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The Cost of Public Higher Education in America: What Has Happened and Why

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Abstract

The issue of student debt and the cost of college has received a great deal of attention over the past few years. Media outlets, think tanks, and policy watchdogs advance various explanations for the increasing cost of higher education—pointing to cuts in state appropriations, expansion of programs and services, demographic changes, larger administrations, higher salaries, demand for better amenities, and other factors as drivers of higher tuition and fees. Despite the outcry, however, the question of what causes tuition inflation has received little recent attention in the empirical literature. This paper thus embarks on an agenda to answer this question. The paper presents the two competing theories prominent in the literature (cost disease and revenue theory), in addition to several alternative explanations, in an effort to develop an appropriate market framework to support analysis. The paper explores the framework's propositions using data for public research universities.

Introduction

The financial burden of American higher education is a vexing concern for modern society. For at least four decades, scholars have contemplated why students must pay such high tuition and fees, and why colleges and universities spend so much (Baumol and Bowen, 1966; Bowen, 1980; Baumol, 1993, 1996, 2012; Clotfelter, 1996; Getz and Siegfried, 1991; Ehrenberg, 2002; Archbald and Feldman, 2010). In recent years, the news media and policy watchdogs have sounded the alarm that college prices are spiraling upwards, having outpaced inflation since the early 1990s, and affordable access to college has been important issue in political campaigns (Matthews, 2013). Scholars, policymakers, and journalists alike have advanced many alternative explanations for increasing costs, yet little empirical work is available to resolve the persistent question of why college costs are so high and rising relative to the prices of other services.

Our research objective is to examine systematically and empirically various explanations for the rising cost of college. This paper contributes to the literature on the cost of higher education by marshaling the relevant literature to distill into an intuitive framework that leads to a series of formal hypotheses, and by offering some initial tests of these hypotheses using a cost and price functions to estimate the relationship between costs and important characteristics of universities. Understanding this relationship is important for policymakers seeking to curb costs to students, universities seeking to understand students' choices and allocate resources efficiently, and students seeking to evaluate the return on their investment in education.

For this analysis, we focus on costs from two perspectives—the costs to the institution and costs to the students. This is an important distinction to clarify, because the public debate is somewhat muddled in its focus. The media and policymakers tend to focus on the price or costs to the students—tuition and fees—while most of the academic scholarship focuses on institutional costs. When academic studies examine the question of why tuition and fees are rising, they focus on the well-known Bennett hypothesis that attributes rising tuition to the availability of government financial aid. Certainly, institutional costs influence the tuition and fees universities charge, so our framework starts with this basic relationship to test the specific influences of each of the competing theories in the literature.

The dominant theories are the cost disease (Baumol and Bowen, 1966; Baumol, 2012) and revenue theories (Bowen, 1980), but other prominent theories include the "Bennett hypothesis regarding the cost impact of federal financial aid" (Bennett, 1980), and that declining state support in higher education is being replaced by tuition revenues (Webber, 2017). Getz and Siegfried (1991) identified four additional potential explanations: shift in demand for the mix of educational services (e.g., changes in programs or amenities); rent-seeking behavior on the part of administrators and faculty; poor and inefficient management by administrators; and the cost impact of government regulations. We test each of these hypotheses.

To headline our results, we find no evidence in support of the cost disease theory, but we do find evidence in support of the revenue theory. In terms of our tuition hypotheses (i.e., costs to the student), we find strong support for the state divestment hypothesis, but pass-through effects that are smaller than found in the literature. We find mixed support for the Bennett hypothesis; we do not find that federal or state aid leads to tuition increase, but we do find that more loans do lead to tuition and fee increases.

These mixed findings underscore the variety and complexity of higher education institutions, their revenue sources, and the choices they make, and argue for closer analyses of costs and spending by organization type. Increasing transparency about the higher education market requires understanding how colleges and universities are similar and different. Thus, we limit our initial analysis to public research universities (doctoral universities under the Carnegie classification) using data from 2001-2018 publicly available from the National Center for Education Statistics's (NCES) Integrated Postsecondary Education Data System (IPEDS).

In the following sections, we review the relevant trends, discuss the various explanations of college costs further, describe our empirical strategy, data, and methods, present and interpret our estimation results, and conclude with next steps for this research agenda.

Policy Context

According to the 2018 *Digest of Education Statistics* from the NCES (Snyder, de Brey, and Dillow, 2019), which is the most recent data available, U.S. expenditures of all degree-granting postsecondary institutions totaled roughly $608 billion for the 2017-2018 academic year. These institutions enrolled 20 million students and employed some 1.5 million faculty and two million other staff. The public degree-granting institutions comprise the majority of these students (72 percent), faculty (65 percent), and staff (52 percent). At these public institutions, average real total expenditures per student were $35,900 (in 2018 dollars), while annual inflation-adjusted prices for undergraduate tuition, fees, room, and board were $17,800, covering only half of the average institutional costs. According to the *Digest*, real institutional spending increased 20 percent since 2010, while real costs to the student increased 31 percent over the past decade, prompting the question: What has happened to costs at public higher education institutions over time and why?

The term "cost" is employed in various ways in discussions of higher education. The media tend to focus on cost from the perspective of consumers, in terms of the prices students pay to attend college. College costs from this perspective typically is considered to comprise tuition and fees, though there are many other things students pay for beyond what is covered by tuition and fees, such as room and board, books and supplies, incidental expenses, and transportation. Thus, the total cost of attendance ($24,300 for public institutions in 2018) far exceeds tuition and fees alone (average about $9,000). These expenses are offset by numerous financial aid awards (grants, scholarships, and loans), and tax credits and deductions, so the cost to the student is appropriately characterized in net terms.

From the producer perspective, costs are the expenses that higher education institutions incur to provide instruction and other services, including research, public service, athletic programs, creative performances, and myriad other activities. While a third of these costs are instructional expenses (about $12,000 per student), and 10 percent each (about $4,000) for research, academic support, and institutional support, much of the debate around the cost of higher education turns on whether institutions spend resources appropriately and wisely, or whether they engage in rent seeking, and charge tuition in excess of what is necessary to educate students.

With these perspectives in mind, several organizations offer detailed descriptive data about cost trends in higher education. Notably, the College Board tracks costs using the IPEDS annual survey data and releases annual reports, most recently *Trends in College Pricing 2018*. According to this report, published in-state inflation-adjusted undergraduate tuition and fees at public four-year institutions rose more in real terms since 2009—up $270 per year—compared to $170 per year from 1989 to 1999 and $250 per year from 2000 to 2009. The bill for tuition, fees, room, and board is $21,400 for an in-state undergraduate student at a public four-year school today, up from $12,000 twenty years ago, a 78 percent increase (3.9 percent per year). At the same time, the report shows that students now receive federal aid (grants, tax credits, and deductions) that cover approximately a third of the costs of tuition, fees, room, and board, where such aid twenty years ago covered a quarter of these costs. Tuition and fees certainly have increased over the past couple of decades, and so has federal aid. Has federal financial aid made tuition and fees cheaper to the student, as intended, or has such aid been captured by the institutions through higher tuition rates, as suggested by Secretary Bennett?

The College Board reports that expenditures per student at public four-year institutions increased in real terms by 17 percent from 2005-06 to 2015-16 at the same time as undergraduate and graduate enrollments have grown and the student-faculty ratio has remained relatively stable. The College Board also reports trends in state and local funding for higher education. Overall, the report reveals that per student appropriations have fallen 11 percent in the last three decades, and notes that the biggest increases in tuition and fees at public universities occurs when state and local appropriation support declines.

When one seeks to explain cost changes over time, one must address how much is simply due to inflation. Indeed, public and media commentary on this topic often point to the rising costs of college by comparing total expenditure growth to a general price index such as the Consumer Price Index (CPI). Comparing costs that universities face with the costs that consumers face assumes that have a similar market basket of goods. A proper way to control for higher education cost inflation is to use the Higher Education Price Index (HEPI) published annually by the Commonfund organization. While the CPI's market basket includes consumer goods (e.g., televisions, computers, cell phones, household utilities, medical care, car insurance) in its market basket approach, the HEPI's market basket includes salaries and fringe benefits for faculty and staff, research equipment, supplies and materials, and utilities. While the CPI increased by 42 percent from 2001 to 2018, the HEPI increased by 62 percent, providing an initial explanation for increasing college costs; the prices that colleges and universities paid for goods and services increased 50 percent faster than the prices paid by typical consumers.[1] The purchases of research equipment, for example, are unique to research universities, and increasing fringe benefit costs that are often borne by public universities are a substantial problem in some states (e.g., Connecticut), where fringe benefit cost can exceed 50 percent of total salary costs.

A cursory analysis of our data shows that while our baseline cost model explains about 52 percent of the variation in nominal total expenditures, when we add the HEPI index to the cost model, it explains 82 percent of the variation in spending. Thus, we estimate that input price inflation in the higher education market explains about a third of the variation in nominal spending across institutions. The important policy question, however, is why did inflation-adjusted spending and tuition and fees rise in higher education?

The reason why it has been so difficult to answer the question of why college costs so much is that so many factors are in play. Colleges and universities vary broadly in size, mission, classification, and sector, but much of the criticism is reserved for well-known private colleges and large public universities. Community colleges rarely draw criticism for being costly as they are the lowest cost option for college. In his 10-part series for the Washington Post entitled, "The Tuition is Too Damn High," Dylan Matthews (2013) highlighted the vast differences in enrollment, tuition growth, and expenditures among colleges and universities. In Part 3, he showed that while net tuition revenue increased regardless of college type, state support and gift revenue declined for community colleges, public research universities, and liberal arts colleges. Only community colleges decreased their overall spending.

Chaney and Farris (1990) surveyed college and university chief financial officers in 1980s, and found that insurance, government regulations, libraries, and scientific and computing

[1] See Table A in Commonfund's Higher Education Price Index 2018 Update comparing the CPI with HEPI: https://www.commonfund.org/wp-content/uploads/2018/12/2018-HEPI-Report.pdf.

equipment and facilities were areas with the fastest growing costs. More recently, Gallup and Inside Higher Ed (2015) surveyed college and university chief financial officers and 61 percent said their institution has recently or will soon change its budget model, suggesting a strong need to rethink college finance in a wholesale fashion. To meet financial challenges today, these business officers are most likely to employ strategies of increasing overall enrollment (82 percent) and launching new revenue-generating academic programs (70 percent).

Our present study focuses on a sample of 153 public four-year doctoral research institutions defined by the Carnegie classification system.[2] Using IPEDS data on these institutions, Figure 1 shows that total revenue per student has increased in nominal terms over the past 18 years (from 2001 - 2018), suggesting to the casual observer that the sticker price of going to college has increased by 44 percent, from roughly $25,000 to $36,000 per student. However, after controlling for higher education inflation, real revenue (in 2018 dollars) has been relatively flat, growing 7.7 percent over the entire two decade-long period. A sharp decline is shown following the 2007 crisis, but revenues recovered quickly to previous levels by 2011. At the same time, total expenditures per student have doubled in nominal terms from $21,000 per student in 2001 to $44,000 per student in 2018. However, in real terms, expenditures have increased by 24 percent, or 1.5 percent per year. Moreover, the apparent surpluses made prior to the crisis where real revenues regularly exceeded real expenditures, disappeared after the crisis, suggesting that public research institutions dipped into financial reserves to increase real spending after the crisis. In what areas did they spend these additional resources?

{Figure 1 about here}

[2] The population of public research universities in the IPEDS data was 196, based on those defined as having "moderate," "high," and "very high" research activity.

Let's look at revenues first. Figure 2 shows trends in real revenues by source over the same period. Most dramatically, real state appropriations fell by 35 percent from 2001 to 2017, from nearly $13,000 per student to $8,000. This decline preceded the economic crisis, and accelerated thereafter before leveling off in 2013. At the same time, real tuition and fees rose by 38 percent from $7,700 per student to $10,700. The relatively flat trend in real total revenues in Figure 1 masks the apparent replacement of tuition and fees for state appropriations as the second most important revenue source shown in Figure 2. State appropriations share of total revenue was cut in half over the past two decades, from 40 percent in 2001 to 21 percent in 2018, while tuition and fees share of total revenue went up from 24 percent in 2001 to 27 percent in 2018. Notably, the "other revenue" category is the largest source of revenue by far, suggesting how important housing, dining, and auxiliary revenues are to public research universities, among revenue from other sources such as research grants. It is a fascinating feature that public research universities' auxiliary businesses are a primary source of revenue that subsidizes its core instructional activity. A strong allocative efficiency argument can be made for closely linking tuition to instructional expenses only, and linking fees to the amenities they often support (e.g., housing, dining, athletics, and student activities), but our data show that average tuition and fees per student for public research universities cover only 75 percent of instructional costs.

{Figure 2 about here}

To explore the trends in spending, Figure 3 shows real expenditures per student by category. That real expenditures on instruction has increased only 3 percent over the 18-year period masks the decline from 2002 to 2007 (minus 4 percent) and strong increase from 2007 to 2015 (plus 20 percent) before declining again from 2015 to 2018 (minus 3 percent). On average, real instructional spending is twice research spending per student, and has decreased by 10 percent over the same time span, just as spending on public service activities decreased by 7 percent. Spending on all other categories increased: academic support (e.g., libraries, media services, academic administration, and technology) increased by 13 percent; student services (e.g., admissions, registrar, and intellectual, cultural, and social student activities) increased by 31 percent; and institutional support (e.g., day-to-day operational and administrative activities) increased by 22 percent. Student service costs have increased by more than any other category, suggesting that the demand for amenities is an important explanatory factor in explaining cost growth. However, increases in real expenditures in instruction and research that occurred after the crisis suggests that public research universities made significant program investments to replace lost revenues.

{Figure 3 about here}

From the student's perspective, tuition and fees rose by more at public research universities over the last two decades (47 percent) than public institutions generally (38 percent). However, this pattern is also true from the institutional perspective, where expenditures also rose faster at public research universities (31 percent) than public institutions generally (23 percent). Explanations for these trends require a focus on both perspectives. After the next section, where we survey the proposed explanations in the literature, we present our strategy for testing these hypotheses.

Related Literature

The debate over what drives up costs in higher education may have been instigated in 1966 when William Baumol and William Bowen published a book that explains cost pressures as a result of productivity lags in the performing arts. Essentially, their argument was that certain sectors of the economy that depend on high-wage, labor-intensive creative inputs cannot be automated, standardized, or made more efficient by capital. In the higher education context, the application of their argument is that since students are not standard, teaching them cannot be standardized and unit costs cannot be reduced by technology. This creates cost pressures, especially when cost control has detrimental effects on productivity and quality, as it would in higher education if faculty were simply assigned more students to teach.

This notion, known as "cost disease" may explain why labor prices rise faster than overall inflation in certain sectors of the economy. As Archibald and Feldman (2008) explain: Cost disease exists when costs rise more rapidly in low-productivity-growth industries (especially those with high wages) than in high-productivity-growth industries. Three decades after their 1966 book, Baumol and Bowen (1993, 1996) explored this idea in the healthcare and education sectors where they identified salary increases without concomitant labor productivity increases because these sectors must compete for employees with other sectors where salaries have increased as a result of productivity gains. Since, the argument goes, higher education is labor-intensive and cannot be engineered to perform faster or more efficiently, labor productivity has not changed over time. Salaries for faculty have to keep up with salaries in the economy as a whole if universities are going to retain them, even though faculty are not any more productive.

A related but somewhat different view, termed capital-skill complementarity, suggests instead that capital expenditures (especially technology investments) increase as the use of skilled labor increases. Archibald and Feldman (2010, 2008a, 2008b) argue that, in the education context, this suggests growth in faculty would be accompanied by greater use of technology, or by demand for fancier laboratories and equipment. Thus, expenditures on equipment and technology go up as the value of labor goes up.

A second dominate perspective on increasing costs in higher education is known as the revenue theory of costs, first advanced by Howard Bowen. Bowen (1980) explained increasing costs in higher education by asserting that higher education institutions raise all they can and spend all they have in the pursuit of quality and prestige, so expenditures increase as revenues do and thus costs spiral upward as institutions engage in something of an arms race. Ehrenberg (2002) describes this as a “winner-take-all” situation, particularly prevalent among selective private institutions that “aggressively seek out all possible resources and put them to use funding things they think will make them better,” rather than improving efficiency or cutting costs. Brinkman (1990) suggests that while there may be some truth to the theory, it is not literally true that institutions raise and spend all they can, or institutions would raise tuition by more than they do and never generate reserves.

Archibald and Feldman (2008a) test these two dominant competing frameworks by examining cross-sectional data about the relative rates of price increases across a variety of goods and services. They conclude that cost per student in education behaves much as costs in other personal services industries that rely on highly skilled labor do, thus supporting the notion that Baumol and Bowen’s cost disease explains costs in higher education. Martin and Hill (2014) also examine the question of which theory contributes more to increasing costs empirically. Using cost models for research universities, they find both effects are present, but that the relative size of the effects depends on how stringent revenue constraints are. Bowen (revenue theory) effects are larger than the Baumol (cost disease) effects under looser constraints.

Getz and Siegfried (1991) point out that if the higher education market is competitive, then they must meet the market test of satisfying their customers. If students demand fancier residential living or recreational amenities, then a competitive university would provide them. If students demand for academic programs shift with the economy, and these programs are more expensive to deliver, then universities will likely find themselves spending more to accommodate this demand. Our data for public research universities show that in 2001, the ratio of degrees conferred in STEM subjects (i.e., science, technology, engineering, and mathematics) to those in liberal arts and humanities was 2.1, while the same ratio in 2017 is 3.7.

Related to this, institutions may use price as a signal of reputation, though whether consumers equate price and quality is unclear. Consumers are uncertain about quality, so rely on price as a proxy and a signal of reputation. Reputation-based competition causes colleges to spend more (on sports facilities, research labs, faculty salaries, and so forth), so tuition increases beyond cost increases because of reputation-enhancing expenditures (Getz and Siegfried, 1991). This circumstance is exacerbated by pressure from published rankings. Institutions invest in things that will improve their *U.S. News* rankings, which correlate poorly with increases in productivity. In addition, rankings are based partially on per-student spending, thus creating pressure to increase spending. Regardless of why institutions spend all the revenue they raise, under the revenue theory of costs, the path to controlling costs must be through controlling revenues, since institutions determine costs based on how much they raise (Archibald and Feldman, 2008a).

Another explanation advanced for increasing tuition costs is that colleges and universities are simply making up for losses in state appropriations. The College Board (2017) does not attempt to assess the causes of increasing education prices, but does indicate that prices at public institutions rise fastest when state support is declining or growing only slowly. As states cut higher education funding, schools make up for lost resources by increasing tuition, so basically consumer costs are shifted from government (taxpayers) to students, even as institutional costs are unchanged. Webber (2017) finds support for this "divestment" hypothesis, finding an increasing "pass-through rate" (i.e., tuition increase divided by appropriation decrease) across time. In some sectors, this may occur at the same time as per-student spending is also cut. Similarly, federal research funding is ever scarcer, even as the cost to do research is rising.

Alternatively, tuition may be driven up by increasing financial aid. Secretary of Education William Bennett argued in a 1987 *New York Times* opinion piece entitled "Our Greedy Colleges" that student aid raises tuition because institutions expect loan subsidies to cushion the blow of increased tuition. As a result, he argues, federal financial aid does not make college more affordable, but instead allows colleges to raise tuition. At the same time, the value of the Basic Educational Opportunity grant has not kept pace with inflation, and so universities make up the difference with institutional financial aid (Ehrenberg, 2002). Archibald and Feldman (2016) develop a theoretical model of enrollment management to explore Bennett's claim. They conclude that nonprofit colleges are unlikely to inflate tuition in response to federal aid, though they may redirect institutionally provided aid to other purposes. Others (see, for example, Cellini and Goldin, 2014; Singell and Stone, 2007; Cunningham et.al., 2001; McPherson and Schapiro, 1991) have examined the Bennett hypothesis but without conclusive results, though Archibald and Feldman (2016) conclude that at least at state universities, federal aid is not taxed and does in fact get to students, while private institutions that offer the most aid themselves also tax it the most. Gillen (2016) disputes the appropriateness of Archibald and Feldman's analytic framework, and concludes that Bowen's revenue theory of costs (which he describes in detail in Gillen, 2012) better explains the mixed evidence related to the Bennett hypothesis.

It is possible that rising costs are fundamentally a result of poor management and inefficiency, which can take various forms. Technical inefficiency is one form where inputs are not minimized to a given level of outputs (or outputs not maximized to a given level of inputs). Faculty inefficiency, which Massy and Zemsky (1994) call the "academic ratchet," arises when faculty shed duties they prefer less, such as teaching and advising, in favor of their own personal and professional goals, such as conducting research. In the worst case, they substitute other valuable activities (such as research), but the suspicion is that they simply work less, as evidenced at least anecdotally by the perception of low teaching loads among tenured faculty. As Ehrenberg (2002) notes, shared governance may be a contributor here because faculty and trustees are slow to react to cost pressures. Faculty have a formal role in shared governance that gives them decision-making power, but they are experts in their respective disciplines, not experts on administration and fiscal management. Trustees, who have fiduciary responsibility and often come from the business world, understand the principals of fiscal management, but not the special nuances of academic scholarship, research, and pedagogy, so their ability to make sound judgments about resource allocation is curbed.

Administrative inefficiency, commonly termed "overhead" or "bloat," is a form of bureaucratic inefficiency within the workforce, whereby administrators hire staff to handle work they would otherwise do themselves. Massey and Wilger (1992) term this the "administrative lattice," explaining that the size of the non-faculty workforce grows to support the wide array of services and activities universities provide. Alternatively, Ehrenberg argues that while senior administrators, like deans, are “at will” employees, it is difficult to remove them if they have faculty and alumni support. Deans who act in ways that favor their schools and colleges over the larger university interests tend to garner local support from their faculty, staff, students, and alumni that is hard to overcome.

Some do argue, however, that growing staffs result from increased compliance requirements (Kirwan and Zeppo, 2015; Higher Education Compliance Alliance). Government regulations (from Title IX to environmental regulations, historical districts, building codes, labor law and collective bargaining) are hard for universities to avoid, since they are immobile. Compliance burdens accumulate from many quarters. State boards for higher education (governing boards and coordinating boards), often established under the guise of increasing efficiency, also exert control and oversight that make them labor-intensive in their own right and may not produce the desired efficiency gains at the institutions whose operations they oversee (Anderson et. al., 1990).

Finally, tuition prices may be increasing because of consumer demand for amenities—that is, students and their families expect high quality services, from state-of-the-art facilities and technology, to innovative course offerings, to modern instructional technology, to premium residential accommodations and health services, to research opportunities, and universities compete to meet these expectations. Koshal and Koshal (1998) show the impacts of both supply and demand factors using a simultaneous equations model, suggesting that supply factors include average costs and institutional level and sector, while demand factors include signals of quality such as average student SATs and the share of faculty with a PhD. While it may seem odd that these metrics would attract prospective student attention, they do feature prominently in the annual *US News Rankings of Best Colleges*.

Ultimately, the literature on the cost of higher education leaves us with a conundrum: There is public outcry about the cost of college education, but society and academia both lack clarity about what is actually happening to costs and why. This confusion stems in part from differing views of what we mean when we say colleges are costly. Is it the costs institutions face or prices (tuition and fees) students face? If both, what is the relationship between cost and price? Specifically, are rising costs driving high tuition rates? Alternatively, is it other things people have hypothesized, as presented above? Do these factors influence tuition directly, or through costs? As this brief review reveals, the literature on the cost of higher education suggests a series of competing explanations about why higher education costs are rising, yet most of the literature is conceptual, supported only by descriptive trend data. There are few attempts to test hypotheses derived from these frameworks. Martin and Hill (2014) formally examine the two dominant hypotheses, but no one addresses the broader range of proposed explanations. Our objective is to tackle this gap systematically for public doctoral institutions. In the next section, we present our empirical approach to examining these questions. Specifically, we formalize a set of hypotheses, explain how we test them, and describe our data.

Empirical strategy, hypotheses, and data

The foregoing discussion raises a broad range of potential explanations for the increasing costs of college. Those who support the cost disease theory as the main driver point to a structural problem in higher education (Baumol and Bowen, 1966; Baumol, 1993, 1996, 2012; Archibald and Feldman, 2008a, 2008b, 2010, 2016), and those who support the revenue theory as the best explanation point to the behavioral problems of administrators and faculties (Bowen, 1980; Ehrenberg, 2002; Marin and Hill, 2014). The other alternative theories can be thought of as nuanced versions of such structural (e.g., state divestment, amenities) or behavioral (e.g., Bennett, academic rachet, administrative bloat) explanations.

Understanding the market structure of higher education is key to understanding the structural aspects of higher education costs. Primarily, public research universities compete for students, faculty, and research grants. On the one hand, demand and supply factors help explain structural factors that increase the costs of higher education. Demand factors include strong demand for a college education and amenities, which drive up tuition and fee rates. Supply factors include faculty, their salaries, and the institutional support to their research. Are colleges responding to high demand for services and amenities, or are they locked into technological investments to enhance the productivity of its faculty? Explanations of this sort suggest a policy response aimed at taming market forces.

On the other hand, behavioral explanations tell a more cynical story that highlight perverse incentives gone awry that drive the decisions of administrators and faculties. Such theories as the revenue and ratchet theories fall into this category, with various forms of rent seeking as a driving motivation. Do such theories leave room for structural explanations, or is our challenge a matter of improving accountability and governance?

Many would agree that universities are complex organizations with multiple missions, and it is likely that plenty of room exists for both structural and behavioral explanations. Our empirical strategy builds a unified framework within which to test hypotheses related to both types of explanations.

Empirical strategy

We develop a model of higher education costs that allow us to directly answer questions about the costs of higher education. Fortunately, a well-developed literature in higher education costs exists to guide us (Verry and Layard, 1975; Cohn et al, 1989; de Groot et al, 1991; Koshal and Koshal, 1999). This literature focuses on the challenges of studying institutions as complex multi-product firms producing teaching and research outputs. Due to the methodological limitations of working with multiple outputs as dependent variables in a production function framework, our approach exploits the duality of production and cost functions and studies the structure of higher education production using cost functions.

Archibald and Feldman (2008a) argue that a cost function approach that incorrectly assumes cost minimization captures only behavior, and not technology, and thus leaves room for support of both cost disease and revenue theories. We agree with the need to address the assumption of cost minimization, but we also believe that both structural and behavioral explanations can co-exist. It is likely that multiple explanations apply to explain college costs, and we proceed on this assumption. Our solution to the cost minimization assumption is to apply a public sector cost model (Bradford et al, 1969) to public higher education, and incorporate a measure of efficiency into the cost function, allowing us to interpret estimated coefficients assuming cost minimization, and distinguish between structural and behavioral effects. This approach has been implemented for primary and secondary schools by Duncombe et al (1996), Ruggiero (1996), Duncombe and Yinger (2007, 2011), and by Robst (2001) for higher education.

We start with the basic budget constraint institutions face where revenues (R) are equal to expenditures (C).[3] On the revenue side, we distinguish tuition and fee revenue (TF) from those

[3] This conceptual starting point allows for revenues to exceed or fall short of expenditures, with the difference simply adding to or subtracting from the fund balance of the institution.

gained from state appropriations (SA), other revenue sources (OR), and federal and state financial aid (GAID). On the expenditure side, we distinguish "custodial costs" (CC)[4] from expenditures designed to enhance academic quality (AQ), amenities (AM), and institutional aid (IAID). Substituting these elements into our basic equality, *R = C*, provides our conceptual starting point:

$$TF + SA + OR + GAID = CC + AQ + AM + IAID \qquad [1]$$

To examine the determinants of college costs from the institutional perspective, we focus on the right-hand side of equation 1 and estimate the following cost equation assuming a standard Cobb-Douglas production framework, where C is the average cost per student to the institution:[5]

$$C = a_0 \prod_{i=1}^{4} CC^{a_i} AQ^{\alpha_5} AM^{\alpha_6} IAID^{\alpha_7} \qquad [2]$$

Custodial costs (CC) represent four core elements of a cost function, such as outputs (α_1), inputs (α_2), the price of inputs (α_3), and efficiency (α_4). Outputs include bachelor and graduate degrees, and research and public service expenditures. Inputs include students and faculty, and the price of inputs is the average faculty salary (for all ranks). Organizational efficiency is

[4] Epple et al (2003) define custodial costs as distinct from the quality components of institutional expenditures. For them, custodial costs include only those related to the size of the student body.
[5] We do not know the shape of the public research university production function, so we chose the Cobb-Douglas model for its flexibility in estimation and ease of interpreting the coefficients as elasticities.

measured by dividing total number of degrees by total employees, and taking the ratio of this value (for each institution) to the maximum value in the data.

The academic quality-enhancing component of costs (AQ) includes expenditures that directly support student success, such expenditures for instruction, academic support, and scholarship support. Amenities (AM) are the institutional reputation-enhancing component of costs, and include expenditures for institutional support and students services. Institutional aid (IAID) represents financial aid provided to the student by the institution.

With the exception of the enrollment and efficiency measures, we expect the estimated cost coefficients to suggest a positive relationship between the cost elements and spending per student (α_1 through α_7). With enrollment, we expect a negative relationship to reflect economies of scale, and a positive relationship with enrollment squared to reflect diseconomies of scale. Our measure of efficiency should have a negative sign reflecting the cost saving benefits of efficiency.

To examine the determinants of college costs from the student's perspective, we isolate tuition and fees (TF) in equation 1, and again assuming a Cobb-Douglas production framework to estimate the following tuition and fee equation:

$$TF = \beta_0 \prod_{j=1}^{7} C^{\beta_j} SA^{-\beta_8} OR^{-\beta_9} GAID^{-\beta_{10}} \qquad [3]$$

Costs, C, in equation 3 include the seven cost factors from equation 2. State appropriations (SA) represent the level of state support to the institution per student, other revenues (OR) represent all other revenues except tuition and fees and state appropriations, and GAID represent the grant and loan aid provided by the federal and state governments to students.

Equation 3 implies that the cost of college to the student –her net tuition and fees (TF)—is equal to, on a per student basis, the institutional cost minus the revenues from other sources, including government aid to students.

In general, we expect the estimated cost coefficients to suggest a positive relationship between cost elements (β_1 through β_7) reflecting increases in marginal costs, and the estimated revenue coefficients (β_8 through β_{10}) to reflect a tradeoff, or a negative relationship between costs and alternative revenue sources. However, support for the revenue and Bennett hypotheses require that alternative revenue sources and federal aid, respectively, have a positive relationship with tuition and fees, reflecting their impact on marginal tuition and fee revenue.

To estimate the cost equation (2), we follow the cost function literature and use a flexible double log functional form, a fixed effects model, and total expenditures per student (C) as the dependent variable to estimate the key parameters, α_i, μ_i measuring the institutional fixed effect, and ε_i capturing the random error. The price variable (average faculty salaries) will be treated as endogenous, and instrumented by the associated state's median household income.[6] The estimated parameters, α_i, are the estimated marginal cost of production (α_1) and the marginal cost of adding a given input (α_2 to α_7). The estimated fixed effects are for research class (ρ_i), state (σ_i), time (τ_i), and the university (υ_i), and ε_{it} is the random error term.

$$lnC_{it} = \alpha_0 + \alpha_1 lnO_{it} + \alpha_2 lnI_{it} + \alpha_3 lnP_{it} + \alpha_4 lnE_{it} + \alpha_5 lnAQ_{it} + \alpha_6 lnAM_{it} + \alpha_7 lnIAID_{it}$$

$$+ \rho_i + \sigma_i + \tau_i + \upsilon_i + \varepsilon_{it} \qquad [4]$$

[6] Endogeneity tests were run for the outcome and price variables, and while we could not reject the null hypothesis that the outcomes are exogenous, we were able to do so with the price variable. To measure outcomes, we added bachelors and graduate degrees into a "degrees" variable, and for the instrumental variable we used the average reading SAT scores for the state in which the institution resides. We use average faculty 9-month equivalent salaries to measure price, with the median household income of the institution's state as its instrumental variable.

To estimate the tuition and fee equation (3), we use a similar double log and fixed effects framework. The key parameters are β_i, the estimated fixed effects are for research class (ρ_i), state (σ_i), time (τ_i), and the university (υ_i), and ω_{it} is the random error. We will treat the custodial cost factors as exogenous.[7] The estimated parameters, β_i, are the estimated marginal tuition and fee revenue impacts of the various cost and revenue factors.

$$lnTF_{it} = \beta_0 + \beta_k \sum_{k=1}^{4} CC_{it} + \beta_5 lnAQ_{it} + \beta_6 lnAM_{it} + \beta_7 lnIAID_{it} - \beta_8 SA_{it} - \beta_9 lnOR_{it}$$

$$\beta_{10} lnGAID + \rho_i + \sigma_i + \tau_i + \upsilon_i + \omega_{it} \qquad [5]$$

Some of the hypotheses we summarized above are statements about the impacts on institutional costs, and some are about the impacts on the prices students face—tuition and fees. We will test the cost hypotheses using equation 4, and test the tuition hypotheses using equation 5. In each case, we test all hypotheses within a unified equation so that the hypotheses are competing with one another.

Baumol's cost disease/productivity lag

H_1: Faculty salaries rise faster than does their instructional productivity.

This hypothesis synthesizes Baumol's cost disease theory, which argues that a productivity lag exists in higher education because institutions have not made teaching more efficient through technology, as is true in the development of most industries. Evidence in support of this cost hypothesis requires that the marginal costs of faculty increase over time while the marginal productivity of faculty falls. Incidentally, universities probably create cost

[7] An endogeneity test was also run for the input price variable in the tuition and fee model, but here we could not reject the null hypothesis that the average faculty 9-month equivalent salaries were exogenous. As with the cost model, we used the median household income of the institution's state as its instrumental variable.

disease by holding student-faculty ratios down. To observe this phenomenon, we add a student-faculty ratio measure to see how our marginal cost effects change over time.

<u>Bowen's revenue theory/reputation-seeking</u>

> *H_2: More revenues induce more spending, and agency rents are taken through reduced productivity.*

This hypothesis synthesizes Bowen's revenue theory, which suggests that universities spend all the revenues they can obtain and take agency rents (where prices exceed costs) in the form of increased institutional spending and reduced productivity. Evidence in support of this cost hypothesis requires that the marginal cost of generating revenue is positive and increasing over time, and that our measure of marginal productivity of faculty declines over time.

<u>State divestment/revenue replacement</u>

> *H_3: Tuition & fees increase as a result of reduced state appropriations.*

This hypothesis contents that state divestment leads institutions to replace these lost state revenues with tuition and fees paid by students. Evidence in support of this tuition hypothesis requires that the marginal revenue coefficient for state appropriations (β_8) is negative and increasing over time.

<u>Bennett Hypothesis</u>

> *H_4: Tuition increases as a result of increasing federal and/or state financial aid.*

This hypothesis is based on former U.S. Education Secretary William Bennett's contention that the financial support provided by the federal government inflates the price of a college education, allowing institutions to charge more than they would otherwise. Support for this tuition hypothesis requires that the marginal revenue coefficients for federal and state aid and federal subsidized and unsubsidized loans (β_{10}) are positive and increasing over time.

Faculty ratchet

H_5: Faculty instructional and advising productivity falls over time.

This hypothesis captures the notion of the academic ratchet. Evidence in support of this cost hypothesis requires that, holding faculty FTE constant, the marginal productivity of faculty falls over time.

Administrative bloat

H_6: Holding administrator FTEs constant, staff FTEs increase as productivity is constant or falls.

This hypothesis might be described as an administrative form of the academic ratchet. Evidence in support of this cost hypothesis requires that holding managerial staff constant, the marginal cost coefficient for the ratio of staff to executives is positive and increasing across time.

Inflated demand for services and amenities

H_7: Both costs and tuition & fees increase as demand for amenities increases.

Evidence in support of this hypothesis requires that the marginal costs and marginal revenue associated with amenities are positive and increasing over time. Amenities are measured by expenditures on student services and auxiliaries.

Capital-skill complementarity (Cost)

H_8: Capital expenditures (especially technology investments) increase as the use of skilled labor (faculty) increases.

This hypothesis formalizes the notion of capital-skill complementarity. Evidence in support of this cost hypothesis requires that, controlling for faculty size and quality-enhancing expenditures, the coefficient for a measure of capital equipment expenditures interacted with the size of the faculty is greater than zero.[8]

Compliance hypothesis

H_9: Costs are higher where compliance requirements are greater.

The compliance burden hypothesis formalizes the relationship between higher education costs and the regulations imposed by state governments. We cannot measure the effect of federal regulations, as they apply to all institutions. Thus, we find support for this hypothesis when the estimated marginal cost coefficient for a state regulation that institutions become accredited to receive state funds is positive and increasing.

Data

The U.S. Department of Education classifies public, private, and non-profit institutions of higher education using its Carnegie classifications, which include various categories each for doctoral universities, master's colleges and universities, baccalaureate colleges, baccalaureate/associate's colleges, associate's colleges, and special focus institutions. Given such diversity in mission, a careful study might focus on one class of institution with high tuition rates. Thus, we focus on public research universities, as they are the most comprehensive of these institutions, serving a broad range of students from their respective states seeking to earn undergraduate and graduate degrees in many different disciplines. It is this class of institution that has been a target of high cost claims and whose state appropriations are highly contested (and declining) in just about every state in the nation.

[8] The capital equipment expenditure variable includes expenditures for movable capital assets such as research equipment, vehicles, office equipment, library collections (capitalized amount of books, films, tapes, and other materials maintained in library collections intended for use by patrons), and capitalized art collections.

The financial crisis of 2007-08 changed the economic environment for many industries, including higher education. Figure 1 shows how before the crisis, public research universities collected real revenues that exceeded real costs, building surpluses, and in 2007 and 2008, real revenues dropped sharply, leaving public research universities facing tighter budgets and deficits after the crisis. Figure 2 shows that this sharp revenue drop was the result of declining state appropriations and other non-tuition and fee revenue. Martin and Hill (2014) suggested that the dominance of the revenue theory was stronger under looser fiscal constraints, and this would have been the environment before the crisis relative to after. Given the importance of this crisis in explaining economic outcomes, we examine how the cost and tuition and fee impacts have changed from before and after the financial crisis in 2007 and 2008.

We will estimate three sets of cost and tuition and fee equations each. The first set uses our full dataset, a 17-year panel of 153 institutions (2,601 observations) using IPEDS data from 2001 to 2018, with the dependent variables having a one-year lead (i.e., 2002 to 2018). The second and third sets of equations are estimated by splitting the full dataset into two panels, one before the economic crisis and one after. The second set is a 7-year panel (2001-2007) with 1,099 observations each, and the third set is a 9-year panel (2009 – 2017). We examine changes in estimated coefficients from the earlier to the later subsamples to test the hypotheses related to increasing costs of public research universities.

Table 1 presents the summary statistics for our sample of 153 public research universities, or 73 percent of the population of public research universities. It shows that the average total expenditure is nearly $39,000 per student and the average net tuition and fees is almost $9,000 per student. On average, tuition and fees at public research universities cover about a quarter of their costs. Average student enrollment for our public research university sample is about 24,000, and the average number of faculty is 1,500 with an average 9-month equivalent salary of $90,000. Public research universities spent 48 percent of their overall spending on academic quality, and nearly 14 percent on amenities. Finally, with $9,000 in net tuition and fees, and $9,700 in state appropriations, these two sources represent about half of total revenues on average, with the remaining $18,300 in other revenue per student coming from a broad range of sources, including auxiliaries, sales and services, and gifts and grants.

{Table 1 about here}

The dependent variable for our cost model (equation 4) is real total expenditures per student (C). The dependent variable for our tuition and fee model (equation 5) is tuition and fee revenue per student (TF).

The independent variables are as follows:

- the outputs (O) are measured by the number of undergraduate and graduate degrees, and expenditures on research and public service;
- inputs (I) are measured by the fall student enrollment, a measure of enrollment diseconomies,[9] and the number of faculty;
- input price (P) is measured by the real average 9-month faculty salary;
- Efficiency (E) is measured by the ratio of degrees to employees, divided by the maximum value of these ratios;

[9] In the higher education cost literature, there are thought to be institutions facing both economies and diseconomies of scale. It is customary to square the enrollment variable to address the potential for diseconomies, but we take a different approach more suitable to our double log framework. The (natural log of) the maximum enrollment per year minus an institution's enrollment will proxy as our measure of enrollment diseconomies.

- Academic quality-enhancing expenditures (AQ) are per student expenditures on instruction, academic support, and scholarships;
- Amenities (AM) are per student expenditures in student services, auxiliaries, and institutional support;
- Institutional aid (IAID) is the financial aid provided to the student by the institution.
- State appropriations per student (SA) is the amount of state appropriations per student;
- Other revenues per student (OR) are measured by all other revenues from sources other than tuition and fees and state appropriations; and
- Government aid (GAID) includes financial aid provided to the student from the federal, state, or local government, including loans.

To estimate equations 4 and 5, we use the 'ivreghdfe' and 'reghdfe' procedures for panel data in Stata 16.0 software. For the cost and tuition and fee models, we conducted Hausman specification tests to confirm that the fixed effects model is the proper choice for both the cost and tuition and fee models.[10]

Results and discussion

The estimated coefficients for our baseline cost and tuition & fee models are shown in Tables 2 and 3, respectively. They show reasonable consistency between the models, with the signs of estimated coefficients mostly pointing in the expected direction. Our cost model estimates suggest the cost structure of public research universities, and how it has changed from

[10] Hausman tests identify the most efficient estimator with the null hypothesis that a random effects specification is the most efficient estimation approach. The fixed effects estimator is consistent under null and alternative hypotheses. For the cost model, the chi-square test statistic of 300.74 (p>chi = .000) rejects the null hypothesis, and for the tuition model, the chi-square test statistic of 291.32 (p>chi = .000) also rejects the null hypothesis. Thus, we use the fixed effects estimator for both models, as it is the more efficient and consistent estimator.

before and after the 2007 economic crisis. Our tuition and fee model estimates will evaluate how cost and revenue factors influence the prices charged by public research universities, and by comparing the associated cost and tuition model coefficients, we can get a sense of the extent to which the costs from various sources get passed on to students in the form of tuition and fees.[11]

Cost model results

The estimated coefficients for equation 4 are in Table 2. In terms of the marginal cost of producing the primary outputs, the results in the first column (full sample) show that for every 10 percent increase in undergraduate and graduate degrees, we estimate a 2.1 percent and 1.1 percent increase in average costs, respectively. It also shows that for every 10 percent increase in expenditures on research and public service, institutions face a .5 percent increase in average costs per student.

In terms of the inputs, there is some evidence that average costs declines throughout the range of enrollment in the data, with a negative sign on both enrollments and enrollment squared, but neither were statistically significant, suggesting that we may have explained institution size impacts away using other factors in the model. For example, the estimated coefficients for faculty and the number of degrees both capture institutional scale as well as enrollment, as degrees naturally correlate with enrollment, and faculty levels often are purposefully held to a given level relative to students (the average in our sample is 18.4, with 99 percent of observations between 12 and 24). The marginal cost of adding faculty suggests that for every 1 percent increase in faculty, average costs increase by 1.4 percent. However, for every 10 percent

[11] Since we use the double log functional form in our estimation strategy, we can interpret our estimated coefficients as elasticities. If a cost factor (e.g., faculty salaries) is estimated to increase costs and tuition and fees by the same amount, it suggests that the marginal increase in costs are offset by a proportionate marginal increases in net tuition and fee revenue. If a 1 percent increase in average salaries leads to a .2 percent increase in both average costs and tuition and fee revenue—$78—then the revenue effect offsets to cost effect.

increase in average faculty salary, we estimate a 14.2 percent increase in faculty costs, which makes sense in the public sector as this cost increase usually includes fringe benefits.

{Table 2 about here}

The first column of Table 2 also shows that the sign on our measure of efficiency is as expected, suggesting that a 10 percent improvement in degree production per employee reduces costs per student by 2.8 percent. In terms of academic quality, a 10 percent increase in average spending on academic quality and amenities saves 3.8 percent and 1.4 percent in average costs, respectively. This result is unexpected, as we would expect greater spending on any item to have a positive effect on total spending. However, this effect is relative to other spending categories, suggesting that there are cost savings to be gained by reallocating existing budget toward these purposes. Finally, we find a small impact of institutional aid on average costs, with a 10 percent increase in aid leading a negligible average cost increase.

In terms of how these cost impacts have changed over time, we look at the split samples in the second and third columns in Table 2. Before the economic crisis, the number of bachelor's degrees was the major output driving costs, with the research and public service missions having a small impact. The number of and average salaries for faculty were the major input cost drivers, with faculty salary representing more twice the impact of faculty size. As with the full dataset, spending on academic quality and amenities were cost saving relative to other areas of spending.

After the economic crisis, structural changes certainly can be observed. The costs of graduating students—particularly with graduate degrees—became more prominent as cost drivers. The marginal cost of a graduate degree appeared after not showing an independent cost impact before the crisis. Moreover, the marginal cost of research and public service increased after the crisis.

Most interestingly is the change in the input effects on costs before and after the crisis. The marginal cost of adding faculty was cut in half after the crisis, while the marginal cost of increasing faculty salaries also fell, though the estimates were not significant. This evidence suggests that the marginal productivity of faculty has increased rather decreased, rejecting a number of theories suggested above.[12]

The marginal cost impact of academic quality feel after the crisis, but the marginal cost of amenity spending slightly. Taken together, these results show that the marginal cost producing degrees increased after the crisis, but that the marginal productivity of faculty also increased after the crisis. These changes will have implications for our tests of hypotheses.

<u>Tuition and fee model</u>

The estimated coefficients for equation 5 are in Table 3, but the associated cost and price changes in Tables 2 and 3 suggest a certain amount of passing on of certain marginal costs to tuition and fees. We compare the impacts of inputs, outputs, and faculty salaries on average costs versus average net tuition and fees, and find interesting patterns that suggests structural and behavioral distinctions. For example, the output coefficients in the cost model suggest increases in marginal costs of producing bachelor and graduate degrees, while the partially offsetting revenue effect has decreased. On average, a 1 percent increase in bachelor degrees adds $115 to average costs per student after the crisis compared to $69 before crisis, but adds $27 to average net tuition and fees after the crisis compared to $31 before the crisis. Thus, the marginal revenue

[12] The relationship between marginal costs (MC) and marginal productivity (MP) is an inverse one defined by MP = P/ MC, where P is the price of the inputs. For example, holding real faculty salaries constant, decreases in MC leads to increases in MP.

associated with producing more undergraduate degrees is only 23 percent of marginal costs after the crisis, when it was 48 percent before the crisis. Similarly, on average, a 1 percent increase in graduate degrees now adds $65 to average costs per student where there was no differential effect before the crisis, but adds $14 to average net tuition and fees after the crisis compared to $20 before the crisis. While the marginal costs of conducting research and public service activities seemed to have declined after the crisis, we observe no marginal revenue effect on net tuition and fees.

Despite the changes in the cost structure after the crisis, public research universities do not (likely cannot) raise net tuition and fees enough to cover the higher marginal costs in the production of higher education services. In terms of inputs, comparisons of the faculty coefficients in the cost and tuition and models suggest how much marginal faculty costs are passed on the students. On average, a 1 percent increase in the number of faculty adds $43 to average costs per student after the crisis compared to $77 before crisis, but adds $14 to average net tuition and fees after the crisis compared to $43 before crisis. Thus, the marginal revenue associated with adding faculty is 33 percent of the marginal costs after the crisis, when it was 56 percent before the crisis. Similarly, on average, a 1 percent increase in average faculty salary adds $64 to average costs after the crisis, which is far less than $186 before the crisis. However, the impact of increasing faculty salaries on net tuition did not change much after the crisis. A 1 percent increase in average faculty salaries adds $19 to net tuition and fees per student after the crisis compared to $20 before crisis.

Another big substantive changes before and after the economic crisis was the premium for academic quality and amenities, which we find has been cut in third. Increases in academic quality expenditures of 1 percent are estimated to save the institution $95 per student, which is down 30 percent from $136 per student before the crisis. Increases in amenity expenditures of 1 percent are estimated to save the institution $37 per student, down 44 percent from $67 per student before the crisis, adding $7 more in net tuition and fees per student. These are some of the largest effect changes observed in our analysis, and suggest that cost increases in these areas may be eroding the potential for savings.

Results from hypotheses tests

We now turn to the results from our tests of the hypotheses. We start by presenting the cost disease results in Figure 4 and Table 4. In short, the cost disease hypothesis requires, at a minimum, that faculty input costs are rising and faculty productivity is falling. Figure 4 tells the opposite story, where real faculty salaries have fallen over the last decade (except in last 2 years), while faculty productivity in terms of degrees per faculty have increased. This finding alone would appear to reject the cost disease hypothesis as it applies to the time period under study.

While Figure 4 shows an increase in productivity in terms of degrees per faculty without controls, Table 4 shows what appears to be a loss of productivity in degree production after controlling for other factors. For bachelor and graduate degrees, marginal revenue impacts fell after the crisis, while cost impacts grew with notable exceptions. First, the cost impact of research and public service fell. Second, and most importantly for the cost disease hypothesis, the cost impact of faculty and faculty salaries decreased substantially, suggesting improved productivity in the use and compensation of faculty since the crisis. Taken together, the only finding that supports the cost disease is the finding on higher marginal costs per degree. Since this could result from changes in demographics, other findings imply improved productivity in the very areas the cost disease hypothesis targets—faculty and faculty salaries.

A return to Figure 1 shows that while nominal costs have increased, costs (i.e., real expenditures) have not beyond inflation in the higher education sector. The $41,000 cost per student in 2001 is no different than the cost in 2018. For the cost disease hypothesis to hold water, it must explain cost differences between industries, and the fact that average real faculty salaries fell from $96,200 in 2001 to $93,127 in 2017—a 17-year real decrease of 3.2 percent. This fundamental tenant of the hypothesis that faculty costs are increasing is simply not true.

Table 5 shows that we also find some evidence in support of the revenue theory, as we find a positive relationship between revenues and subsequent costs after the economic crisis; for every 10 percent increase in revenues, costs increased by 3 percent. We find no evidence, however, of rent seeking. The estimated coefficients for peer assessment were not statistically significant. Also, the ratio of institutional spending to student support suggests that while before the crisis more institutional spending increased costs, this effect went away after the crisis. Thus, before the economic crisis, we find that some institutions raised costs by shifting operating funds to institutional spending, after the crisis this effect disappeared. The revenue theory, however, has more support than the cost disease theory.

Table 6 shows the results of the state divestment and Bennett hypotheses. First, the estimated coefficients for the state divestment hypothesis supported the idea that tuition is replacing state support, but this impact fell somewhat after the crisis relative to before the crisis. The estimated coefficients suggest that for every 10 percent decrease in state appropriations, public research universities raised tuition and fees by .7 percent before the crisis, and by .5 percent after the crisis. Though the difference is not statistically significant, it suggests a "pass-through" rate of about 5 to 7 percent of lost state support to students.

We found no support for Secretary Bennett's argument with regard to federal and state aid, but we did find support for the idea that more loans available to students increased tuition and fees—at least for public research universities. While we did not find this effect before the economic crisis, after the crisis we found that a 10 percent increase in loans led to 1.8 percent increases in tuition and fees.

In terms of the popular idea that higher education costs are high because faculty and administrators "feather their nests," we find only slight evidence of this behavior in Table 7. First, estimated coefficients for the ratio of research to instructional spending suggests that more research activity reduces the average operating costs, which makes sense because such costs are often covered by research grants rather than the institution's operating budget. However, this benefit fell over time, suggesting that faculty are relying more on the operating costs to support their research relative to instruction. In terms of administrative bloat, we find none. There was no marginal cost impact of increasing staff per executives before the crisis, but we detect slight cost savings from doing so after the crisis. None of these findings lends strong support for the notion that faculty and administrators engage in perverse behavior.

We do, however, find evidence that amenity spending is an important cost determinant, but we do not see this impact increase over time. Table 8 shows that the amenity cost effect declines over time, but we find no effect of amenity spending on tuition and fees, which also makes sense because these costs are covered by auxiliary revenues. This table also shows that we found no marginal cost or marginal tuition effect from our product-mix variable, the ratio of STEM degrees conferred to liberal arts and humanities degrees.

Finally, Tables 9, 10, and 11 show the results from the tests of the management, skill-capital complementarity, and government regulation hypotheses, respectively. We found no evidence in support of the poor management and government regulation theories, but we did find some support for the skill-capital complementarity hypothesis, though the estimated effects are small.

Conclusions and future research

This paper is the beginning of a research project that we hope will bear fruit in providing clear prescriptions for universities in addressing the increasing cost of college. Most faculty and administrators of public institutions care deeply about the work they do, as they (we) see it as noble work that benefits society. Collectively, we are altruistic, and we see ourselves as performing a public service. However, our collective efforts to improve the quality of our offerings may be working against the very goals of access, equality of opportunity, and fairness many of us claim to hold dear. By undertaking a careful study of college costs, we hope to hone in on the cost determinants for narrowing this far-flung debate to the development of solutions.

Though our findings are preliminary, we find strong evidence for the state divestment theory, weak evidence for the revenue theory, and no evidence for the cost disease theory. We found mixed evidence on declining productivity; the marginal cost of producing degrees increased, but the marginal costs of hiring more faculty declined, as real faculty salaries declined, violating a critical tenant of the cost disease theory.

Archibald and Feldman (2016: 17) offer useful advice in stating that “Building a causal model of university behavior is certainly not the only path to wisdom, but the absence of one makes interpreting these very contradictory results quite difficult.” Consistent with Martin and Hill (2014), we seek to build such a model with the cost function as the foundation. However, we deviate from their approach in our attempt to embed the institutional cost model within a larger framework to explain the costs that students face—tuition and fees. In doing so, consistent with

Webber (2017), we find other external forces driving student costs in the form of reduced state support. Finally, we provide support to the Bennett notion that more government funding could be captured by the institutions, except institutions respond to loan availability rather that capturing aid.

Admittedly, some of our measures need improvement. As a next set of steps, we will seek to improve our tests by developing measures with closer fidelity to the associated hypothesis, and use alternative empirical strategies to gain greater confidence in our results. For example, our capital-skill complementarity measure may not be capturing any element of relative skill in the faculty, and our revenue measure for the revenue theory might still reflect serial correlation between revenues in one year and expenditures in the next. Finally, evidence in Figure 1 that revenues far exceeded expenditures before the crisis suggests that public research universities may have been engaging in rent seeking by stockpiling surpluses, but the rent seeking behavior is belied by the response after the crisis. Real expenditures on instruction and research increased to meet revenues, while tuition and fees increased to replace state support. Our next steps will focus on investigating these suggestive findings to further clarify what is happening to college costs.

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Figures and Tables

Figure 1. Total revenues and expenditures per student (nominal and real), 2001 - 2017

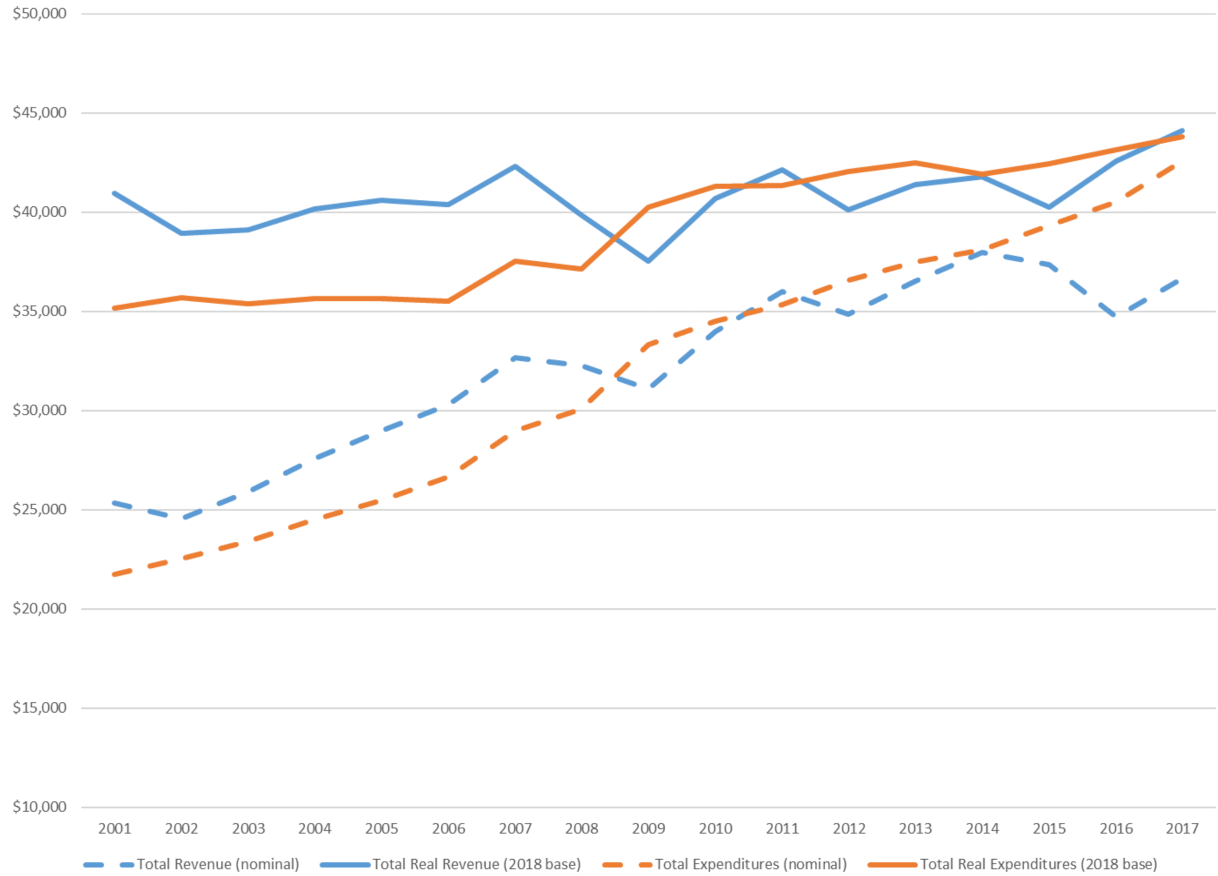

Figure 2. Real revenue per student (2018 dollars) by source, 2001 – 2018

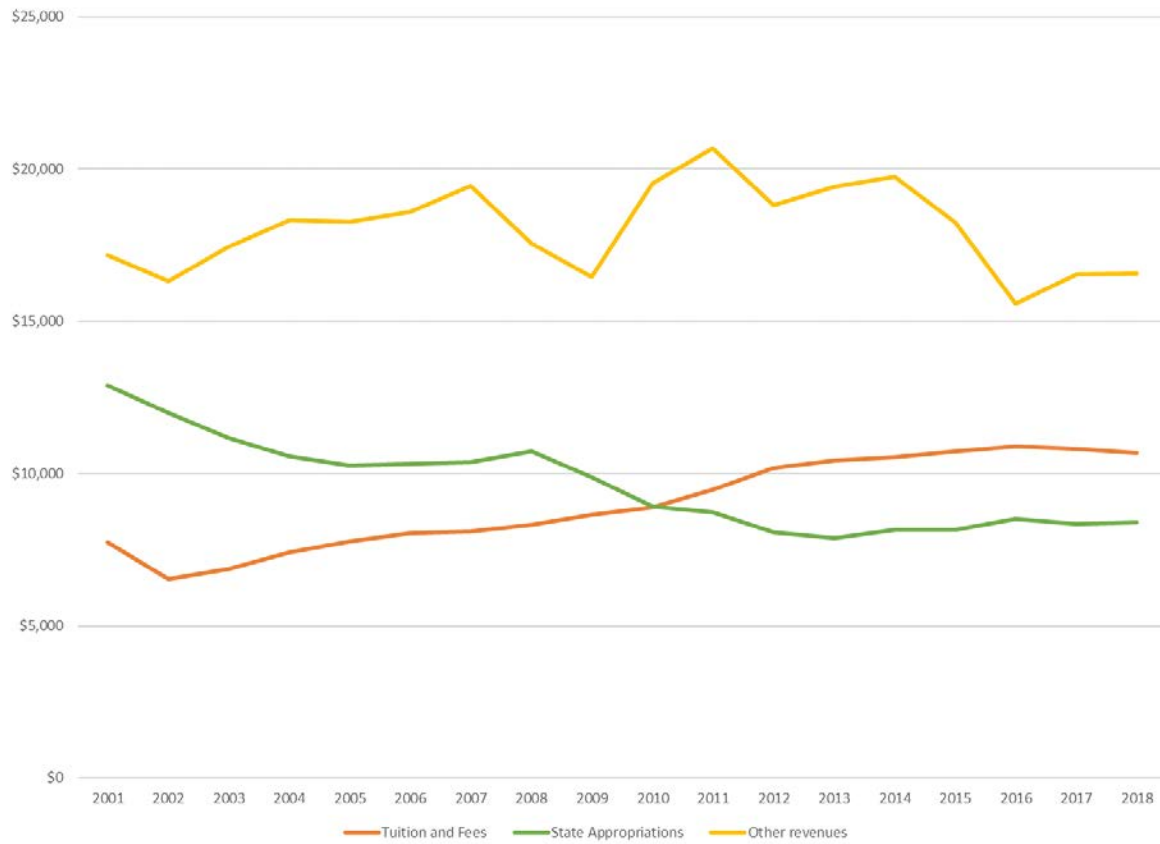

Figure 3. Real expenditures per student (2018 dollars) by category, 2001 – 2018

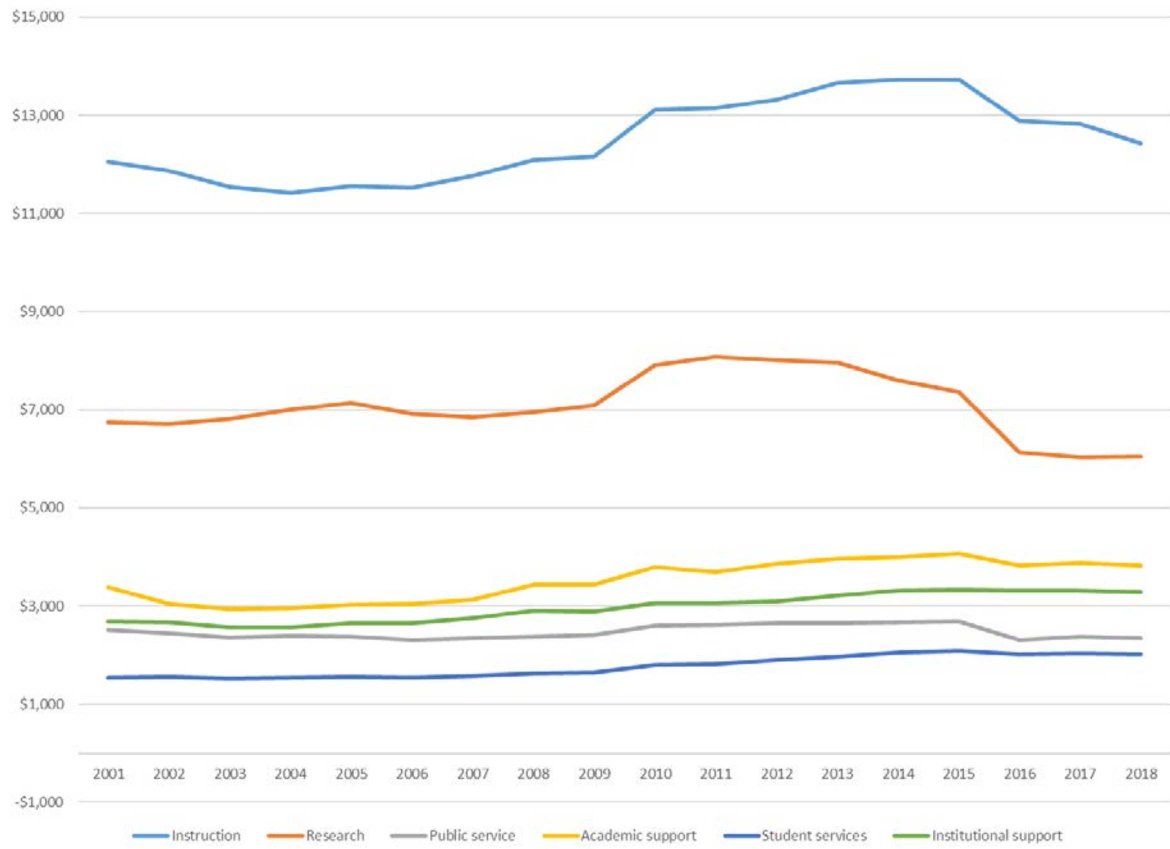

Table 1. Variables and descriptive statistics (n = 2,617, institutions = 152)

Variable	Description (per student FTE)	Mean	St. Dev.	Min.	Max.
Dependent variables					
C	Total expenditures per student FTE	$39,208	$19,819	$13,038	$177,782
TF	Tuition and fees per student FTE	$9,058	$3,618	$2,769	$25,873
Independent variables					
O	Number of undergraduate degrees	3,681	2,100	395	13,210
	Number of graduate degrees	1,634	1,069	104	6,167
	Research and public service expenditures per student FTE	$122,032	$94,523	$340	$813,671
I	Student FTEs	24,271	11,385	4,883	73,378
	Faculty FTEs	1,548	1,074	275	7,050
P	Average faculty salaries	$90,374	$15,266	$58,093	$166,897
EF	Efficiency ratio	23.8	9.6	4.4	75.6
AQ	Academic quality as share of total expenditures	48.2	9.8	18.2	92.2
AM	Amenities s share of total expenditures	13.5	4.8	3.2	47.1
InstAid	Institutional financial aid per student FTE	$5,313	$2,519	$258	$18,955
SA	State appropriations per student FTE	$9,598	$4,678	$50	$31,770
OR	Other non-tuition and non-appropriation revenues per student FTE	$18,514	$13,039	$3,339	$86,942
FedAid	Federal financial aid per student FTE	$4,553	$785	$1,076	$9,732
StAid	State financial aid per student FTE	$3,543	$2,187	$123	$12,918
Hypotheses					
AnyLoan	Any subsidized and unsubsidized loans per student FTE	$6,076	$1,558	$868	$15,830
Peer	Peer assessment from US News rankings	2.9	0.6	1.7	4.8
Stemratio	Ratio of degrees awarded in STEM programs to humanities and social science programs	3.0	14.4	0.2	581.0
RespIns	Percent of research and public service to instructional expenditure	49.2	40.4	0.0	244.8
StaffAdm	Staff FTE per Administrator FTE	13.8	9.9	1.8	70.5
SkillCap	Spending on equipment and art * percent of faculty who are full professors * 100	$17,960	$55,711	$0	$754,622
Regulation	States requiring accreditation for receipt of public funds (Yes = 1, No = 0)	.542	.498	0	1

Table 2. Cost models

Dependent variable = Expenditures per student FTE			
*Robust standard errors (SE)^*	**Full Sample Estimated α's (SE)**	**2001-2007 Sample Estimated α's (SE)**	**2009-2017 Sample Estimated α's (SE)**
<u>Outputs (O)</u>			
ln(BachelorDegrees)	.208***	.162***	.216***
	(.026)	*(.051)*	*(.040)*
ln(GraduateDegrees)	.111***	.038	.120***
	(.017)	*(.033)*	*(.024)*
ln(ResearchPubSerExp)	.050***	.038***	.059***
	(.011)	*(.015)*	*(.015)*
<u>Inputs (I)</u>			
ln(TotalEnroll)	-.542	.595	.926
	(.485)	*(1.42)*	*(.714)*
ln(TotalEnrollSquared)	-.003	-.054	-.070**
	(.024)	*(.071)*	*(.036)*
ln(Faculty)	.140***	.214***	.112***
	(.023)	*(.039)*	*(.026)*
<u>Price of inputs (P)</u>			
ln(AllRank9Salary)	1.42***	.699	.167
	(.253)	*(.887)*	*(.612)*
<u>Efficiency (EF)</u>			
ln(Efficiency)	-.282***	-.180***	-.199***
	(.028)	*(.056)*	*(.032)*
<u>Other cost determinants</u>			
ln(AcademicQualityExp)	-.378***	-.476***	-.289***
	(.034)	*(.053)*	*(.038)*
ln(AmenityExp)	-.140***	-.143***	-.127***
	(.017)	*(.023)*	*(.025)*
ln(InstitutionalAid)	.005*	.005	-.007
	(.007)	*(.006)*	*(.014)*
Centered R-squared	.330	.515	.374
F-statistic	78.5 (p=.000)	20.7 (p=.000)	36.0 (p=.000)
Observations / Institutions	2,600 / 153	1,070 / 153	1,377 / 153

^ *These models include institution, year, research class, and state fixed effects.*

** Denotes estimate is statistically significant at 90 percent; ** at 95 percent and *** at 99 percent level of confidence.*

Table 3. Tuition & fee models

Dependent variable = Tuition & fees per student FTE			
*Robust standard errors (SE)^*	**Full Sample Estimated β's (SE)**	**2001-2007 Sample Estimated β's (SE)**	**2009-2015 Sample Estimated β's (SE)**
<u>Outputs (O)</u>			
ln(BachelorDegrees)	.129***	.200***	.044
	(.041)	*(.084)*	*(.041)*
ln(GraduateDegrees)	.030	.087	.014
	(.028)	*(.061)*	*(.027)*
ln(ResearchPubSerExp)	.044***	.016	.016
	(.012)	*(.025)*	*(.012)*
<u>Inputs (I)</u>			
ln(TotalEnroll)	-2.00	-5.00*	1.98**
	(.626)	*(2.73)*	*(.904)*
ln(TotalEnrollSquared)	.084	.234*	-.109**
	(.031)	*(135)*	*(.045)*
ln(Faculty)	.114***	.018	.107***
	(.024)	*(.053)*	*(.028)*
<u>Price of inputs (P)</u>			
ln(AllRank9Salary)	.354***	.183*	.185***
	(.061)	*(.106)*	*(.065)*
<u>Efficiency (EF)</u>			
ln(Efficiency)	-.025	-.164***	.033
	(.026)	*(.067)*	*(.031)*
<u>Other cost determinants</u>			
ln(AcademicQualityExp)	.088***	.274***	.047
	(.030)	*(.050)*	*(.035)*
ln(AmenityExp)	.037	-.045	.020
	(.023)	*(.36)*	*(.023)*
ln(InstitutionalAid)	.016	-.007	.026**
	(.011)	*(.015)*	*(.013)*
<u>Other tuition & fee determinants</u>			
ln(StateAppropriations)	-.085***	-.081***	-.037***
	(.008)	*(.014)*	*(.019)*
ln(OtherRevenue)	.027*	-.061*	.008
	(.016)	*(.033)*	*(.015)*
ln(FederalAid)	-.044*	-.001	-.022
	(.027)	*(.028)*	*(.022)*
ln(StateAid)	.038***	.007	.033***
	(.006)	*(.011)*	*(.009)*
ln(Loans)	.077***	.035**	.175***
	(.015)	*(.016)*	*(.030)*
Adjusted R-square	.931	.935	.963
F-statistic	21.0 (p=.000)	6.2 (p=.000)	7.0 (p=.000)
Observations / Institutions	2,600 / 153	1,077 / 153	1,377 / 153

^ *These models include institution, year, research class, and state fixed effects.*

* *Denotes estimate is statistically significant at 90 percent; ** at 95 percent and *** at 99 percent level of confidence.*

Figure 4. Change in faculty productivity and real compensation (2018 dollars)

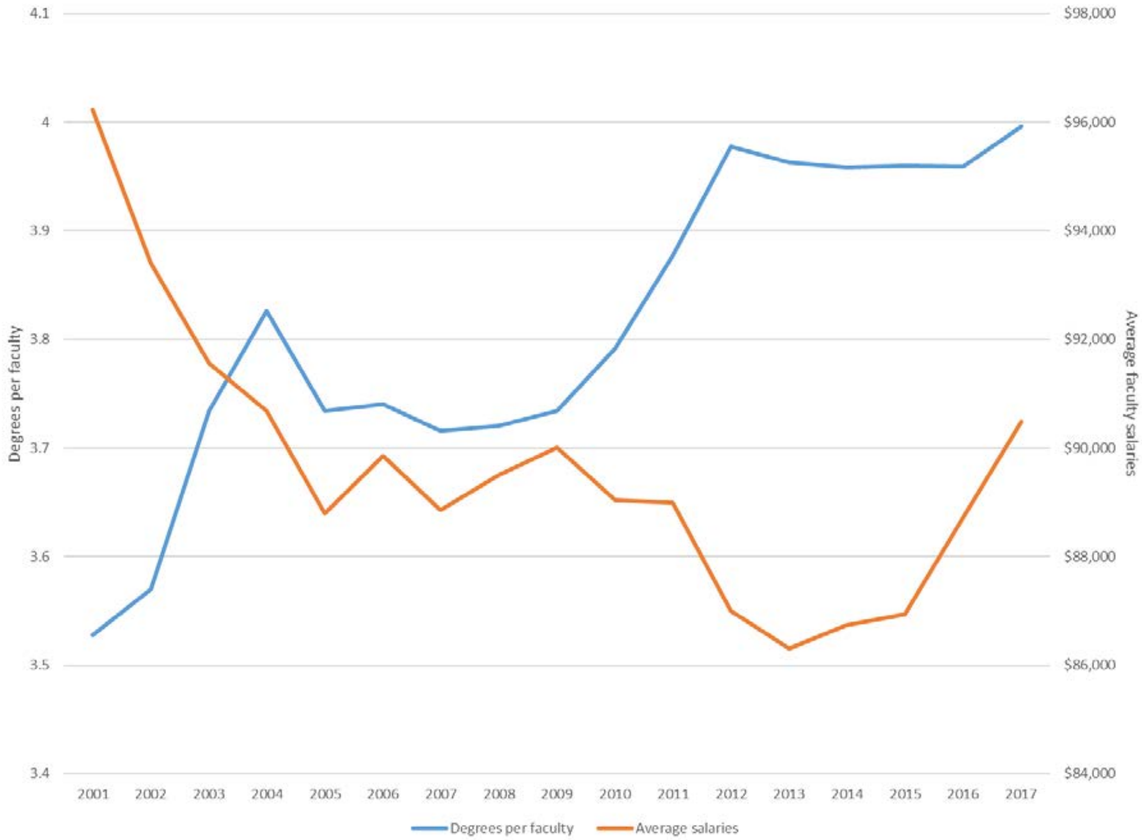

Table 4. Testing the cost disease hypothesis

	Pre-2008 Marginal Impacts	**Post-2008 Marginal Impacts**	**Change**
Cost impact of outputs			
Bachelor Degrees	.194*	.236***	Marginal costs grew
Graduate Degrees	.060	.115***	Marginal costs grew significantly
Research & public service	.307***	.008	Marginal costs fell significantly
Cost impact of inputs			
Faculty	.575***	.021	Marginal costs disappeared
Faculty salaries	2.24***	-.072	Marginal costs disappeared

Table 5. Testing the Revenue Theory hypothesis

	Pre-2008 Marginal Impacts	**Post-2008 Marginal Impacts**	**Change**
Cost impacts			
Total revenue	.087	.308***	Marginal costs grew significantly
Peer assessment	-.010	.135	No marginal cost effect
Ratio of institutional to academic and student support spending	.101**	.013	Marginal cost disappeared

Table 6. Testing Divestment and Bennett hypotheses

	Pre-2008 Marginal Impacts	**Post-2008 Marginal Impacts**	**Change**
State dis-investment hypothesis			
State Appropriations	-.075***	-.048**	Marginal revenue offset fell
Bennett hypothesis			
Federal financial aid	.014	-.000	No marginal revenue effect
State financial aid	-.012	-.014	No marginal revenue effect
Loans	.028	.180***	Marginal revenue grew significantly

Table 7. Testing the academic rachet and administrative bloat hypotheses

	Pre-2008 Marginal Impacts	Post-2008 Marginal Impacts	Change
Academic rachet			
Research to instructional costs	-.307***	-.021***	Marginal cost grew significantly
Peer assessments	-.010	.135	No marginal effect
Administrative bloat			
Ratio of institutional to academic and student support spending	.101**	.013	Marginal cost fell significantly
Staff to executive ratio	.002	-.010***	Marginal cost fell significantly

Table 8. Testing the demand for product mix and amenities hypothesis

	Pre-2008 Marginal Impacts	Post-2008 Marginal Impacts	Change
Revenue impact			
Amenities	-.069	.011	No marginal revenue effect
Stem ratio	.031	.009	No marginal revenue effect
Costs impact			
Amenities	-.194***	-.128***	Marginal cost grew
Stem ratio	-.010	.135	No marginal cost effect

Table 9. Testing the poor management hypothesis

	Pre-2008 Marginal Impacts	Post-2008 Marginal Impacts	Change
Cost impact			
Efficiency ratio	.086	-.168***	Marginal cost fell significantly

Table 10. Testing the skill-capital complementarity hypothesis

	Pre-2008 Marginal Impacts	Post-2008 Marginal Impacts	Change
Cost impact			
Skill-capital interaction	-.010***	.005***	Marginal grew slightly

Table 11. Testing the government regulation hypothesis

	Pre-2008 Marginal Impacts	Post-2008 Marginal Impacts	Change
Cost impact – no regulation			
Faculty	.570***	.011	Marginal cost fell significantly
Faculty salaries	2.73	-.342	No marginal cost effect
Stem ratio	.004	.023	No marginal cost effect
Cost impact – with regulation			
Faculty	.584***	.024	Marginal cost fell significantly
Faculty salaries	1.60*	-.402	Marginal cost fell significantly
Stem ratio	.012	.090	No marginal cost effect