditure categories in each public university, lower state appropriations are likely to negatively affect the expenditures in most, if not all, areas.

State appropriation decreases are likely to have a larger negative impact on community colleges than on other types of public higher education institutions, since community colleges have less ability to make upward price adjustments to reduce total revenue loss. They are bound by the open access mandate and high price sensitivity of the low-income students they serve. Furthermore, community colleges have a different cost structure than other types of institutions; since their budgets do not allot for research, there are accordingly no research expenditures that could be cut. The impact of state funding cuts in community colleges is expected to be concentrated on education and related expenditures.

2.4 Hypotheses on Effects of State Appropriations on Student Degree Completion

Many people consider the number of degrees granted as the ultimate, most important output that higher education institutions produce. Degree production depends on inputs from both students and universities, which are influenced by tuition prices and school expenditures (Long 2016). This can be represented as $\frac{q_1}{S} = f(\frac{R_1}{S}, \frac{E}{S})$, where educational output $\left(\frac{q_1}{s}\right)$ is measured by degrees granted per 100 FTE students. This measure is commonly known as degree productivity in the higher education field (Desrochers and Hurlburt 2014).

Higher tuition prices have ambiguous effects on degree productivity. Since they could reduce student inputs in degree productions through multiple channels, higher tuition prices may lower degree productivity. Facing a household budget constraint, part-time students may have to take fewer classes each year when a class credit becomes more expensive. Therefore, either it will take them longer to complete their degree programs, or they will not ever complete the programs, and universities will likely grant fewer degrees to part-time students each year. More students will also likely need to get a part-time job(s) or work longer hours to pay for higher tuition and fees. Facing the time constraint, these students will likely have less study time, which could delay or even derail degree completion. Conversely, higher tuition prices may increase degree productivity. With higher revenue from tuition and fees, schools may provide more inputs through increasing expenditures to help students to complete their degrees.

Lower expenditures are likely to hurt degree productivity. Less spending on instruction could result in (1) fewer offered classes, some of which students are required to take in order to graduate (Korn and McWhirter 2017, Lannan 2017a); (2) larger class size, resulting in less individual student attention and thus lower academic performance; (3) more classes quickly reaching the enrollment cap which excludes students from registering for a course; and (4) lower

quality and quantity of teaching faculty and staff (Lannan 2017a). Less spending on academic support and student services could reduce resources to assist students' degree completion.[18] Webber and Ehrenberg (2010) show that student services and academic support are important determinants of student degree completion. Student services are particularly important for students at institutions with lower entrance test scores and higher Pell Grant expenditures per student.

Because state appropriation cuts could cause higher tuition prices and lower expenditures, state funding cuts are likely to result in lower degree productivity. Because community colleges suffer larger negative consequences from state funding cuts than other types of public higher institutions do, they are likely to experience a larger reduction in the number of degrees completed.

3 Data Source

The National Center for Education Statistics' Integrated Postsecondary Education Data System (IPEDS) Delta Cost Project provides the data used to test the hypotheses. This database is a nationwide, institutional-level, longitudinal dataset. It contains detailed information about each postsecondary institution in several areas: institutional characteristics (public vs. private, four-year vs. two-year); finance (revenues and expenditures); student enrollment; degree completion; graduation rates; student financial aid (government grants and student loans); and human resources (faculty and staff). The database covers the period of 1987–2012, although the staffing

[18] Academic support includes the retention, preservation, and display of educational materials (such as libraries, museums, and galleries), formally organized and separately budgeted academic personnel development, and course and curriculum development expenses, as well as information technology expenses related to academic support activities. Student services include expenses for admissions, registrar activities, and activities whose primary purpose is to contribute to students' emotional and physical well-being and to their intellectual, cultural, and social development outside the context of the formal instructional program, such as student activities, cultural events, student newspapers, intramural athletics, student organizations, supplemental instruction outside the normal administration, and student records.

survey was only required for even-numbered years and some questions were only added in later years' surveys.

4 Empirical Model

This paper uses a panel data model with institution and year fixed effects to test the hypotheses. While in a reduced form, each estimation equation is loosely motivated by and connected to the theoretical framework.

4.1 Tuition and Fees Equation

Following school budget constraint ($\frac{E}{S} = \frac{R_1}{S} + \frac{R_2}{S} + \frac{R_3}{S}$) and household budget constraint ($\frac{R_1}{S} = Y - C + A$), tuition and fees can be estimated as

$$(\frac{R_1}{S})_{it} = \alpha + \beta(\frac{R_2}{S})_{it} + \gamma\,(\frac{R_3}{S})_{it} + \theta U_{it} + I_i + T_t + V_{it}.$$

Because there are different hypotheses for different concepts of tuition and fees, and in order to test the robustness of the results, I use various measures of ($\frac{R_1}{S}$), including sticker price (with different combinations of in-state/out-of-state and undergraduates/graduates), average tuition (with different combinations of in-state/out-of-state and undergraduates/graduates), and net tuition and fees per FTE student.[19] $\frac{R_2}{S}$ is state appropriations per FTE student. $\frac{R_3}{S}$ represents (a) federal grants and contracts, and (b) private gifts, grants, and contracts, separately.[20] U is the

[19] In addition to out-of-state tuition and fees, I also examined the percentage of full-time, first-time undergraduates who are out-of-state. The results are not significant. Rizzo and Ehrenberg (2004) also find that the out-of-state enrollment share is insensitive to state appropriations per student.

[20] While public institutions may receive additional revenues such as federal or local appropriations and investment return, these other revenues tend to be smaller and more static (Goodman and Henriques 2015). They also have a

unemployment rate of the state where the institution is located. Unemployment rate is included because changes in the local labor market may affect the demand and therefore the price for higher education; however, the labor market condition in the institution's state is less relevant for out-of-state students (including international students) than for in-state students. Out-of-state students are less likely to stay in the institution's state after graduation, and their parents' incomes are less likely to be directly linked to the institution's state economy. Therefore, unemployment rates of the institution's state are excluded from regressions of out-of-state tuition.[21] *I* is the institution fixed effects, which capture the institutions' constant characteristics over the sample period, such as their selective status, admission policies, and pricing models. *T* is the year fixed effects, which capture the common factors shared by all institutions in a specific year, such as national economic recessions. *V* is the error term.

To accommodate the potential heterogeneity in the institution's ability to change tuition and fees and in exposure to out-of-state students, I run the estimation equation for each type of institution separately. Doing so allows the regression coefficients on each explanatory variable to differ across institutional type. The Carnegie Commission of Higher Education classifies most higher education institutions by four mutually exclusive categories based on the type and number of degrees awarded: doctoral institutions, master's institutions, bachelor's institutions, and associate's institutions (i.e., community colleges). I also run a separate regression for flagship institutions, which are a more elite subset of public doctoral institutions and which might behave differently from other public doctoral institutions.

larger number of missing values in the data. As a result, including them would significantly further reduce the sample size for a balanced panel analysis.

[21] The IPEDS Data treat out-of-state students as an aggregate group. There is no detailed breakdown of out-of-state students by state and country. Nevertheless, I tried including the unemployment rate of the institution's state in the regressions of out-of-state tuition. Results are similar to those excluding the unemployment rate.

Table 1, Panel A presents summary statistics of the variables in the regressions of tuition and fees. In order to make a proper comparison across different concepts of tuition, this paper limits all these tuition variables to the same sample period of 2000–2012 because the variable of average tuition only appeared in the survey in 2000 and onward.[22] Institutions without missing values are kept in order to run a balanced panel regression analysis. Table 1 shows that on average, public institutions' out-of-state tuition is two or three times the cost of in-state tuition, regardless of the tuition measures and types of public institutions. Doctoral institutions (especially flagship institutions) have higher tuition than master's and bachelor's institutions, while associate's institutions have the lowest tuition. Despite the long-run decline, state appropriations on average are still the largest revenue source. In addition, state funding is unevenly distributed across institutions. Public doctoral institutions receive nearly twice the amount of state appropriations per FTE student as public associate's institutions.

Appendix Figures 2A–I examine whether there is a negative correlation between each tuition measure and state appropriations in the raw data, which would be consistent with the hypotheses. For illustration purposes, I use public doctoral institutions as an example to draw each scatter plot.[23] Each dot is a unit of institution-year. The straight line generated from a univariate regression is consistently downward sloping across figures, suggesting an indeed negative correlation between tuition and state appropriations. However, the line is much flatter than a perfect substitution between state appropriations and tuition would imply. The related hypotheses will be more rigorously tested in the next section.

[22] I also tried not restricting the sample period to be the same across various tuition measures. When I used the longest balanced panel for each tuition variable as data allow, results were similar to those in Table 2.
[23] The general pattern of scatter plots based on other types of public higher education institutions is similar to the pattern based on public doctoral institutions.

4.2 Financial Aid Equation

Based on household budget constraint, student financial aid need depends on tuition and fees and family income. That is, $A = \frac{R_1}{S} - (Y - C)$. After substituting $\frac{R_1}{S}$ with the previously developed tuition and fees equation, an estimation equation for student financial aid can be derived as

$$A_{it} = \alpha + \beta(\frac{R_2}{S})_{it} + \gamma(\frac{R_3}{S})_{it} + \theta U_{it} + I_i + T_t + V_{it}.$$

Based on data availability, there are four measures of student financial aid (A): (1) institutional grants per FTE student; (2) percentage of full-time, first-time undergraduates receiving federal grants; (3) Pell Grants per FTE student; and (4) percentage of full-time, first-time undergraduates receiving student loans.[24] Family income contribution to the consumption of higher education $(Y - C)$ is approximated by the state unemployment rate (U) and institution and year fixed effects (I and T).

Table 1, Panel B shows the summary statistics of the variables in the regressions of student financial aid. Similar to Panel A, Panel B limits all variables to the same sample period of 2000–2012, because institutions have only reported the percentage of full-time, first-time undergraduates receiving federal grants and student loans since 2000.[25] On average, students at doctoral institutions receive larger institutional grants but are less likely to receive federal grants and student loans and are awarded smaller Pell Grants than students at master's and bachelor's institutions. Because community colleges mainly serve low-income students, their students are more likely to receive federal grants and are awarded larger Pell Grants than students at other

[24] I also examined student loan amounts per FTE student using the same regression specification as in Table 3. While the coefficients on state appropriations per FTE student are negative as expected, they are not statistically significant. Due to data limitation, institutional grant per FTE student at associate's institutions is excluded. A large number of observations from associate's institutions are missing a value for this variable, likely because it is less common for community colleges to offer fellowships or scholarships.

[25] I also tried not restricting the sample period to be the same across measures of student financial aid. Based on the longest balanced panel for each financial aid variable as data allow, results are similar to those in Table 3.

types of public institutions. However, community college students are less likely to obtain student loans, partly due to lower tuition prices and lower incomes. Using doctoral institutions as an example, Appendix Figures 3A–D show a negative correlation between each financial aid measure and state appropriations in the raw data. This general pattern is consistent with the theoretical predictions.

4.3 Institutional Expenditure Equation

This paper includes two versions of the estimation equation for institutional expenditures. First, based on the balanced school budget constraint ($\frac{E}{S} = \frac{R_1}{S} + \frac{R_2}{S} + \frac{R_3}{S}$), $\frac{R_1}{S}$ is substituted with the previously developed tuition and fees equation and an institutional expenditure equation is derived as

$$(\frac{E}{S})_{it} = \alpha + \beta(\frac{R_2}{S})_{it} + \gamma(\frac{R_3}{S})_{it} + \theta U_{it} + I_i + T_t + V_{it}.$$

Here the coefficient β captures both the direct, independent effect of state appropriations and the indirect, secondary effect of state appropriations through the tuition and fees channel. These effects go opposite directions; state appropriation cuts put direct downward pressure on institutional expenditures, but they could also lead to higher tuition and fees, meaning more revenues to support school expenditures. Because increases in tuition and fees are unlikely to fully offset state appropriation cuts, the direct effect of state appropriations is likely to dominate the indirect effect of state appropriations on school expenditures. Therefore, the net effect of state appropriation cuts is expected to be negative (that is, β is hypothesized to be positive).

In the second version of the expenditure equation, the price of tuition and fees ($\frac{R_1}{S}$) is added to the first version as an additional control variable:

$$(\frac{E}{S})_{it} = \alpha + \delta(\frac{R_1}{S})_{it} + \beta(\frac{R_2}{S})_{it} + \gamma(\frac{R_3}{S})_{it} + \theta U_{it} + I_i + T_t + V_{it}.$$

By controlling for tuition and fees, I in effect shut down the price adjustment channel through which state appropriations have an indirect, secondary effect on institutional expenditures. As a result, the coefficient β in this regression reflects only the direct, independent effect of state appropriations on institutional expenditures. Given that the indirect, secondary effect of state appropriations works against the direct, independent effect of state appropriations, this coefficient β is expected to be slightly larger than the coefficient β in the first version of the equation. However, because tuition and fees are likely to be endogenous of state appropriations, the first version of the expenditure equation is preferable to the second version.

To examine the potentially disparate impact of state funding cuts on different school spending areas and also to recognize that different types of institutions may have different cost structures, this paper separates institutional expenditures by category, including education and related expenditures, academic support expenditures, student services expenditures, research expenditures, and public service expenditures. In addition, this paper specifically examines instructional expenditures and faculty-to-student ratio (a key determinant of student performance).[26]

Table 1, Panel C shows summary statistics of the variables in the regressions of institutional expenditures. All dependent variables, except instructional faculty per 100 FTE students, have data from 1987 to 2012. The data on instructional faculty start from 1988. Education and related expenditures are the largest expenditure category across institutional type. On average, institutions use more than half of their education and related expenditures on

[26] Public institutions may respond to state appropriation cuts by using more part-time, adjunct faculty who are paid significantly less than full-time faculty. To test this hypothesis, I examined the proportion of all faculty members that are full-time employees. However, I found no significant results.

instruction. Appendix Figures 4A–G show that measures of institutional expenditures are positively correlated with state appropriations among public doctoral institutions, consistent with the theoretical predictions.

4.4 Degree Productivity Equation

In the conceptual framework, the degree production function is described as $\frac{q_1}{S} = f(\frac{R_1}{S}, \frac{E}{s})$. After substituting $\frac{R_1}{S}$ and $\frac{E}{s}$ with the previously developed tuition and fees equation and expenditure equation, the estimation equation for degree productivity is derived as

$$(\frac{q_1}{S})_{it} = \alpha + \beta(\frac{R_2}{S})_{it} + \gamma(\frac{R_3}{S})_{it} + \theta U_{it} + I_i + T_t + V_{it}.$$

The coefficient β captures the net effect of state appropriations on degree productivity. State appropriation cuts have a direct negative impact on school expenditures, which in turn reduces school inputs in degree productions. In addition, state appropriation cuts could result in higher tuition and fees, which in theory have an ambiguous effect on degree productions. Assuming the first channel is more dominant, I expect β to be positive.

Similar to the second version of the expenditure equation, tuition and fees serve as an additional control variable in the second version of the degree productivity equation:

$$(\frac{q_1}{S})_{it} = \alpha + \delta(\frac{R_1}{S})_{it} + \beta(\frac{R_2}{S})_{it} + \gamma(\frac{R_3}{S})_{it} + \theta U_{it} + I_i + T_t + V_{it}.$$

The inclusion of tuition and fees effectively turns off the second channel of the effect of state appropriation cuts through increases in tuition and fees. However, because tuition and fees may be endogenous of state appropriations, the first version of the degree productivity equation is preferable.

Different types of institutions specialize in different types of degrees and may have different degree production functions. Therefore, doctoral, master's, bachelor's, and associate's degree completions are considered separately.[27] Table 1, Panel D shows summary statistics of the variables in the regressions of degree completions. Appendix Figures 5A–C show that as expected, there is a positive correlation between bachelor's and higher degrees granted and state appropriations among public doctoral institutions. Appendix Figure 5D shows that associate's degrees granted are also positively correlated with state appropriations among associate's institutions.

5 Econometric Issues

In the model, standard errors are clustered at the state level. This allows for arbitrary correlations between the error terms not only within institutions but also between institutions within the same state, which might be caused by some unobserved state-level factors. Clustering standard errors also addresses the potential heteroskedasticity.

By controlling for institution fixed effects, the model relies on the variation over time within institutions to identify the coefficient β. Accordingly, the results are not driven by the unobserved heterogeneity.

There are several reasons why state appropriations can be used as an exogenous (at least pre-determined) variable in the model. First, state appropriations for public higher education are determined before the corresponding academic year starts. As part of the public budgeting process, state legislatures usually determine the amount of higher education funding for academic year *t*, which usually starts in September of calendar year *t*-1, between January and

[27] I also examined certificates and awards and the percentage of students graduating within 150 percent of normal time. Results are not significant.

June of calendar year *t*-1. In 19 states with biennial budgets, the amount of state appropriations for higher education for academic year *t* could be planned even earlier, in calendar year *t*-2. Because of this budgeting process setup, state appropriations are pre-determined and lead the dependent variables of this paper measured in academic year.[28]

Second, the underlying causes for changes in state higher education funding are often orthogonal to the demand for public higher education and to student and institutional behaviors. States often treat public higher education as a balance wheel of the state budget (Serna and Harris 2014), applying a residual budgeting approach to funding higher education—prioritizing appropriations for Medicaid, pension, K–12 education, and other mandatory spending. Public higher education may experience funding cuts if (1) state pension funds perform below expectations; (2) pension liability increases because states change the discount rate; (3) Medicaid caseloads increase because of federal or state policy changes; (4) Medicaid spending rises because of higher healthcare prices; or (5) states increase K–12 education funding to comply with new court rulings. Political changes in the makeup of state legislatures and governors can also result in changes in state appropriations for higher education. Previous research shows that democratic-controlled state legislatures and governors tend to provide more funding to public higher education than their republican-controlled counterparts (Koshal and Koshal 2000, Lowry 2001a, Okunade 2004).

Third, recent performance-based funding reforms, which might create reverse causality between state appropriations and degree completion, occurred after the end of the sample

[28] For example, in late June 2017, the University of Massachusetts System still had not determined how much the increase in tuition and fees would be for academic year 2018 while waiting for the state's overall fiscal year 2018 budget to be completed (Murray 2017). In the previous year, the University of Massachusetts Board of Trustees also waited to set tuition rates until state legislatures completed budget negotiations and clarified public funding for the university system (Lannan 2017b).

period.[29] During the sample period, states still used traditional enrollment-based funding models, which funded public institutions based on the number of enrolled students (National Conference of State Legislatures 2015).

Fourth, previous studies conduct tests that validate the assumption about the exogeneity of state appropriations. For example, Lowry (2001a) shows that tuition and fees as an independent variable are highly insignificant in the regression of state government funding. Goodman and Henriques (2015) prove in five ways that state appropriations are exogenous to student attendance and borrowing outcomes.

One potential concern is that the allocation of state funding across institutions within states may be endogenous. Examining flagship institutions alone helps address this concern. Because there is only one flagship institution in each state, regressions for flagship institutions do not include the variation between public institutions within states. Results for flagship institutions are fairly similar to those for public doctoral institutions.

Another potential concern is that the results of this paper might be driven by data from the unusual period of the Great Recession in which states, institutions, and students may have behaved differently than in other periods of time. To address this concern, I tried dropping the academic years 2007-2008 and 2008-2009, which correspond to the Great Recession. The results are similar to those including the two years.

Furthermore, it seems possible that state appropriations of not only the current year but also the previous year(s) could affect students and institutions. Public institutions may make

[29] National Conference of State Legislatures (2015) documents that some states started to incorporate university performance measures into funding models in the mid–2010s. However, they use the performance measures of past academic year(s), and not the upcoming academic year, since the latter are still unavailable when the state legislatures are deciding on the appropriation level for the upcoming academic year. In addition, many states used performance-based models to allocate only a small portion of total appropriations for public higher education (for example, less than 1 percent for Illinois and 2.4 percent for Pennsylvania), while still relying on traditional enrollment-based models to determine the majority of state funding for each institution.

gradual adjustments to respond to state funding changes. The impact of state appropriations could therefore last longer than one year. To test this hypothesis, a one-year lag of state appropriations per FTE student was added to an alternative specification. However, the estimated coefficient on this lag variable is rarely significant. Even when it is significant in few cases, its magnitude is much smaller than the estimated coefficient on the contemporaneous variable. Goodman and Henriques (2015) similarly find that after two lagged terms are added, the cumulative effect of state appropriations is not statistically different from the contemporaneous effect of state appropriations.

6 Results

Overall, the regressions produce many results that support the stated hypotheses. They show that there is significant heterogeneity in institutional responses to state funding cuts. The contrast between public research/doctoral universities and community colleges is particularly stark.

6.1 Effects on Tuition and Fees

Table 2 shows strong evidence of public doctoral institutions' responses in tuition and fees to state appropriation changes. The coefficient on state appropriations per FTE student is consistently negative, significantly different from zero, and significantly smaller than one, regardless of the tuition measure. For a $1 decline in state appropriations per FTE student, sticker-price tuition and fees on average increase from $0.11 for in-state full-time graduate students to $0.26 for out-of-state full-time undergraduate students; average tuition similarly increases from $0.12 for in-state full-time graduate students to $0.32 for out-of-state full-time undergraduate students. Accounting for institutional grant aid, net tuition and fees increase $0.17

on average in response to a $1 decrease in state appropriations. The differences in regression results for flagship institutions from results for public doctoral institutions are not statistically significant.

These results show that public doctoral institutions indeed turn to hikes in tuition and fees to help cope with state funding cuts. However, the increases in tuition and fees are generally insufficient to fully offset the loss of state appropriations, likely because these universities' ability to raise tuition and fees is constrained by the political environment, governing structure, state policy, and market forces.

Price increases of public doctoral institutions are unevenly distributed across different student segments. These institutions approximately double the increase in in-state undergraduate tuition for out-of-state undergraduate tuition (both sticker price and average amount). Differences between the two are statistically significant. This finding is consistent with the notion that the political environment and the state higher education governing structure make out-of-state tuition increases easier to implement than in-state tuition increases.

While point estimates for out-of-state graduate tuition (both sticker price and average amount) are greater than point estimates for in-state graduate tuition, differences between the two are not statistically significant. This is likely because public doctoral institutions have less market power in the graduate education market than in the undergraduate education market. Out-of-state graduate students tend to search nationwide for suitable schools because graduate schools emphasize specialization and research more than undergraduate programs and the best schools matching graduate students' needs are likely to sit outside the students' home region. In comparison, out-of-state undergraduate students tend to go to schools still in their home region to stay closer to their families. Therefore, public doctoral institutions have more competitors and

less market power in attracting out-of-state graduate students (in a larger, national market) than they have in attracting out-of-state undergraduate students (in a smaller, regional market).

This paper also examines whether public doctoral institutions raise graduate and undergraduate tuition to a different degree. While the estimated coefficient on graduate tuition is always smaller than the estimated coefficient on the corresponding undergraduate tuition (for example, in-state sticker-price graduate vs. in-state sticker-price undergraduate), only the difference between average out-of-state graduate tuition and average out-of-state undergraduate tuition is statistically significant. This difference likely occurs because public doctoral institutions face less competition in recruiting out-of-state undergraduates than they face in recruiting out-of-state graduate students, who tend to search more widely geographically than out-of-state undergraduates.

In addition, sticker price and average tuition largely move in parallel. While point estimates for sticker price are smaller than point estimates for the corresponding average tuition (for instance, sticker price for in-state undergraduates vs. average tuition for in-state undergraduates), differences between the two are not statistically significant.

In contrast with public doctoral institutions, other types of public institutions have few tuition changes resulting from changes in state appropriations. For master's and bachelor's institutions, the coefficient on state appropriations is only significant in the regression of average in-state tuition and average out-of-state tuition, respectively.[30] More importantly, no results are significant for associate's institutions. The differences in the coefficient on state appropriations between associate's and doctoral institutions are statistically significant in the regression of average in-state undergraduate tuition and net tuition and fees per FTE student. The lack of tuition and fees adjustments for associate's institutions is likely because these schools are

[30] The sample size for public bachelor's institutions is very small. Their results should be interpreted with caution.

required to carry out a free access policy and cannot discourage price-sensitive low-income students from enrolling. Therefore, community colleges are unable to raise tuition and fees. This result is different from the findings of Goodman and Henriques (2015) that state appropriation cuts lead to increases in community colleges' gross tuition and fees.

6.2 Effects on Student Financial Aid

Table 3 shows that public doctoral institutions' student grants increase slightly after states cut appropriations. This is likely because these universities raise tuition and fees to partly offset state funding loss (Table 2), and some states have either an official policy or a common practice to dedicate a portion of tuition increases to student financial aid. These doctoral universities may also offer more grants to maintain competitiveness in the recruitment of talented minorities, low-income students who are rather sensitive to price increases. Nonetheless, the increase in institutional grants is small compared with increases in tuition and fees. For a $1 decrease in state appropriations, on average institutional grants increase $0.04, while on average tuition increases from $0.12 for in-state full-time graduate students to $0.32 for out-of-state undergraduate students.[31]

Public bachelor's institutions and public doctoral institutions respond differently to state funding cuts. Bachelor's institutional grants, on average, decrease $0.08 with a $1 cut in state appropriations. This presumably reflects the fact that these schools are not as able as public doctoral institutions to raise tuition and fees; therefore, they have a shrinking pool of resources to fund student financial aid after states cut appropriations. Nonetheless, the results of bachelor's institutions should be viewed cautiously because of a small sample size.

[31] This is consistent with the result in Table 2 that tuition and fees net of institutional grants on average increase $0.17 in response to a $1 decrease in state appropriations.

Table 3 also shows that more students at public master's institutions turn to federal grants and student loans to pay for higher tuition and fees following state funding cuts. For a one-standard-deviation decrease in state appropriations per FTE student ($2,309), the percentage of full-time, first-time undergraduates receiving federal grants and student loans increases 1.54 percent and 2.01 percent, respectively [(-2.309) × (-0.669) = 1.54 and (-2.309) × (-0.872) = 2.01]. Students at public master's institutions also receive slightly more in Pell Grants since they demonstrate a higher financial need after schools raise tuition and fees. For a $1 cut in state appropriations, on average Pell Grants increase $0.02. This is much smaller than the $0.12 increase in average in-state undergraduate tuition. Like public master's institutions, public bachelor's institutions also have a higher percentage of full-time, first-time undergraduates receiving federal grants and student loans following state funding cuts and increases in tuition and fees. These results are different from Goodman and Henriques (2015), who find that state appropriations have no impact on student borrowing at public institutions. Their (non-)results are likely driven by the fact that they combine all types of public institutions, including community colleges, within states. This paper finds that state appropriations have no effects on student borrowing at community colleges, which may mute the effects of state appropriations on student borrowing at public master's and bachelor's institutions in Goodman and Henriques (2015).

Unlike students at other types of public institutions, community college students show no significant changes in their borrowing and grant-seeking behavior after states cut appropriations. This is likely because tuition and fees of community colleges are not responsive to state funding cuts (see Table 2), for economic, political, and policy reasons.

6.3 Effects on Institutional Expenditures

Results from the two versions of the regressions of institutional expenditures can be seen in Table 4. The first version, in Panel A, excludes tuition and fees from control variables. The coefficient on state appropriations in this version can be interpreted as the direct effect of state appropriations on institutional expenditures, net of the indirect effect of state appropriations through negatively affecting tuition and fees. The second version of the regression model, in Panel B, includes net tuition and fees as an additional control variable. By holding tuition and fees constant, the coefficient on state appropriations in this version captures only the direct effect of state appropriations on institutional expenditures. Therefore, the coefficients in Panel B are slightly larger than the corresponding coefficients in Panel A.[32] Nevertheless, the results in Panel A and Panel B are fairly similar. The focus below is on Panel A with a preferable model specification that does not include a potentially endogenous tuition and fees variable.

As the theory predicts, cuts in state appropriations which are un-earmarked general-purpose revenues have a negative impact on almost all expenditure functions. Education and related expenditures experience the largest impact, regardless of institutional type. For example, for public doctoral institutions, a $1 cut in state appropriations leads to an average drop of almost $0.50 in education and related expenditures. Within education and related expenditures, the impact of state appropriations is concentrated on instructional expenditures. The impact on instructional expenditures accounts for more than half of the impact on education and related expenditures, except for public bachelor's institutions. This result is different from Goodman and Henriques (2015), who find no significant effect of state appropriations on instructional expenditures and who speculate that instructional expenditures are relatively sticky.

[32] As Table 2 shows, there is a lack of response in tuition and fees to state funding cuts by community colleges. Therefore, they are unlikely to experience the indirect effect of state appropriations on institutional expenditures through the tuition and fees channel. Because there is a weak positive correlation between net tuition and fees and state appropriations for associate's institutions in the data (Table 2), the coefficients for associate's institutions in Panel B are slightly smaller than the corresponding coefficients in Panel A.

Since a large portion of instructional expenditures goes to instructional faculty, it is not surprising that cuts in state appropriations have a significant negative impact on the instructional-faculty-to-student ratio. For a one-standard-deviation decrease in state appropriations per FTE student, instructional faculty per 100 FTE students decrease by 0.42, 0.36, and 0.70 for public doctoral, master's, and associate's institutions, respectively ($0.0795 \times 5.253 = 0.42$, $0.151 \times 2.415 = 0.36$, $0.348 \times 2.016 = 0.70$).

Table 4 shows that state appropriations have a significant effect on research expenditures of public doctoral institutions. This result differs from Lowry (2001a), who finds that state appropriations have no impact on research expenditures of public four-year institutions. The non-finding of his paper is likely due to his data, which combine research universities with non-research universities that have few research expenditures.

There is significant heterogeneity by institutional type in the effects of state appropriations on school expenditures. For the same amount in state funding cuts, associate's institutions experience larger effects than other types of public institutions on each spending area except public service expenditures. The differences in these effects between associate's institutions and other types of public institutions are almost always statistically significant.[33] Associate's institutions likely behave differently in spending adjustments from other types of public institutions because they have different cost structures. For example, they have no research activities and cannot spread cuts into research expenditures as doctoral institutions do. Also unlike doctoral institutions, associate's institutions are unable to raise tuition and fees to offset state funding cuts.

[33] There are two exceptions. The difference in the regression of academic support expenditures between associate's institutions and doctoral institutions is not significant at the 10 percent level. Also, the difference in the regression of student service expenditures between associate's institutions and master's institutions is not significant.

Furthermore, public doctoral institutions cut fewer instructional faculty than other types of public institutions for the same amount of reductions in state appropriations per FTE student. The coefficient on state appropriations for doctoral institutions is statistically significantly different from the coefficient on state appropriations for other types of public institutions in the regression of instructional faculty. Doctoral institutions may be less able or less willing to cut instructional faculty for several reasons. First, they may have fewer part-time, adjunct faculty, who are easier to cut, and more full-time tenured or tenure-track faculty, who are more difficult to cut. Second, they may face larger and stronger labor unions that fight to protect faculty job security. Third, because instructional faculty at doctoral institutions also often do research, universities may hesitate to lay them off, so as to not disrupt research activities and lose external research funding. Fourth, search and hiring costs tend to be higher at doctoral institutions, because they usually do a national or even international search for qualified faculty candidates. Matching is more difficult because candidates' research interests and experience must fit hiring institutions' particular needs. Such high search costs may give doctoral institutions a disincentive to make faculty adjustments.

6.4 Effects on Degree Completions

Similar to Table 4, Table 5 presents results from two versions of the regressions. Regressions in Panel A exclude net tuition and fees as a control variable since it may be endogenous of state appropriations. Therefore, estimated coefficients on state appropriations capture the effects of state appropriations on degree completions through both the school expenditure channel and the tuition and fees channel. Regressions in Panel B include net tuition and fees as an additional control variable. Since the cost of net tuition and fees is held constant, estimated coefficients on

state appropriations in Panel B capture only the effects of state appropriations on degree completions through the school expenditure channel. The results in both panels are fairly similar.[34] Discussion focuses on Panel A results.

Cuts in state appropriations have a negative impact on the graduate degree productivity of public doctoral institutions. A one-standard-deviation decline in state appropriations per FTE student reduces public doctoral institutions' doctoral and master's degrees granted by 0.07 and 0.43 per 100 FTE students, respectively ($0.0127 \times 5.338 = 0.07$ and $0.0807 \times 5.338 = 0.43$). Public doctoral institutions likely experience lower graduate degree productivity because schools scale back expenditures that contribute to producing educational output in order to cope with state funding cuts (see Table 4). They cut back not only educational expenditures (especially instructional expenditures and instructional faculty), academic support, and student services, but also research expenditures. Many graduate students, particularly PhD students, rely on research assistantships. Graduate students also have a greater risk of not finishing their dissertations/theses on time or not finishing them at all, since their work is often tied to faculty research projects. In addition, by reducing the number of instructional faculty to save money, public doctoral institutions may increase the remaining faculty's teaching load, which in turn makes them less available to advise graduate students.

On the other hand, the effect of state appropriations on the undergraduate degree productivity of public doctoral institutions is not statistically significant, even though the sign of the coefficient is consistent with the hypotheses. This suggests that public doctoral institutions facing state funding cuts might shift resources away from graduate students to protect undergraduate education. They may have an incentive to do so because it is much more costly

[34] The fact that the estimated coefficients in Panel B are slightly larger than those in Panel A suggests that the effects of state appropriations through the tuition and fees channel work against (but are dominated by) the effects of state appropriations through the school expenditure channel.

for them to educate and to support graduate students. Many graduate students, especially PhD students, receive a full or partial tuition waiver, university fellowships, scholarships, and teaching or research assistantships.

Different from public doctoral institutions, public master's institutions experience a negative effect of state appropriation cuts on the undergraduate degree productivity, not on the graduate degree productivity. For a one-standard-deviation decline in state appropriations per FTE student, bachelor's degrees granted by public master's institutions decrease by 0.44 per 100 FTE students ($0.156 \times 2.811 = 0.44$). The estimated coefficient on state appropriations for public bachelor's institutions is almost identical to that for public master's institutions. However, it is not statistically significant likely due to the relatively small sample size.

Finally, public associate's institutions also suffer a loss of degree productivity from state funding cuts. Corresponding to a one-standard-deviation decline in state appropriations per FTE student, associate's degrees granted by community colleges decrease by 1.68 per 100 FTE students ($0.566 \times 2.962 = 1.68$). More importantly, community colleges experience a larger loss of degree productivity than public doctoral and master's institutions when they receive the same amount of state funding cuts per FTE student. Estimated coefficients in the first and third rows are added to obtain the effects of state appropriations on total degree productivity for public doctoral and master's institutions, respectively. These sums, 0.121 and 0.145, are statistically significantly smaller than the coefficient for public associate's institutions, 0.566. This result is consistent with the findings in Table 4 that given the same state funding cuts, community colleges have to cut more education and related expenditures (particularly instructional expenditures and faculty), academic support, and student services—all key determinants of student degree completion—than public doctoral and master's institutions do.

7 Conclusion

State support for public higher education has declined significantly over the past few decades. Policymakers, practitioners, researchers, students, faculty, and school administrators are concerned about the potential negative effects of state funding cuts on public institutions and their students. This paper indeed finds strong evidence of these negative effects.

The paper shows that many public institutions have to raise tuition and fees, especially for out-of-state undergraduates, to offset state funding decreases; few if any public institutions can completely offset these decreases. A higher share of public university students have federal Pell Grants and student loans to cope with increases in tuition and fees associated with state appropriation cuts. Public institutions also have to institute widespread cuts in expenditures. They ultimately suffer a loss in degree productivity, since fewer resources are available to help students complete their degrees.

While serving the largest share of undergraduates in the United States, community colleges are more vulnerable to the negative effects of state funding cuts than other types of public institutions. Unlike public doctoral institutions, community colleges are unable to raise tuition and fees and therefore have no cushion against state funding decreases. Without research expenditures to cut from, community colleges have to trim educational expenditures more deeply than other types of public institutions. As a result, they experience the largest loss in degree productivity associated with state funding cuts among all types of public higher education institutions.

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Table 1. Summary Statistics

(A) Variables in the Regressions of Tuition and Fees (2000–2012)

	Doctoral Institutions	Flagship Institutions	Master's Institutions	Bachelor's Institutions	Associate's Institutions
Dependent Variables:					
Sticker-Price Tuition and Fees for In-State Full-Time Undergraduates	6.990	7.250	5.808	5.906	2.926
	(2.577)	(2.533)	(1.760)	(2.481)	(1.501)
Sticker-Price Tuition and Fees for Out-of-State Full-Time Undergraduates	17.90	19.70	13.44	13.04	
	(5.214)	(5.671)	(3.166)	(4.709)	
Sticker-Price Tuition and Fees for In-State Full-Time Graduates	7.908	8.191	6.476		
	(3.199)	(3.426)	(2.423)		
Sticker-Price Tuition and Fees for Out-of-State Full-Time Graduates	17.39	19.08	13.06		
	(5.291)	(5.431)	(3.848)		
Average Tuition for In-State Full-Time Undergraduates	5.775	6.129	4.443	4.474	2.615
	(2.507)	(2.442)	(1.789)	(1.752)	(1.424)
Average Tuition for Out-of-State Full-Time Undergraduates	16.51	18.32	11.89	11.54	
	(5.187)	(6.026)	(3.235)	(3.605)	
Average Tuition for In-State Full-Time Graduates	6.799	7.203	5.312		
	(3.155)	(3.401)	(2.445)		
Average Tuition for Out-of-State Full-Time Graduates	16.12	17.83	11.71		
	(5.310)	(5.837)	(3.913)		
Net Tuition and Fees per FTE Student	8.191	9.018	5.929	5.337	3.093
	(3.055)	(3.526)	(1.880)	(1.515)	(1.356)
Explanatory Variables:					
State Appropriations	10.02	11.06	6.934	7.972	5.254
	(4.657)	(4.922)	(2.633)	(3.229)	(2.611)
Private Gifts, Grants, and Contracts	1.506	2.198	0.300	0.879	0.212
	(1.806)	(2.274)	(0.341)	(2.298)	(0.342)
Federal Grants and Contracts Less Pell Grants	5.615	7.663	0.921	1.007	0.811
	(5.241)	(5.319)	(0.921)	(1.012)	(0.882)
State Unemployment Rate	6.132	5.742	6.155	5.578	6.318
	(2.143)	(2.072)	(1.979)	(2.021)	(2.241)
Observations	1,378	494	1,547	286	2,574

(B) Variables in the Regressions of Student Financial Aid (2000–2012)

	Doctoral Institutions	Flagship Institutions	Master's Institutions	Bachelor's Institutions	Associate's Institutions
Dependent Variables:					
Institutional Grants	1.461	1.748	0.604	0.743	
	(1.160)	(1.198)	(0.591)	(0.702)	
Percentage of Full-Time, First-Time Undergraduates Receiving Federal Grants	26.61	22.09	32.19	39.29	42.65
	(12.02)	(9.567)	(13.06)	(13.14)	(15.85)
Pell Grants	0.861	0.689	1.142	1.356	1.688
	(0.428)	(0.344)	(0.523)	(0.553)	(0.833)
Percentage of Full-Time, First-Time Undergraduates Receiving Student Loans	45.93	42.51	52.01	52.89	26.82
	(14.10)	(13.66)	(16.55)	(16.30)	(19.16)
Explanatory Variables:					
State Appropriations	10.22	11.07	6.656	6.943	4.887
	(4.563)	(4.943)	(2.309)	(2.972)	(2.235)
Private Gifts, Grants, and Contracts	1.626	2.309	0.333	1.103	0.195
	(1.896)	(2.320)	(0.506)	(2.746)	(0.345)
Federal Grants and Contracts Less Pell Grants	6.154	7.560	0.795	0.713	0.769
	(5.703)	(5.316)	(0.694)	(0.428)	(0.882)
State Unemployment Rate	6.270	5.895	6.298	5.427	6.132
	(2.191)	(2.153)	(2.071)	(2.021)	(2.203)
Observations	1,274	468	1,248	195	1,313

Table 1. Summary Statistics (Continued)

(C) Variables in the Regressions of Institutional Expenditures (1987–2012)

	Doctoral Institutions	Flagship Institutions	Master's Institutions	Bachelor's Institutions	Associate's Institutions
Dependent Variables:					
Education and Related Expenditures	17.02	18.22	12.24	13.26	10.13
	(5.660)	(5.620)	(2.533)	(4.338)	(2.722)
Instructional Expenditures	10.93	12.11	6.666	6.577	5.298
	(4.091)	(4.159)	(1.384)	(1.825)	(1.326)
Instructional Faculty per 100 FTE Students	4.810	4.977	4.489	4.769	3.447
	(0.911)	(0.867)	(0.684)	(1.271)	(1.086)
Academic Support Expenditures	2.888	3.234	1.481	1.516	1.046
	(1.513)	(1.308)	(0.531)	(0.878)	(0.549)
Research Expenditures	6.061	7.703	0.400		
	(5.109)	(4.483)	(0.725)		
Student Services Expenditures	1.343	0	1.221	1.460	1.211
	(0.617)	(0.554)	(0.507)	(0.678)	(0.620)
Public Service Expenditures	2.137	3.005	0.610	0.682	0.521
	(2.325)	(2.950)	(0.531)	(0.690)	(0.760)
Explanatory Variables:					
State Appropriations	11.69	12.47	7.391	8.564	4.933
	(5.253)	(5.227)	(2.415)	(3.212)	(2.016)
Private Gifts, Grants, and Contracts	1.780	2.378	0.392	0.868	0.195
	(1.780)	(2.063)	(0.509)	(1.998)	(0.310)
Federal Grants and Contracts Less Pell Grants	5.069	6.764	0.904	0.773	0.827
	(4.670)	(4.700)	(0.991)	(0.672)	(0.894)
Net Tuition and Fees	6.939	7.525	5.042	4.636	3.001
	(2.986)	(3.489)	(1.828)	(1.692)	(1.233)
State Unemployment Rate	5.958	5.626	5.921	5.483	5.975
	(1.920)	(1.882)	(1.783)	(1.669)	(1.928)
Observations	3,068	1,092	2,340	468	1,768

(D) Variables in the Regressions of Degree Completions (1987–2012)

	Doctoral Institutions	Flagship Institutions	Master's Institutions	Bachelor's Institutions	Associate's Institutions
Dependent Variables:					
Doctoral Degrees Granted	0.856	1.046			
	(0.494)	(0.513)			
Master's Degrees Granted	5.400	5.188	4.005		
	(2.288)	(1.513)	(2.115)		
Bachelor's Degrees Granted	16.03	15.95	16.55	15.18	
	(2.796)	(2.139)	(3.989)	(5.233)	
Associate's Degrees Granted					14.43
					(4.600)
Explanatory Variables:					
State Appropriations	11.74	12.47	7.751	8.309	5.719
	(5.338)	(5.227)	(2.811)	(3.178)	(2.962)
Private Gifts, Grants, and Contracts	1.795	2.378	0.364	0.859	0.211
	(1.800)	(2.063)	(0.490)	(1.997)	(0.295)
Federal Grants and Contracts Less Pell Grants	5.189	6.764	0.861	0.872	0.733
	(4.978)	(4.700)	(0.979)	(0.811)	(0.862)
Net Tuition and Fees	6.912	7.525	4.984	4.594	2.656
	(2.972)	(3.489)	(1.863)	(1.695)	(1.225)
State Unemployment Rate	5.969	5.626	6.004	5.284	5.868
	(1.920)	(1.882)	(1.858)	(1.707)	(1.976)
Observations	3,120	1,092	3,042	468	3,770

Source : IPEDS Delta Cost Project and author's calculations.

Notes : (1) All monetary variables are in thousands of 2012 dollars per FTE student.

(2) Standard deviations are reported in parentheses.

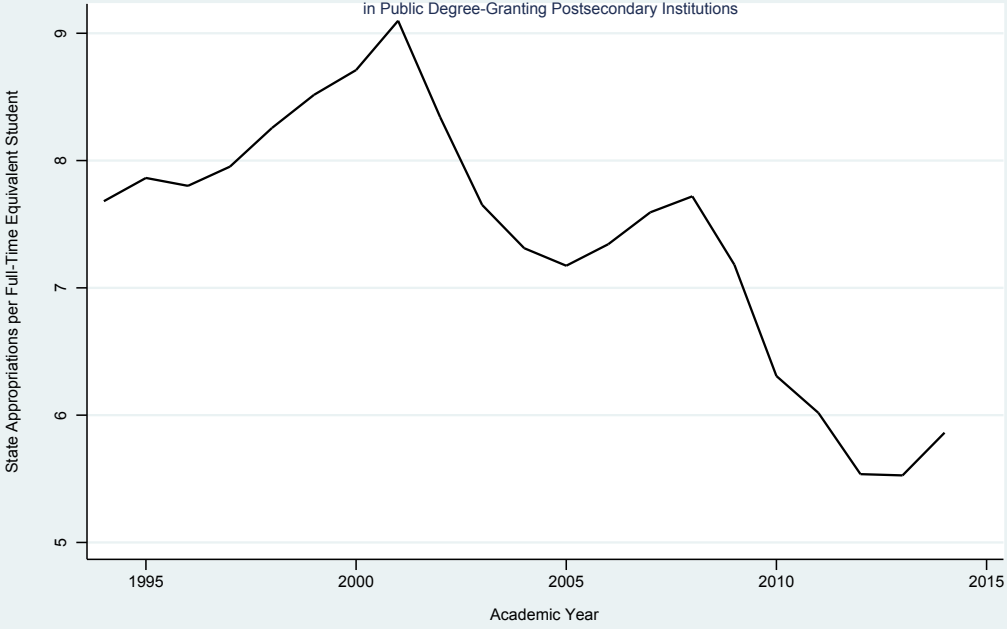
(3) Sticker price is a fixed amount of money charged to a full-time student by an institution that covers tuition and required fees for an academic year.

(4) The sample period for instructional faculty per 100 FTE students is 1988–2012. The 1987 survey did not ask a question about the number of instructional faculty.

(5) Degree completion variables are per 100 FTE students.

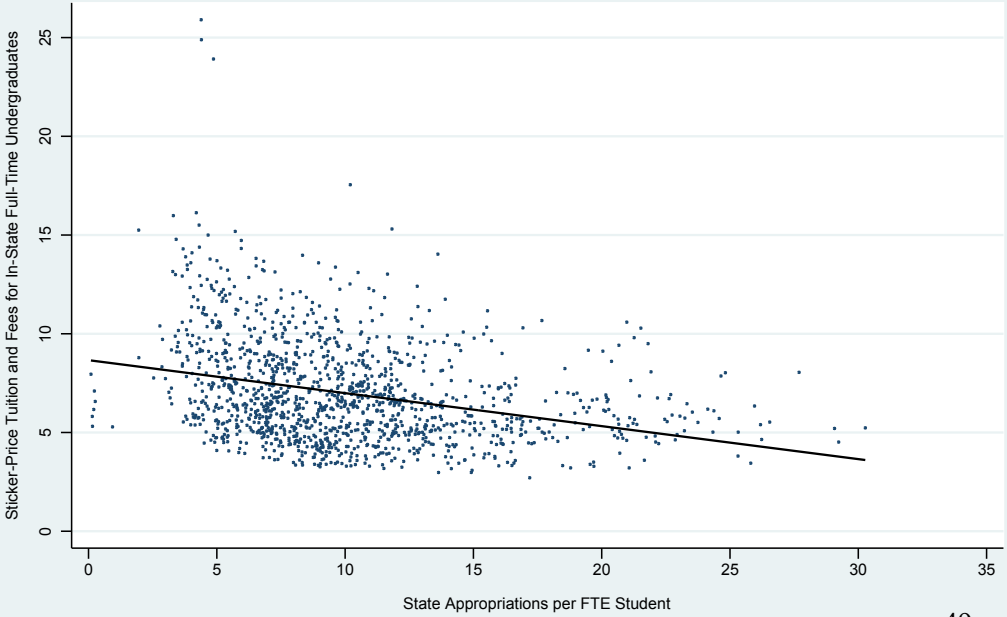
(6) According to the Carnegie Classification of Institutions of Higher Education, a doctoral institution awards at least 20 research/scholarship doctoral degrees a year; a master's institution awards at least 50 master's degrees and fewer than 20 doctoral degrees a year; a bachelor's institution awards degrees which at least half of should be baccalaureate or higher degrees; the highest-level degree awarded at associate's institutions is an associate's degree. The IPEDS Delta Cost Project data use the definition of flagship institutions provided by Gerald and Haycock (2006), who define a flagship institution as the oldest, largest, or best-known campus in a public state higher education system. Based on this definition, each state has only one flagship institution.

Appendix Figure 1. State Appropriations per Full-Time Equivalent Enrollment in Public Degree-Granting Postsecondary Institutions



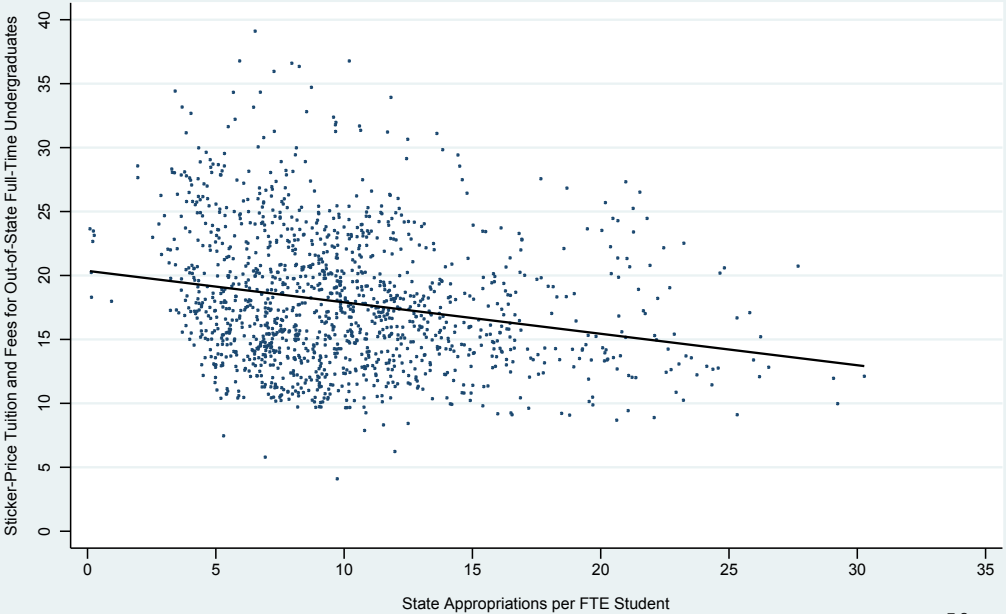
Source: National Center for Education Statistics, Digest of Education Statistics.
Note: State appropriations for 2002 are missing and are estimated using interpolation. State appropriations are inflated to 2014 dollars and are in thousands of dollars.

Appendix Figure 2A. State Appropriations vs. Sticker-Price Tuition and Fees for In-State Full-Time Undergraduates (Doctoral Institutions, 2000-2012)



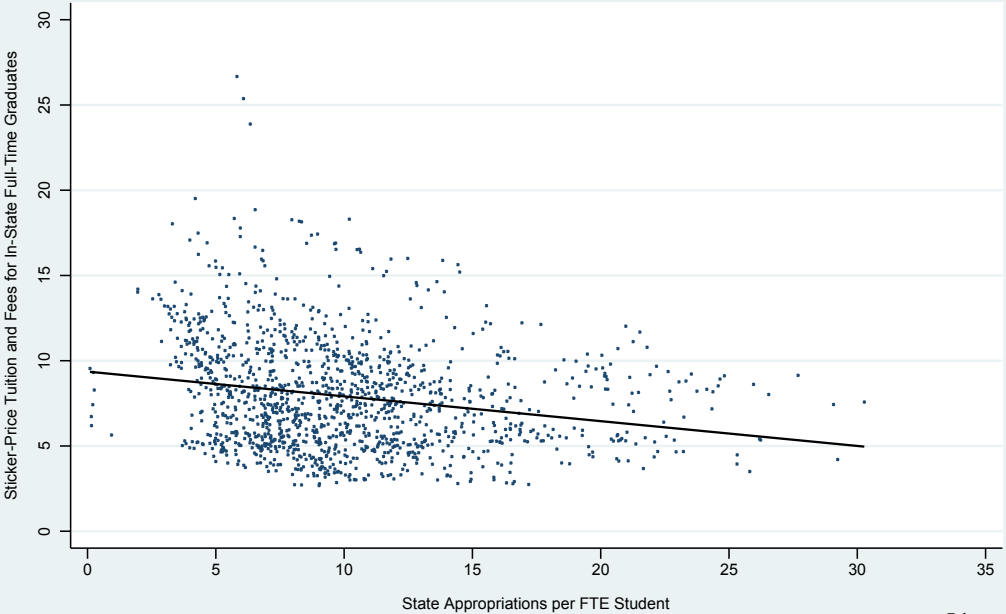
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 106 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 2B. State Appropriations vs. Sticker-Price Tuition and Fees for Out-of-State Full-Time Undergraduates (Doctoral Institutions, 2000-2012)



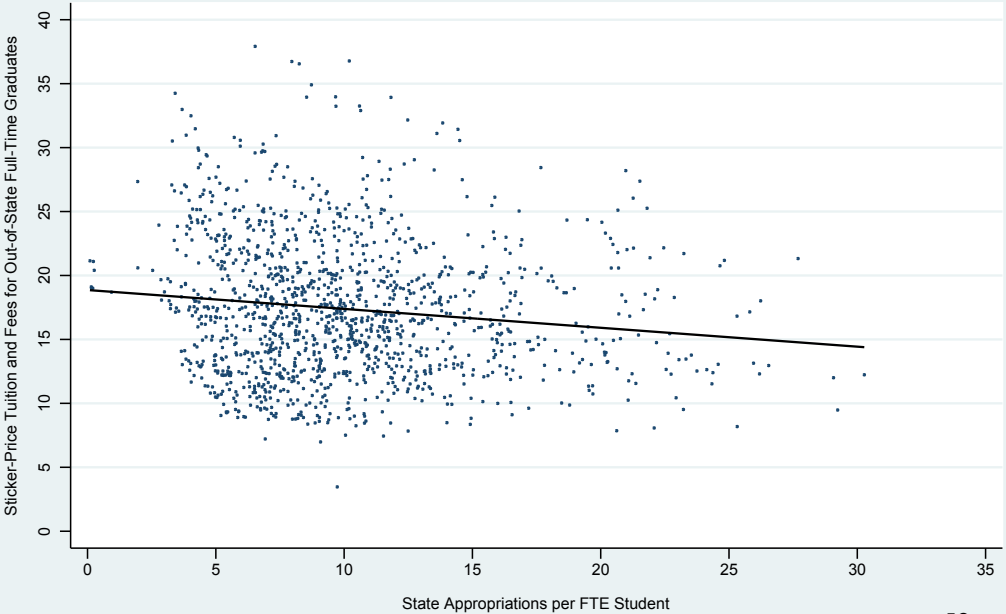
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 106 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 2C. State Appropriations vs. Sticker-Price Tuition and Fees for In-State Full-Time Graduates (Doctoral Institutions, 2000-2012)



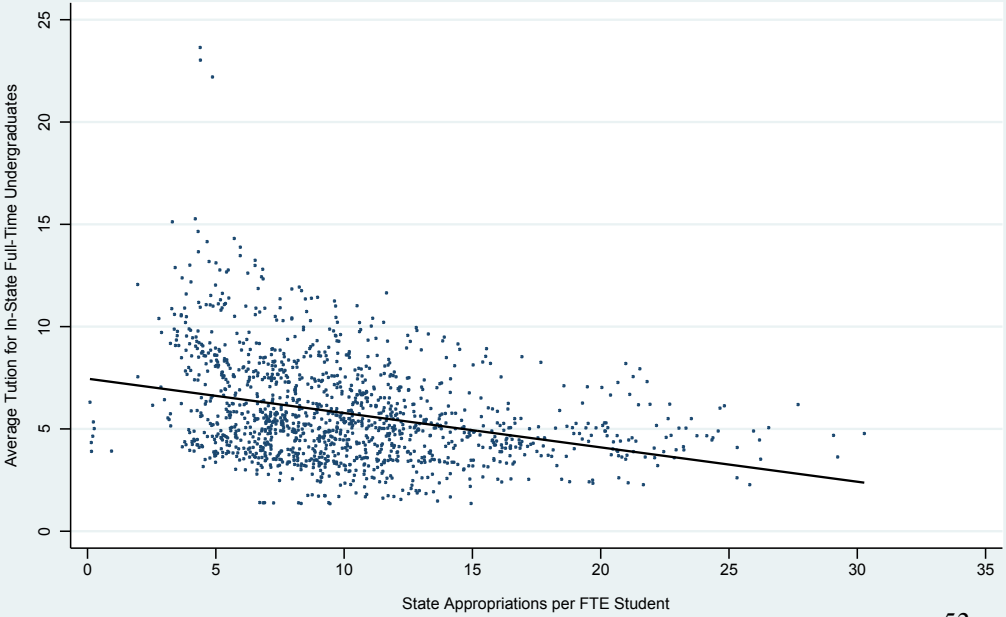
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 106 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 2D. State Appropriations vs. Sticker-Price Tuition and Fees for Out-of-State Full-Time Graduates
(Doctoral Institutions, 2000-2012)



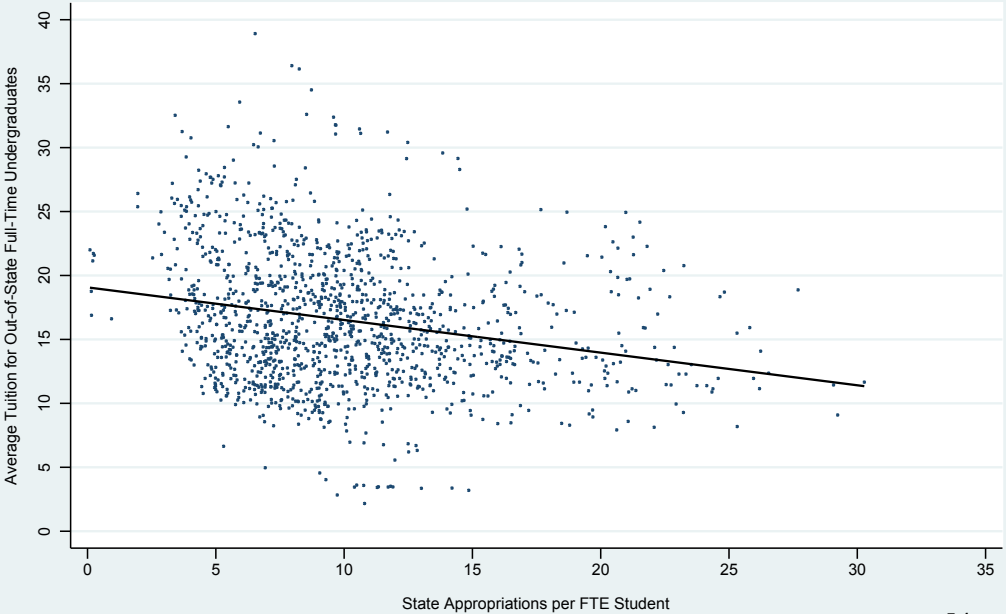
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 106 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 2E. State Appropriations vs. Average Tution for In-State Full-Time Undergraduates
(Doctoral Institutions, 2000-2012)



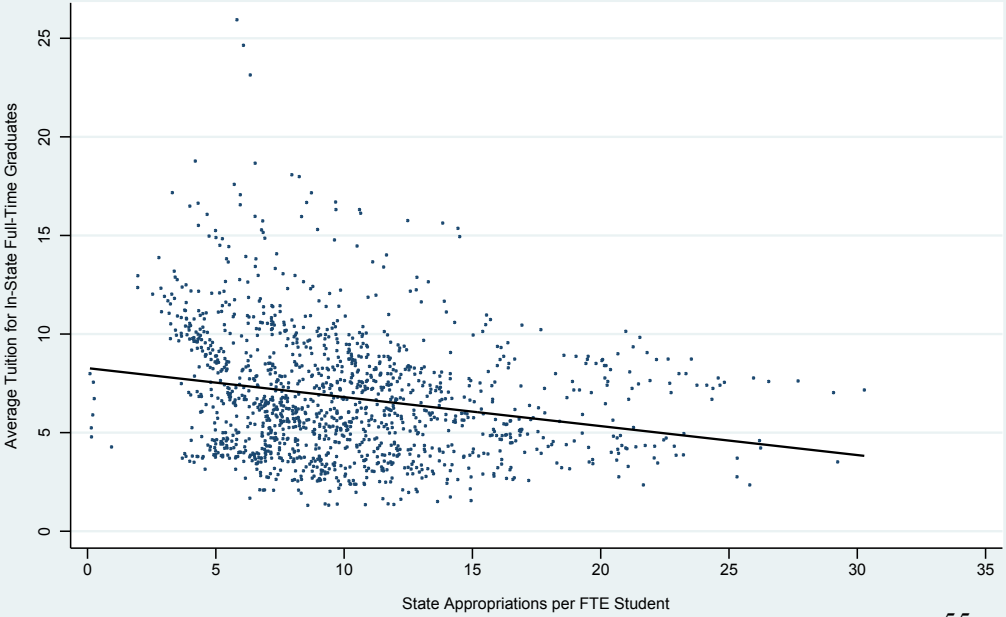
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 106 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 2F. State Appropriations vs. Average Tuition for Out-of-State Full-Time Undergraduates
(Doctoral Institutions, 2000-2012)



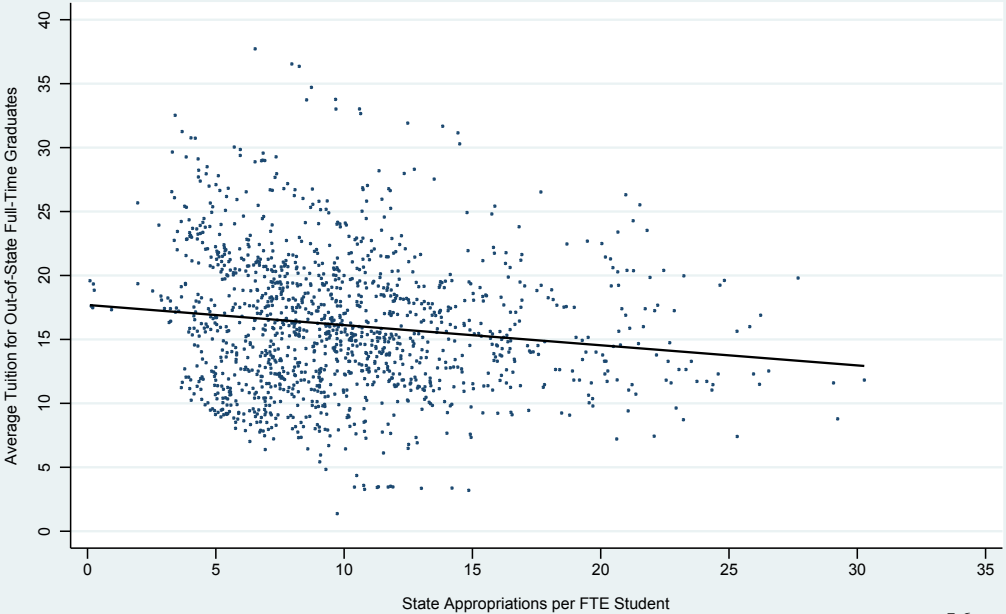
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 106 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 2G. State Appropriations vs. Average Tuition for In-State Full-Time Graduates
(Doctoral Institutions, 2000-2012)



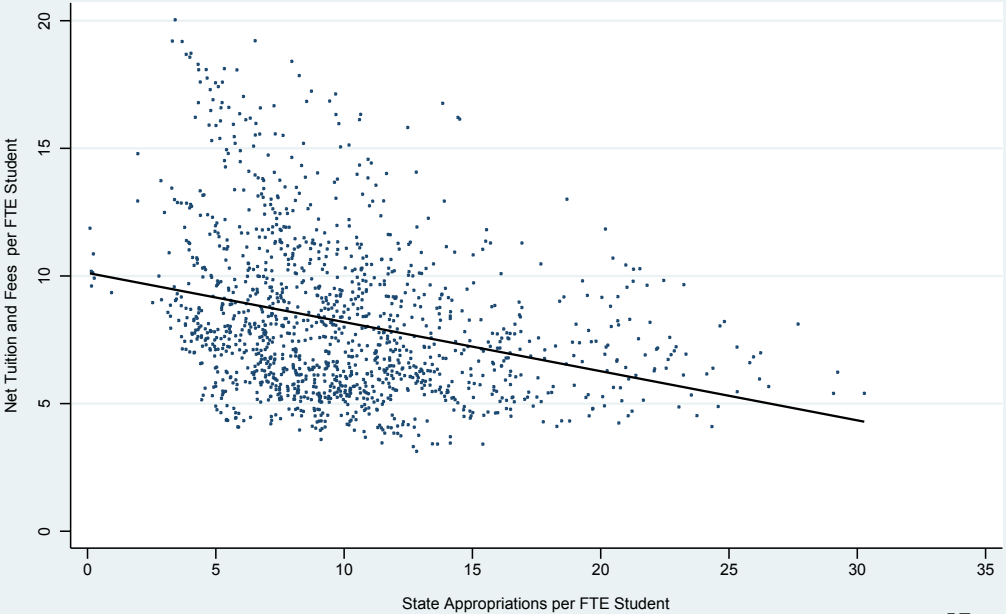
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 106 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 2H. State Appropriations vs. Average Tuition for Out-of-State Full-Time Graduates
(Doctoral Institutions, 2000-2012)



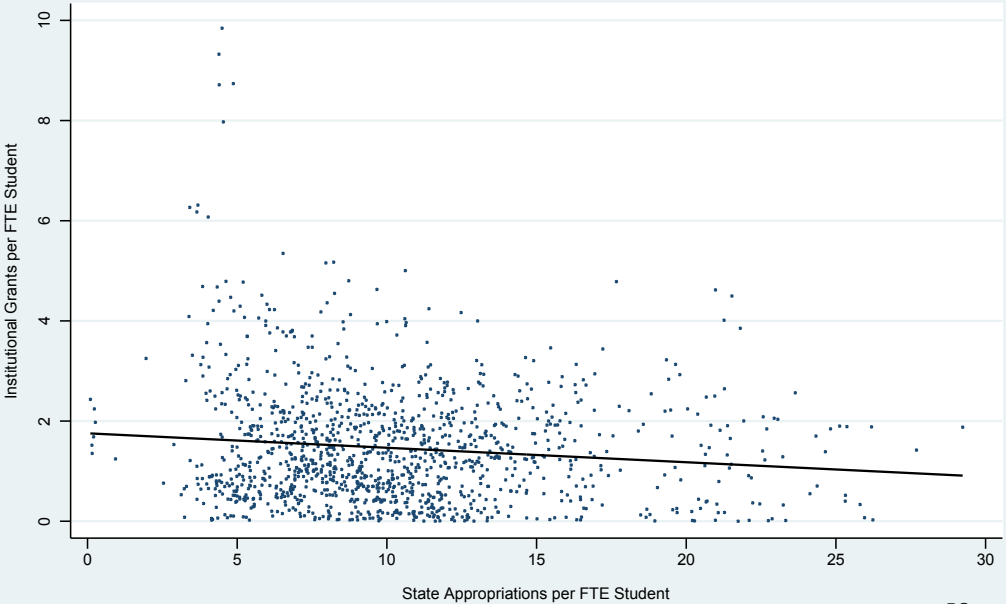
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 106 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 2I. State Appropriations vs. Net Tuition and Fees
(Doctoral Institutions, 2000-2012)



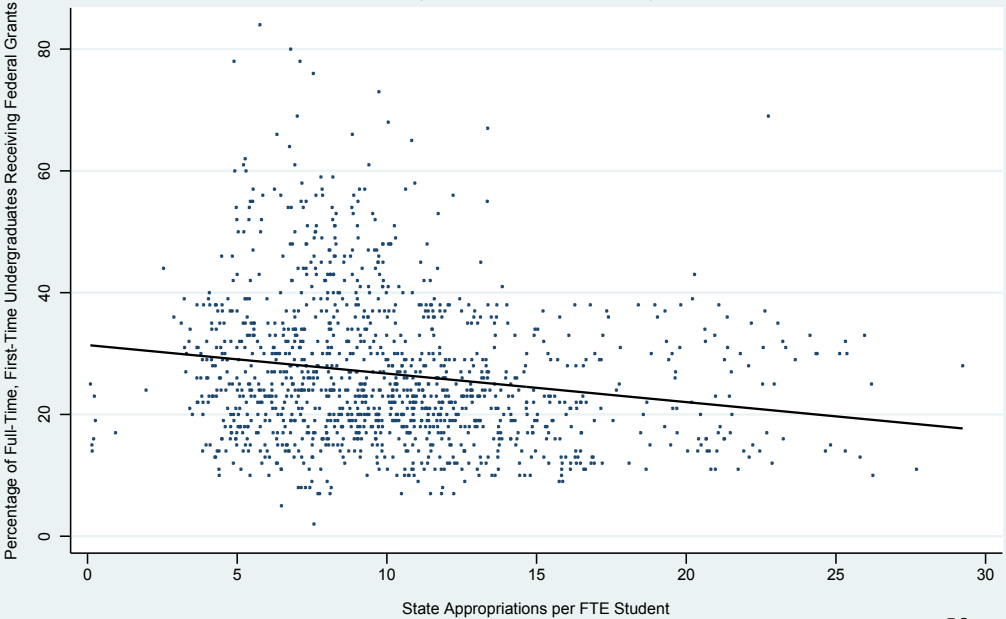
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 106 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 3A. State Appropriations vs. Institutional Grants (Doctoral Institutions, 2000-2012)



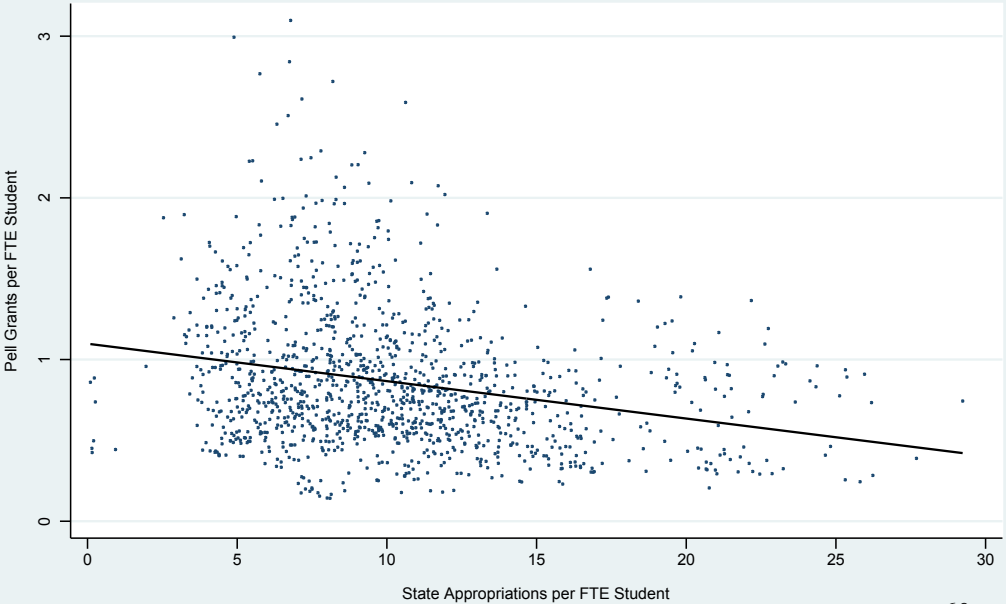
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 98 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 3B. State Appropriations vs. Percentage of Full-Time, First-Time Undergraduates Receiving Federal Grants (Doctoral Institutions, 2000-2012)



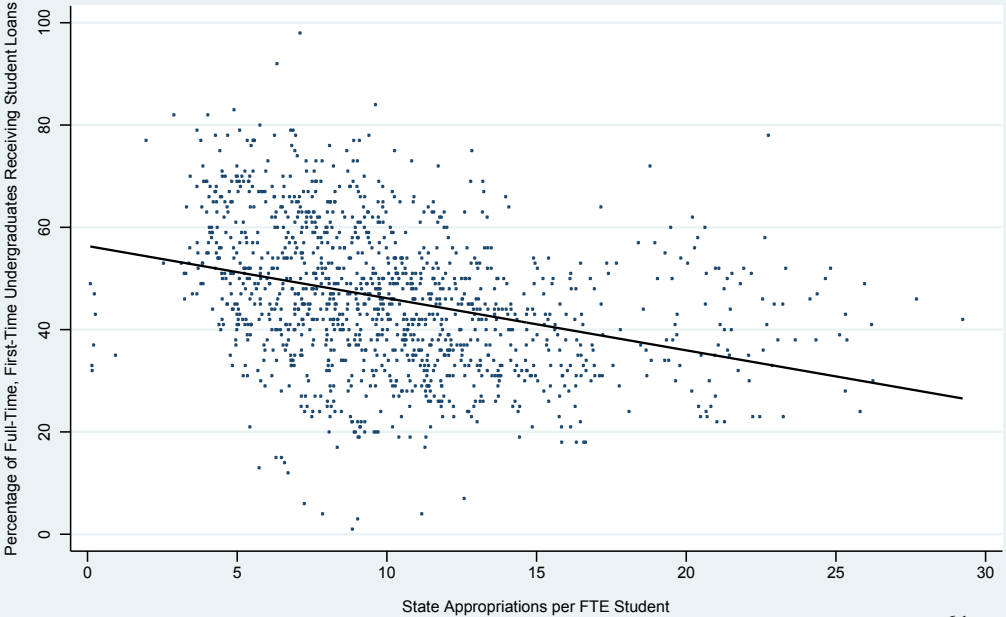
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 98 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 3C. State Appropriations vs. Pell Grants
(Doctoral Institutions, 2000-2012)



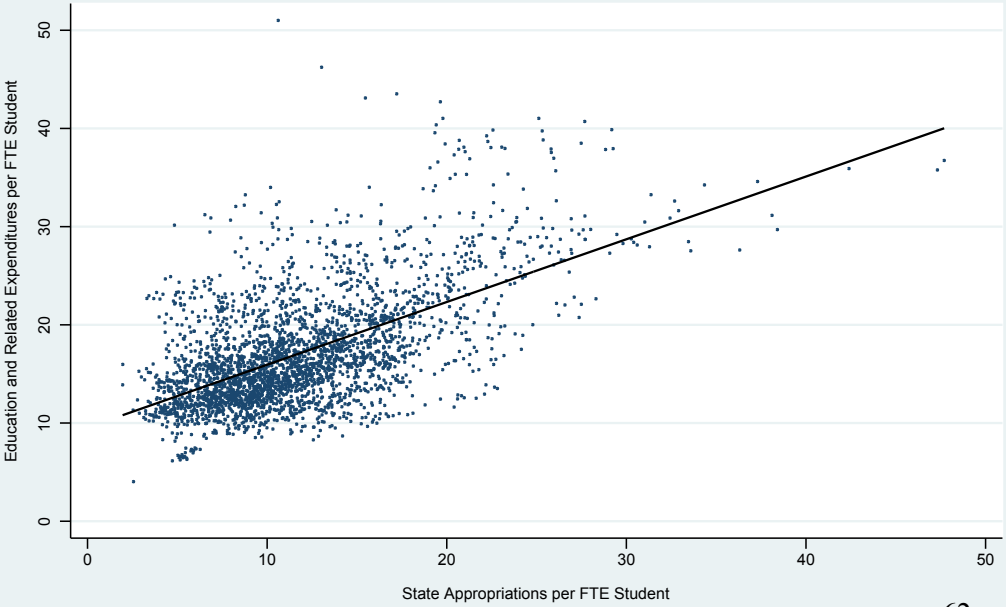
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 98 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 3D. State Appropriations vs. Percentage of Full-Time, First-Time Undergraduates Receiving Student Loans (Doctoral Institutions, 2000-2012)



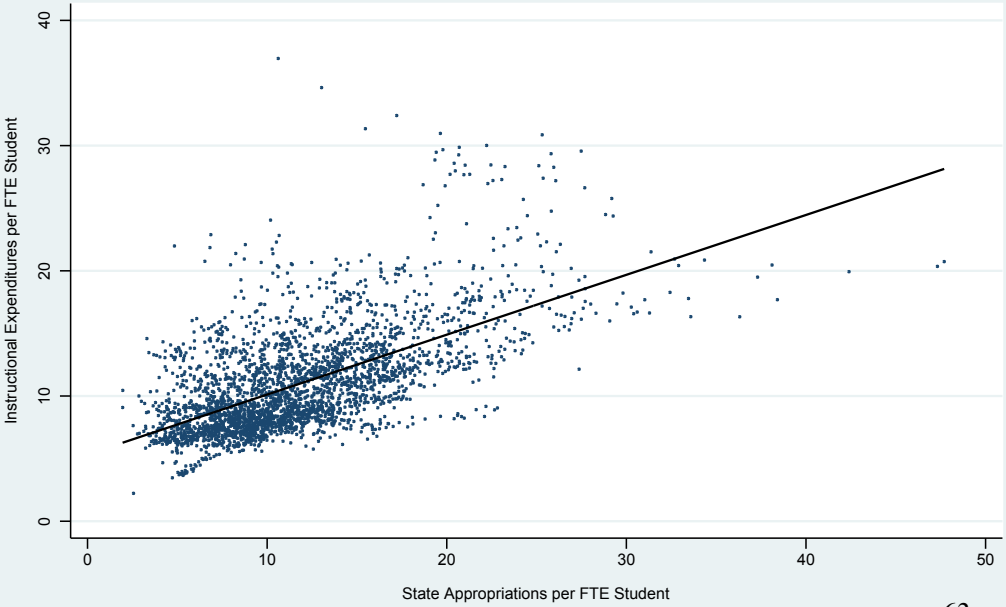
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 98 doctoral institutions for 2000-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 4A. State Appropriations vs. Education and Related Expenditures
(Doctoral Institutions, 1987-2012)



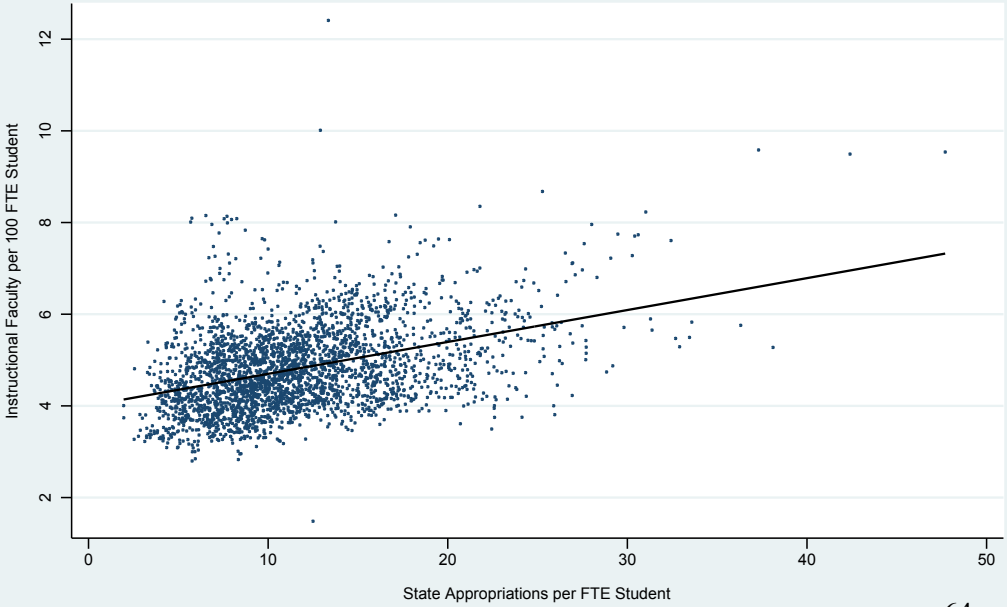
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 118 doctoral institutions for 1987-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 4B. State Appropriations vs. Instructional Expenditures
(Doctoral Institutions, 1987-2012)



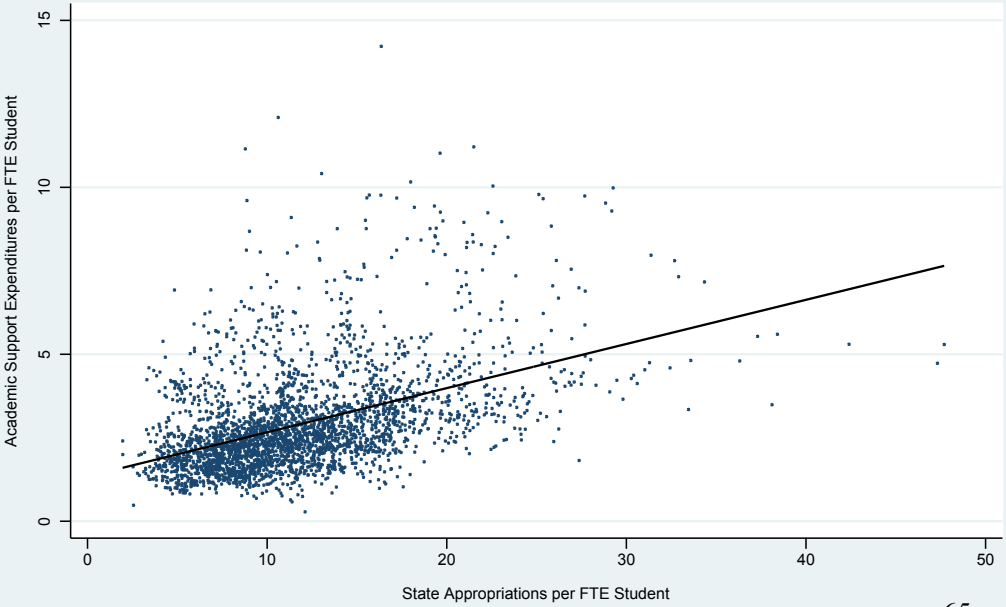
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 118 doctoral institutions for 1987-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 4C. State Appropriations vs. Instructional Faculty (Doctoral Institutions, 1988-2012)



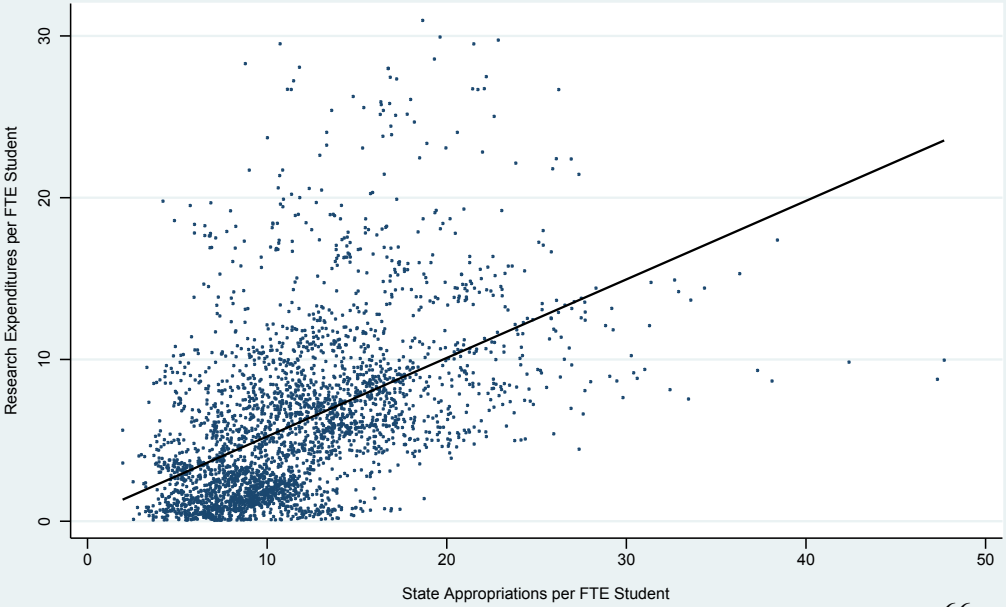
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 118 doctoral institutions for 1988-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 4D. State Appropriations vs. Academic Support Expenditures (Doctoral Institutions, 1987-2012)



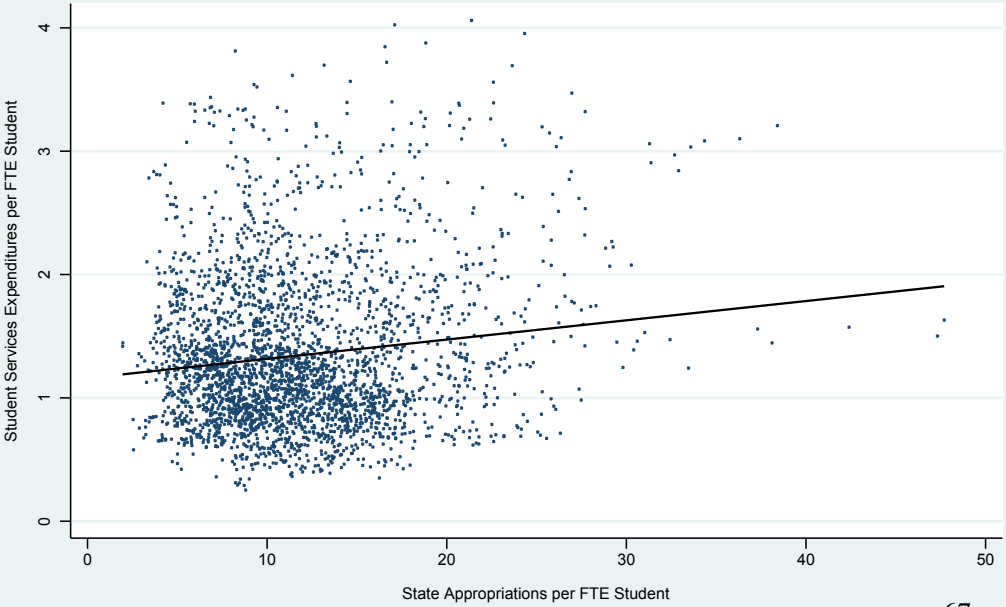
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 118 doctoral institutions for 1987-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 4E. State Appropriations vs. Research Expenditures
(Doctoral Institutions, 1987-2012)



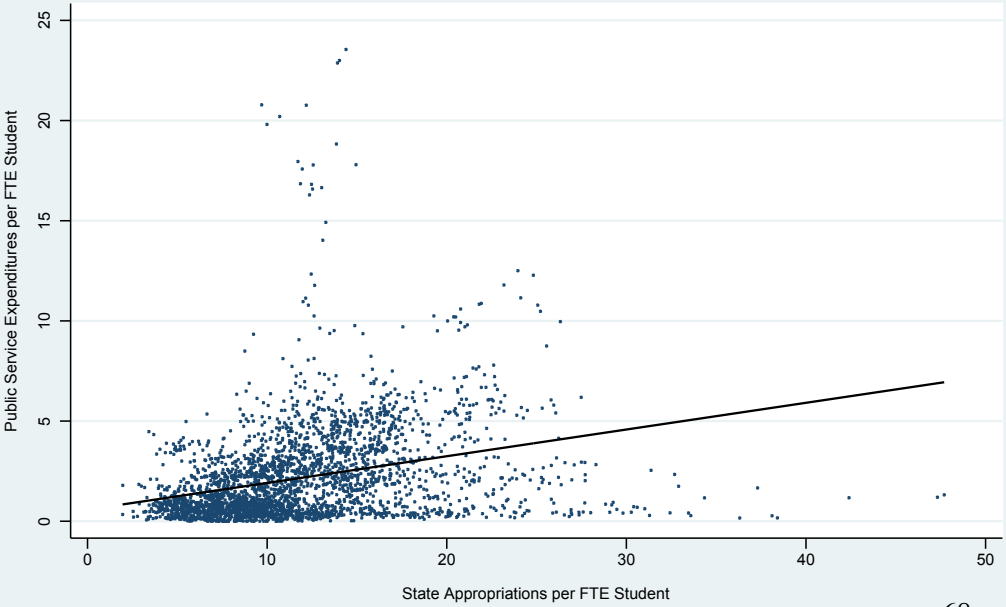
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 118 doctoral institutions for 1987-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 4F. State Appropriations vs. Student Services Expenditures
(Doctoral Institutions, 1987-2012)



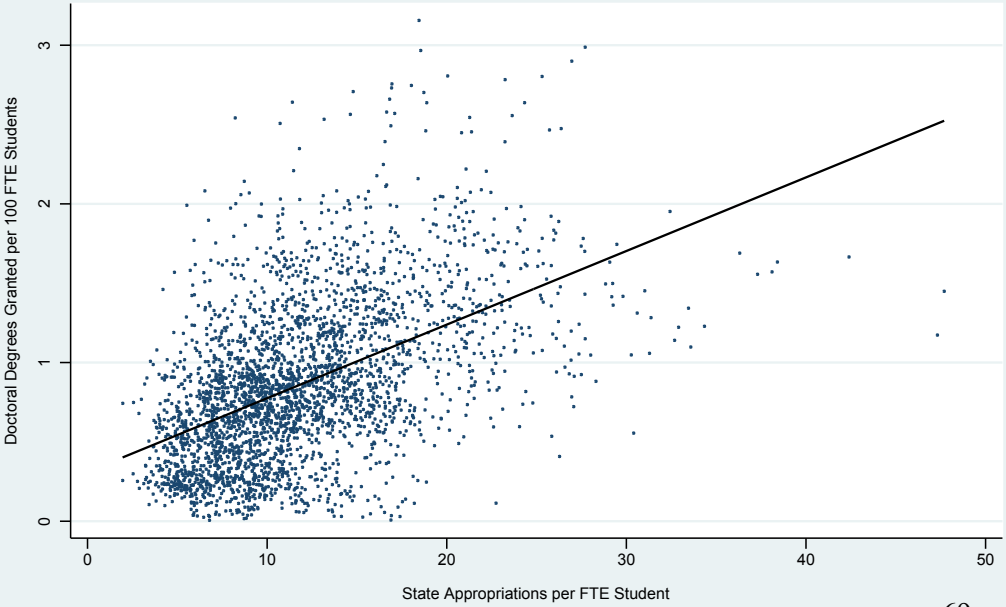
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 118 doctoral institutions for 1987-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 4G. State Appropriations vs. Public Service Expenditures
(Doctoral Institutions, 1987-2012)



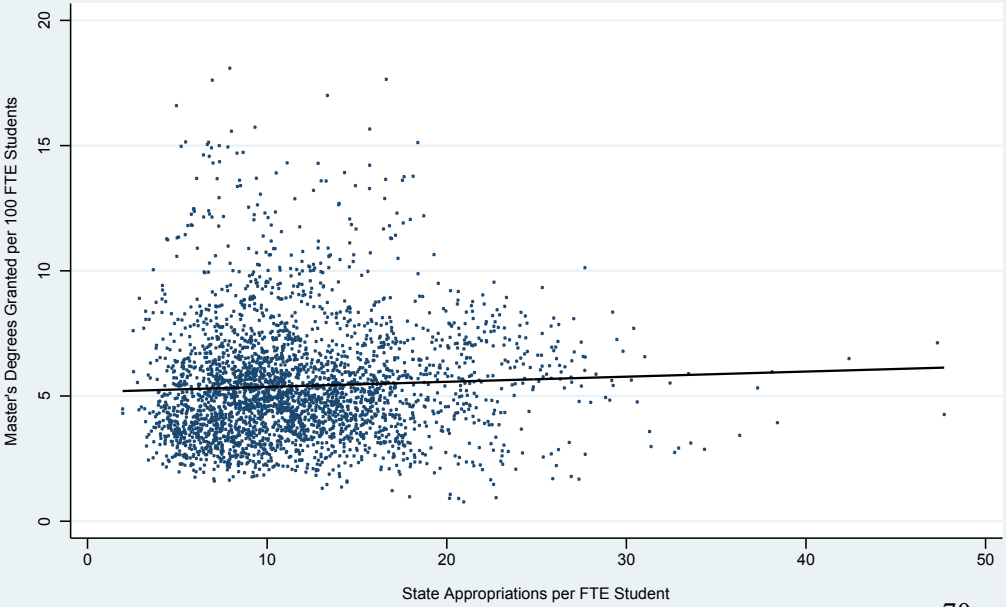
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 118 doctoral institutions for 1987-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 5A. State Appropriations vs. Doctoral Degrees Granted
(Doctoral Institutions, 1987-2012)



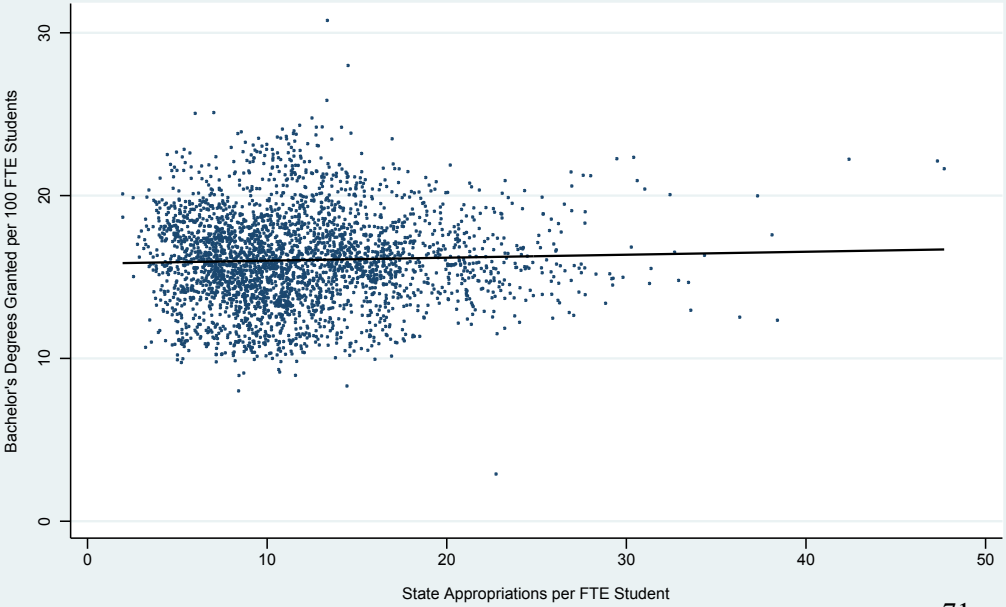
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 120 doctoral institutions for 1987-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 5B. State Appropriations vs. Master's Degrees Granted (Doctoral Institutions, 1987-2012)



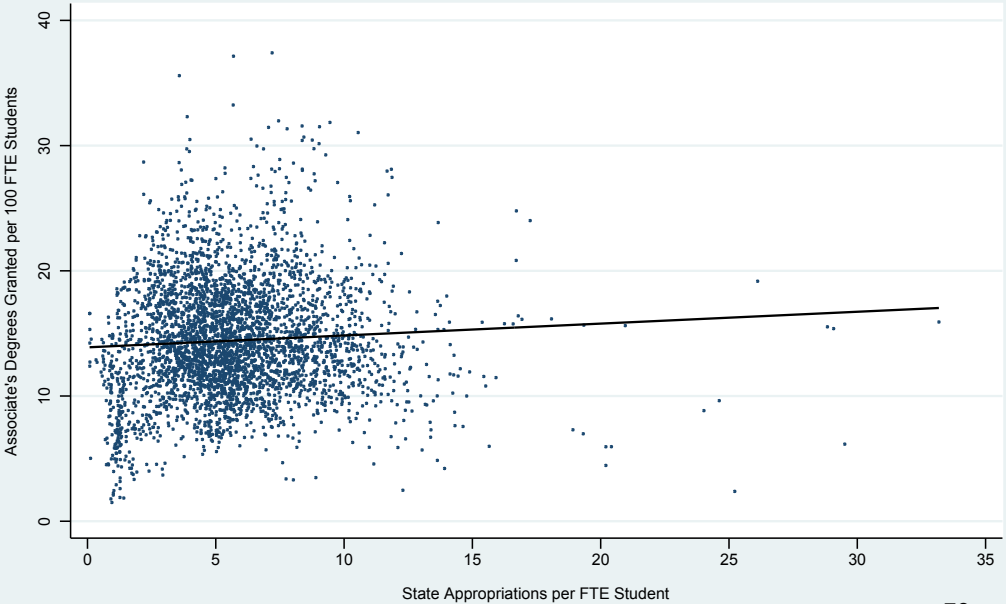
Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 120 doctoral institutions for 1987-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 5C. State Appropriations vs. Bachelor's Degrees Granted
(Doctoral Institutions, 1987-2012)



Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 120 doctoral institutions for 1987-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.

Appendix Figure 5D. State Appropriations vs. Associate's Degrees Granted (Associate's Institutions, 1987-2012)



Source: IPEDS Delta Cost Project.
Note: The figure is based on the data of 145 public associate's institutions for 1987-2012. The straight line is generated from a univariate regression. All monetary variables are in thousands of 2012 dollars.