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College Affordability: The Implications of State Funding, Costs, and Other Resources

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Abstract

This paper examines factors influencing tuition and fees across public four year universities in the United States. It begins with a review of the positions taken in existing literature relevant to this topic. It proceeds with a theoretical explanation of why greater state funding can be expected to lead to lower tuition and fees. It further posits that an institution's expenses and other revenues can be expected to influence tuition and fees. It then employs several multiple regression models, incorporating different measures of tuition and fees as well as different combinations of control variables, to test for the hypothesized relationships. Ultimately, the analysis provides evidence of a strong negative relationship between state funding and tuition and fees. There is also evidence that as expenses increase, so do tuition and fees; and as other revenues increase, tuition and fees decrease. The paper concludes with the implications of these results for institutions and state policymakers seeking to bolster college affordability.

1. Introduction

Over the last two decades, the topic of college affordability has gained a prominent place in American political discourse. Discussions on this topic have centered particularly on the rising cost of obtaining a degree, the significance of state funding of higher education, and the importance of higher education to the economy's future. Over the past several decades the sticker price of higher education has risen far faster than average household incomes. The College Board reports that adjusted for inflation, the average price of a four-year degree at public institutions has on average more than tripled since 1985[1]. At the same time, there are downward pressures on state funding for higher education. According to the State Higher Education Executive Officers Association, state funding per student in constant dollars fell by more than $2,000 between 1990 and 2015[2]. Since the turn of the century, economic pressures such as the 2008 recession, in combination with competing state budget priorities, have led state funding per student to stagnate in many states.

Not all institutions are similarly situated in this context. Between universities there are noticeable differences in tuition and fees, state funding, revenues, and expenses. For example, the College Board reported that 38% of students enrolled at public four year institutions in academic year 2015 faced tuition and fee rates between $6,000 and $8,999; while 19% of students faced rates of $15,000 or more. The range in charges between Penn State University and the University of Wyoming, the most and least expensive state flagship universities in the country respectively, was nearly $13,000.

Similar variation is apparent in state funding for public universities. In 2015 for example, New Hampshire allocated on average approximately $2500 per student to their public four year universities, while in the same year Wyoming provided more than $17,000 per student. Recently, North Carolina legislators mandated that tuition be reduced to $500 per year at several of the state's 16 public universities, promising to replace the forgone tuition revenues with a much heavier subsidy from state expenditures[3].

Universities also vary greatly in how much they spend. Data from the U.S. Department of Education's National Center for Education Statistics, which will be used throughout this paper, reveal an enormous variation in spending across institutions[4]. The data show that in 2013, the two universities with the highest per student spending nationwide respectively dedicated greater than 73 and 15 times more money per student than the institution with the lowest per student expenditures. At the same time, institutions differ in the revenue they can raise from sources outside of student charges and state funding. Some institutions have vast sources of wealth beyond the revenues that they realize from tuition and fees while others have very little. For example, the National Association of College and University Business Officers reported that the largest endowment fund in 2015 was held by the University of Texas System, with a value of over 24 billion dollars. The University of Michigan's endowment, with a value of nearly 10 billion dollars, was the largest single university's endowment in the country. In contrast, the 20th largest public endowment was held by the University of Florida Foundation, with a value of just over 1.5 billion dollars[5].

Despite rising college costs and fluctuating state funding, greater attainment of higher education is increasingly seen as a key to future economic success. According to Georgetown University's Center on Education and the Workforce, nearly 99% of the jobs gained since the end of the 2008 recession have gone to those with at least some experience in higher education[6]. In response to such trends, many states have set goals to reach postsecondary educational attainment rates of between 40 and 60% in the coming decades[7]. In the 2016 election cycle, candidates and political leaders have floated numerous ideas to address educational costs. Many of these proposals have been founded on increasing state funding for universities as a method of reducing or eliminating the cost of college attendance. Considering the economic imperative to expand access to higher education to more citizens, along with the litany of recently proposed political solutions to this end, developing a deeper of the variability in college charges is crucial. In this vein, this paper seeks to address why tuition and fees vary so widely between public four year institutions of higher education. Specifically, does greater state support lead to lower tuition and fees at the institutional level?

To answer these questions, this paper will begin with a review of existing perspectives on this topic. It will then proceed with a theoretical explanation of why state funding can be expected to negatively influence tuition and fees. It continues by outlining the structure of the quantitative analysis employed to test for such a relationship. This analysis is centered on sixteen statistical models, all of which provide evidence of a strong negative relationship between state funding and tuition and fees. Additionally, the models quantify the effects of institutional expenses, revenues, degree offerings, and flagship status on tuition and fees. The paper concludes with concrete takeaways on how both state policymakers and institutions themselves can make progress towards improving college affordability.

2. Literature Review

Since college costs began to garner significant attention in the late 1980s, studies have sought to determine the factors that influence variation in these charges. Some have taken a longitudinal approach, following changes in tuition over time. Others have taken a cross-sectional approach, comparing institutions or states during a fixed period. Most analyses examine trends on the state level, while fewer use individual institutions as their unit of analysis. Analyses typically include a measure of state support and a measure of university spending as a predictor of tuition, but fewer explicitly include a measure of the resources available to institutions outside of student charges and state funding. Many studies include region as a predictor of tuition, though this is likely a proxy for other factors such as local economic conditions, regional costs of goods and services, or patterns support from private citizens. Interestingly, few studies have included required fees in their discussion of college costs. Overall, among these studies there is some disagreement on whether state funding drives to lower college costs.

In a report to the College Board and the American Council on Education, Hauptman[8] sought to address the causes of increasing college charges over time at public and private universities across the United States. This study examined multiple hypotheses to explain rising college costs. Overall, it concluded that inflation was partly responsible for increasing college tuition rates. Additionally, it found that the pattern of state funding was a major factor behind increasing tuition at public institutions. Finally, it concluded that competition to enroll and retain students led universities to increase spending on recruitment and student services, ultimately driving up costs for students.

Mumper and Anderson[9] sought to evaluate how states managed college affordability in the 1980s and determine the factors driving rising tuition in this time. They hypothesized that inflation was partly responsible for rising college costs. They further posited that in the face of falling state appropriations, institutions increased their reliance on students as a source of revenue. Finally, like Hauptman, they proposed that institutions increased their spending to compete for applicants and provide students with more resources to help them complete their degrees. Though

they did not pursue a quantitative analysis, they concluded in response to their broader question that states were not able to effectively support college affordability through the 1980s.

Hearn, Griswold, and Marine[10] employed a cross sectional analysis to assess predictors of state tuition and student aid policies. The authors posited that approaches to higher education financing are associated with region, social values, economic resources, and governance arrangements. Their analysis of tuition in each state's two and for year institutions found that region was a strong predictor of a state's tuition and aid approach. The authors qualified, however, that region is not a true causal factor as much as a potential proxy for social values and economic conditions in an area. They also found that economically developed states tend to have lower tuition rates, though this may be because they did not directly consider state funding as an independent variable. They did not find evidence of a connection between larger, centralized state and university governance structures and higher tuition, as they had hypothesized.

Similarly, Hossler *et. al*[11] sought evidence of a systematic connection between state tuition and financial aid policies. The authors were specifically interested in examining whether states were deliberately pursing a policy of imposing high tuition rates while providing high levels of financial aid. To address this question they tested for relationships between state political environment, state values, public appropriations for higher education, state financial aid policies, and tuition rates. In contradiction with several other studies, their cross-sectional analysis of states did not provide evidence of a systematic connection between these factors.

Also examining a cross-section of states, Kojal and Kojal[12] hypothesized that there is an inverse relationship between state funding per student and tuition. Their statistical analysis incorporated region and state appropriations per student as predictors of tuition levels. Their predictors also included median family income and the proportion of students from out-of-state as proxies for students' ability to pay. Their results demonstrated evidence of a connection between region and tuition, a positive relationship between ability to pay and tuition, and a negative relationship between state appropriations and tuition.

Taking a narrower approach, Burgess[13] investigated the factors that lead to variation in tuition rates specifically at public land grant institutions. This cross-sectional analysis employed as its independent variables the proportion of state budget dedicated to higher education, state appropriations per student, state legislature political affiliation, state legislature professionalism, region, and *U.S. News and World Report* Ranking. Of these, the only statistically significant factors at a 90% confidence level were state appropriation per student and region.

Finally, Delaney[14] examined college affordability as the share of family income required to pay the price of attending college. This study specifically considered state appropriations, family income, tuition and fees, and student financial aid as factors influencing college affordability over time. It found that tuition revenues appear to fill the gap when state funding is reduced, and that growing investments in student aid have not kept up with tuition increases.

3. Theory

3.1. State Funding

Considering the mechanics of state budgeting and the structure of the financial resources available to universities, we can expect to observe a negative relationship between state funding and tuition and fees. Generally, state appropriations for public universities are made legislatively in advance of both the time at which they will be spent and the time at which institutions determine their tuition and fees. Numerous factors have been proposed to explain variation in these appropriations across states and institutions including competing budgetary priorities, political climate, region, and economic conditions. Ultimately, however, the cause of variation in state funding is outside of the scope of this study. What is relevant in this instance is simply that state funding varies widely across universities.

In addition to state appropriations, public universities have multiple non-state sources of revenue with which they can cover the costs of their operations. Many of these non-state revenue sources are volatile from year to year under the influence of broader economic conditions and can require significant up-front investments to realize returns. One such source is monetary gifts to institutions from individuals and organizations. Such financial gifts, along with related returns from investing them, require maintaining fundraising operations and taking time to cultivate relationships with donors. Additionally, giving and investment returns are vulnerable to economic downturns. A further constraint is imposed by the fact that donated funds often come with specific instructions and limitations guiding how they can be used. Another source of revenue comes from business ventures such as sponsorships and athletics ticket sales. This income also requires significant up front investments in facilities, staff, and equipment. As

with fundraising, revenues from this source are also vulnerable to economic conditions. Revenue can also be realized by pushing innovations generated through academic research to the private sector and building public-private partnerships. Doing so however necessitates first investing resources in the facilities and faculty positions needed for conducting research. Overall, almost all of the non-state sources of revenue available to public universities require significant up-front investment and are exposed to economic risk once established. Additionally, the pursuit of these revenue sources can conflict with an institution's mission. For example, not every university desires to build high-profile athletics teams or a large research programs, regardless of the financial benefits they could reap.

With such constraints on most forms of non-state revenue, tuition and student fees stand out as likely the most reliable and easiest to augment sources of revenue. Student fees are typically earmarked for specific purposes such as funding student activities, covering the costs of academic materials, or paying the costs of capital projects. In parallel, tuition is typically used for broad instruction-related purposes. Given enrollment trends, tuition and fees can be considered a reliable source of revenue. Even in light of economic downturns and decades of rising tuition and fee rates, enrollment at public institutions grew across the country through 2010. This demonstrates that generally, there has been a fairly steady supply of students willing to pay to have a seat at public institutions. Therefore, when state funding falls short of meeting a university's needs, or universities seek to provide services beyond what can be funded with state dollars, they can be expected turn to adjusting tuition and fees. With higher levels of state funding, universities will have less of a need to resort to students for revenue.

3.2. Expenses & Other Revenues

University expenses have also been singled out in academic studies and in popular media as drivers of tuition and fee increases in the past two decades. Universities have been lambasted for passing the cost of what is typically labeled as administrative bloat on to students. In a *New York Times* editorial, for example, Paul Campos pointedly labeled the "constant expansion of university administration" and their increasing salaries as responsible for skyrocketing college costs[15]. Given universities' previously discussed financial circumstances, expenses can also be expected to explain some of the variation in tuition and fees across institutions.

Universities spend on a wide array of goods and services including salaries, classroom materials, research, public service, facilities, admissions programs, student activities, and financial aid. These expenses can be covered by universities using a variety of the revenue sources available to them. As discussed above, tuition and fees are an attractive revenue source due to their reliability. When university expenses exceed the revenue that is readily available from other sources, universities can be expected to pass excess costs on to students via tuition and fee charges. Therefore, all else equal, we can expect a positive relationship between expenses and tuition and fees, and a negative relationship between other revenues and tuition and fees.

> *Hypothesis*: Tuition and fees at public four year universities are negatively related to state funding, negatively related to other revenues, and positively related to expenses.

4. Research Design

4.1. Measurement of Variables

In order to test this hypothesis, several concepts of interest must be defined and measured. All of the concepts in this study can be measured as variables with dollar values. For almost all of the public institutions under consideration, data is readily available. All institutions that participate in federal student aid programs are required to respond to surveys administered by the U.S. Department of Education's National Center for Education Statistics (NCES). These surveys collect extensive information on characteristics including student populations, graduation and retention rates, program offerings, and institutional finances. These responses are in turn made available through the Integrated Postsecondary Education Data System's online Data Center, which was used to produce data files including responses for the desired variables.

The independent variable will be state funding for higher education, and is defined as budgetary support that state governments provide to their public four-year institutions of higher education. State funding will be measured using the dollar value of a state's annual appropriation per full time equivalent (FTE) student at each university. This approach differs from measuring state funding using the appropriation per student enrolled. The number of FTE

students at an institution is calculated by dividing the amount of credit hours students took overall in a period of time by the number of credit hours that is considered a full-time course load. For example, if students at an institution took a total of 300,000 credit hours during an academic year and 30 credit hours was considered a full time course load, then the institution would have 10,000 FTE students in that year. Measuring appropriations per FTE student allows a clearer comparison between institutions by accounting for differences in the number of students enrolled as well as the amount of credit hours they pursue.

University expenses will be included as a control variable, and are defined as the amount that universities spend on their operations including instruction, research activities, academic and student life programs, operation and upkeep of buildings, and administrative staff. Expenses will be measured as the sum of expenditures reported under each core expense category in NCES surveys. University expenses will also be considered per FTE student.

A university's other revenues will also be included as a control variable. Other revenues will be defined as revenues from sources other than tuition, fees, and state appropriations. These sources include appropriations from local governments, revenues from private and public gifts and contracts, and income from investments. These university revenues will be measured as the sum of revenues reported under each core revenue category in NCES surveys. As with state funding and university expenses, other revenues will be measured per FTE student.

The dependent variable, tuition and fees, will be measured in two ways. Tuition is defined as charges assessed to students for instructional services. In tandem, student fees are defined as charges assessed to students for programs not covered by tuition. The first measure will be the published dollar amount of tuition and fee charges for a university's in-state students, those that meet the requirements set in order to be considered in-state residents. Tuition and fees will also be measured using the tuition and fee revenues that a university collects per FTE student, which captures how much money is actually collected from students. This accounts for the higher rates tuition and fee rates typically assessed to out of state students as well as practices such as tuition discounting or of using portions of overall tuition revenues to subsidize financial aid for a smaller subset of students.

4.2. Overview of Data

A quantitative approach, using the individual institution as the unit of analysis, will be used to test the hypothesized negative relationship between state funding and tuition and fees. Some of the public four-year institutions reported in the IPEDS Data Center output will not be included in this analysis due to either their unique funding circumstances or shortcomings in the data set. Five military service academies and eight tribally administered universities will be excluded, as their public funding comes from entities other than individual states. Ten institutions will be omitted because while the IPEDS Data Center reported that they received zero dollars in state appropriations, the College Board reported that they do in fact receive state funding. Finally, forty-four of the institutions in the data set were entirely missing financial responses in the IPEDS Data Center output.

Table 1 displays summary statistics for tuition and fee rates and revenues, state appropriations per FTE, other revenues per FTE, and expenses per FTE for all public four year universities included in the analysis. In the 2013 academic year, tuition and fee rates had a median of $7,090 and a mean of $7,438. Valencia College and Palm Beach State College were tied for the lowest tuition and fee rates in the country, each at $2,378. At the other end of the spectrum, the University of New Hampshire Main Campus had a tuition and fee rate of $13,762. Both Valencia College and Palm Beach State College were exclusively community colleges until recently and continue to primarily offer associates degrees. The University of New Hampshire, in contrast, is a state flagship university with an enrollment of over 15,000 students and a high number of research-intensive graduate programs.

In the same year, tuition and fee revenues per FTE student had a median of $5,818 and a mean of $6,444. Northern New Mexico College, a small institution which was founded as a community college and began granting bachelor's degrees in 2005, had tuition and fee revenues per FTE student of only $802. The University of Vermont, the state's flagship institution and a university considered to be a "Public Ivy," had the highest tuition and fee revenues per FTE student at $21,995.

Table 1. summary statistics for tuition and fee rates and revenues, expenses, other revenues, and state appropriations

	Tuition and Fee Rates	Revenue from Tuition and Fees Per FTE	State Appropriations Per FTE	Other Revenues Per FTE	Expenses Per FTE
Minimum	$2,378	$802	$252	$944	$6180
1st Quartile	$5,764	$4,387	$3,958	$4,401	$12,442
Median	$7,090	$5,818	$5,348	$6,361	$15,423
3rd Quartile	$8,886	$7,935	$7,502	$10,135	$20,499
Maximum	$16,496	$21,995	$107,022	$278,662	$454,958
Mean	$7,438	$6,444	$6,245	$9,371	$18,979
Standard Deviation	$2,680	$3,257	$5,290	$13,707	$20,475

Table 1 Summary statistics for the variables under consideration, calculated using responses from the 603 institutions that reported reliable data. Values for each variable's first and third quartiles are included for the purpose of calculating the bounds used to determine outliers.

For the 2010 academic year, state appropriations per FTE student had an average of $6,245 and a median of $5,348. The lowest state appropriation per FTE student in this year was $252 at Colorado State University Fort Collins. Interestingly, this university is the flagship institution in the state of Colorado, with more than 30,000 students enrolled and a large research program. The highest state appropriation per FTE student was $107,022 at the University of Minnesota Rochester, which may be influenced by this institution's status as the newest campus in the University of Minnesota system. Established in 2006, this university had an enrollment of only 495 students in 2010 and offers programs almost entirely focused on healthcare. The second highest state appropriation per FTE student nationwide was $25,911 at the New Mexico Institute of Mining and Technology. More than a quarter of this institution's students are enrolled in graduate programs, and overall the institution specializes in science, technology, engineering, and math (STEM) fields.

Nationwide, other university revenues in the same year had an average of $9,371 per FTE student and a noticeably lower median of $6,361. The Wright State University Lake Campus had the lowest level of other revenues, at $944 per FTE student. This institution is small, with an enrollment of less than 1,200 in 2013, and offers almost entirely associates degrees. The highest levels of other revenues was observed at two universities previously discussed, $278,662 per FTE student at the University of Minnesota Rochester and $75,089 per FTE student at the New Mexico Institute of Mining and Technology.

Finally, expenses per FTE student had a median of $15,423 and average of $18,979. Valencia College had the lowest expenses per FTE student at $6,180, while the University of Minnesota Rochester had the highest at $454,958. As with other revenues, the second highest level of expenses at $95,632 was observed at the New Mexico Institute of Mining and Technology.

Overall, Table 1 highlights fairly large standard deviations, noticeable discrepancies between means and medians, and large ranges between minimum and maximum observations. Together, this suggests that there are likely significant outliers in the data set. There are eighty institutions with observations that can be classified as outliers by applying a statistically calculated upper limit to the responses for every variable. These institutions comprise 13.3% of the overall 603 institution dataset. No institutions had observations below the calculated lower limit for any of the variables. Summary statistics for the institutions with outlier observations, along with the number of observations above the upper limit for each variable, are included in Table 2. Several states had a heavier concentration of outlier institutions. Nine were located in California; five in New York and North Carolina; four in Virginia, and three in Illinois, Indiana, Michigan, and New Jersey. Twenty-nine were state flagship universities as defined by the College

Board. In general, flagship institutions are typically the best known institution in a state, were established the earliest, are the largest and most selective, and have research-intensive programs.

Table 2. summary statistics for tuition and fee rates and revenues, expenses, other revenues, and state appropriations at outlier institutions

	Tuition and Fee Rates	Revenue from Tuition and Fees Per FTE	State Appropriation per FTE	Other Revenues Per FTE	Expenses Per FTE
Upper Limit	$13,569	$13,256	$12,819	$18,736	$32,583
Observations Above Q3+1.5IQR	17	21	24	48	47
Minimum	$3,756	$2,303	$903	$1,030	$10,634
Median	$10,015	$10,636	$9,788	$20,250	$34,912
Maximum	$16,496	$21,995	$107,022	$278,662	$454,958
Mean	$10,219	$10,510	$11,778	$26,219	$42,233
Standard Deviation	$3,209	$4,131	$12,057	$31,905	$48,902

Table 2 Summary statistics for the variables under consideration, calculated using responses from the 80 institutions with outlier observations for at least one variable. This table includes the upper limit, calculated as Q3+1.5IQR, above which observations were considered outliers. It also includes the number of observations above this upper limit. No institutions had observations below the calculated lower limit of Q1-1.5IQR.

Summary statistics for the set of institutions without outlier observations are displayed in Table 3. These non-outlier institutions differ from the outlier institutions in several regards. The non-outlier institutions display lower discrepancies between the means and medians for each variable, as well as lower standard deviations. The outlier institutions have average tuition and fee rates that are more than $3,000 higher than the non-outlier institutions, and average tuition and fee revenues per FTE student that are more than $4,000 higher. Non-outlier institutions receive less than half the average state appropriations per FTE student and have almost three quarters less in other revenues. Furthermore, the outlier institutions have average per-student expenses of almost three times higher than those at non-outlier institutions.

Table 3. summary statistics for tuition and fee rates and revenues, expenses, other revenues, and state appropriations at institutions without outlier observations

Table 3	Tuition and Fee Rates	Revenue from Tuition and Fees Per FTE	State Appropriation per FTE	Other Revenues Per FTE	Expenses Per FTE
Minimum	$2,378	$802	$252	$944	$6,180
Median	$6,775	$5,615	$4,965	$5,820	$14,570
Maximum	$13,397	$13,186	$11,902	$18,598	$30,982
Mean	$7,012	$5,822	$5,398	$6,794	$15,422
Standard Deviation	$2,314	$2,594	$2,205	$3,531	$5,099

Table 3 Summary statistics for the variables under consideration, calculated using responses from the 523 institutions that did not have outlier observations for any variable.

The outlier institutions tend to be larger, with an average enrollment of 21,220 students compared to an average enrollment of only 11,405 at the non-outlier institutions. As of 2013, a quarter of the outlier institutions operated hospitals while only 1% of the non-outlier institutions did. Similarly, only 7% of non-outlier institutions offered a medical degree while 47.5% of the outlier institutions did.

4.3. Controls

Several additional control variables will be included in the analysis in an effort to account for the unique financial characteristics of the institutions classified as outliers. These controls will include a dummy variable for an institution's status as a state flagship university. If an institution is classified as a flagship by the College Board, it will be coded with a one; otherwise, it will be coded with a zero. The controls will also include a dummy variable for whether an institution offers a degree in a medical field. If an institution offers one or more medical degrees as reported by the IPEDS Data Center it will be coded with a one; otherwise, it will be coded with a zero. Finally, the controls will include a dummy variable for whether an institution operates an affiliated hospital. If an institution operates a hospital according to the IPEDS Data Center output it will be coded with a one; otherwise, it will be coded with a zero.

5. Analysis

Multiple linear regression will be used in order to test the hypothesized relationships between appropriations, expenses, other revenues, and tuition and fees. Two sets of eight regression analyses will be produced, one based on responses from all 603 institutions reporting reliable data and the other based only on responses from the 523 non-outlier institutions. In addition to the predictor variables, these analyses will include several different combinations of control variables.

For these regression models, data will be collected from two different years. Tuition and fees will be measured from 2013 while expenses, revenues, and appropriations will be measured from 2010. This lagging of data for appropriations, expenses, and revenues seeks to address the concern of reverse causality. If this were not done, it is possible that evidence of a relationship between the variables could be indicative of a causal relationship other than the one hypothesized. For example, it could be that the level of tuition and fees, and the revenues that result, influence decisions on state appropriations and drive spending choices at the institutional level. Lagging the independent variable and controls in relation to the dependent variable of tuition and fees strengthens the likelihood

that if a relationship is found, it indicates that past levels of appropriations, expenses, and revenues were taken into account by universities as they set their tuition and fees.

5.1. Regressions with All Institutions

The initial set of eight regression analyses was performed on the dataset including all 603 institutions with reliable responses. The outputs of these analyses are shown in Table 4. All eight of these models returned coefficients that are statistically significant at a 99% confidence level. In all cases state appropriations were negatively correlated with tuition and fee rates and revenues as expected. Additionally, expenses were positively correlated with tuition and fee rates and revenues as hypothesized; and other revenues were negatively correlated with tuition and fee rates and revenues as predicted. These results provide grounds to reject the null hypothesis and indicate that the relationship between state funding and tuition and fees is not negligible.

Models 1, 2, 3, and 4 in this set use tuition and fee rates as their response variable. Model 4 demonstrates the highest R^2 and adjusted R^2 values and has the highest coefficient for half of the variables. This model predicts that all else equal, every additional $1000 in state appropriations per FTE student will decrease tuition and fee rates by an average of $336. For every $1000 in additional other revenues per FTE student, it predicts that tuition and fee rates will fall by an average of $258, all else equal. A $1000 increase in expenses per FTE student can be expected to increase tuition and fee rates by $271 on average, all else equal.

Model 4 also includes the dummy variables for an institution's status as a flagship university, whether it grants medical degrees, and whether it operates a hospital. Following the model, flagship institutions can be expected to have tuition and fee rates that are on average approximately $1370 higher than other institutions, all else equal. Furthermore, institutions that grant medical degrees can be expected to have tuition and fee rates approximately $1160 higher on average, all else equal. Institutions that operate hospitals are predicted to have rates on average approximately $1580 higher, all else equal.

Models 5, 6, 7, and 8 use tuition and fee revenues per FTE student as their response variable. Model 8 has the highest R^2 and adjusted R^2 values of this group, as well as the strongest coefficient for many of the variables. It forecasts that every $1000 increase in state appropriations per FTE student will reduce the tuition and fee revenues collected per FTE student by $498 on average, all else equal. It also predicts that tuition and fee revenues per FTE student will fall by $312 on average for every $1000 increase in other revenues per FTE student, all else equal; and forecasts that tuition and fee revenues per FTE student will rise by $355 on average for every $1000 increase in expenses per FTE student, all else equal.

With regard to the control variables, this model predicts that all else equal, flagship institutions will have tuition and fee revenues per FTE student approximately $2875 higher on average than other institutions. Institutions that grant medical degrees can be expected to have higher tuition and fee revenues per FTE student by an average of approximately $2270, and institutions that operate hospitals by an average of approximately $1994; all else equal.

Table 4. Regression outputs for all institutions

ALL	Model 1 DV Tuition & Fee Rates	Model 2 DV Rates, Healthcare Dummy Variables	Model 3 DV Rates, Flagship Dummy Variable	Model 4 RV Rates, Healthcare & Flagship Dummies	Model 5 RV Revenues	Model 6 RV Revenues, Healthcare Dummies	Model 7 RV Revenues, Flagship Dummies	Model 8 RV Revenues, Healthcare and Flagship Dummies
Intercept	$6745.879*** 163.90	$6525.720*** 160.37	$6626.432*** 161.23	$6490.326*** 159.20	$5629.508*** 188.58	$5237.187*** 173.26	$5392.699*** 175.50	$5162.863*** 167.05
State Appropriations Per FTE	-$0.361*** 0.05	-$0.337*** 0.04	-$0.353*** 0.05	-$0.336*** 0.04	-$0.540*** 0.05	-$0.500*** 0.05	-$0.525*** 0.05	-$0.498*** 0.05
Other Revenues Per FTE	-$0.208*** 0.03	-$0.250*** 0.03	-$0.230*** 0.03	-$0.258*** 0.03	-$0.226*** 0.04	-$0.295*** 0.03	-$0.270*** 0.03	-$0.312*** 0.03
Total Expenses Per FTE	$0.258*** 0.03	$0.268*** 0.03	$0.264*** 0.03	$0.271*** 0.03	$0.332*** 0.03	$0.349*** 0.03	$0.344*** 0.03	$0.355*** 0.03
Flagship	-	-	$2100.619*** 317.08	$1369.874*** 392.47	-	-	$4164.568*** 405.01	$2876.415*** 411.83
Medical Degree	-	$1601.824*** 345.97	-	$1163.714*** 365.03	-	$3189.310*** 373.80	-	$2269.383*** 383.04
Hospital	-	$1563.059*** 570.00	-	$1578.702*** 564.57	-	$1960.895*** 615.86	-	$1993.742*** 592.62
R^2	0.20	0.26	0.24	0.28	0.28	0.42	0.39	0.46
Adjusted R^2	0.19	0.25	0.23	0.27	0.28	0.41	0.38	0.45

Table 4 displays eight multiple regression models based on all 603 institutions reporting valid data. Models 1-4 use tuition and fee rates as the response variable, models 4-8 use tuition and fee revenues per FTE as the response variable.
The coefficient for each variable is listed in bold type, followed by the standard error in italics. For each model the R^2 and Adjusted R^2 are provided.
Significance for coefficients at the .10 level is denoted by *, at the .05 level by **, and at the .01 level by ***.

5.2. Non-Outlier Institutions

The second set of eight regression models was based only on the non-outlier institutions. The outputs of these analyses are shown in Table 5. Again, all eight models returned coefficients for state appropriations, expenses, and other revenues that are statistically significant at a 99% confidence level. State appropriations were again negatively correlated with tuition and fees in as expected, providing further evidence of a strong negative relationship between the two. With the outlier institutions removed from the dataset however, the dummy variables for healthcare offerings and flagship status lost much of their significance and their strength as predictors of tuition and fees. In comparison with the first set of models, the coefficients from the second set of models indicate that other revenues and total expenses per FTE student have a stronger impact on tuition and fee rates at the non-outlier institutions.

Models 9, 10, 11, and 12 use tuition and fee rates as their response variables. In all four of these models the dummy variables for flagship status, medical degree offerings, and hospital operation were not statistically significant. Of this set, model 9 appears to best fit the data. It predicts that on average, an additional $1000 in state funding per FTE student will reduce tuition and fee rates by $376, all else equal. If also predicts that for every additional $1000 in other revenues per FTE student, tuition and fee rates will fall by an average of $403, all else equal. Finally, it forecasts that for every additional $1000 in expenses per FTE student, tuition and fee rates will rise an average of $553, all else equal.

Models 13, 14, 15, and 16 use tuition and fee revenues per FTE student as their response variables. When included, the dummy variable for medical degree offering was statistically significant at a 95% confidence level. Flagship status was significant at a 90% confidence level in model 15, but not in model 16. In addition to weakening their statistical significance, excluding the outliers from the dataset reduced the predicted effects of these variables. With outliers removed, the predicted effect of flagship status was reduced by more than 75%. Likewise, the predicted effects of healthcare offerings were more than halved in every model. Furthermore, the coefficients for state appropriations, other revenues, and expenses per FTE student were not noticeably different between the models that included and excluded each of these dummy variables. Finally, including these variables in the models for non-outlier institutions resulted in only negligibly higher R^2 values, though including them in the previous models based on all institutions greatly increased R^2 values .

With this in mind, model 13 is most appropriate to explain the variation in tuition and fee revenues per FTE when excluding outlier institutions. Out of the entire set of sixteen models, model 13 has one of the highest R^2 values. It predicts that for every additional $1000 in state appropriations per FTE student, tuition and fee revenues per FTE student will fall by an average of $684, all else equal. Notably, of the sixteen regressions, this model predicts the strongest negative relationship between state funding and tuition and fees. It also forecasts that on average, every additional $1000 in other revenues per FTE student will lower tuition and fee revenues per FTE student by $493, all else equal. Finally, this model projects that for every $1000 in additional expenses per FTE student, tuition and fee revenues per FTE student will rise by $757, all else equal. Of all the regressions, this model predicts the strongest positive relationship between expenses and tuition and fees.

Table 5. regression outputs for non-outlier institutions

	Model 9 DV Tuition & Fee Rates	**Model 10** DV Rates, Healthcare Dummy Variables	**Model 11** DV Rates, Flagship Dummy Variable	**Model 12** RV Rates, Healthcare & Flagship Dummies	**Model 13** RV Revenues	**Model 14** RV Revenues, Healthcare Dummies	**Model 15** RV Revenues, Flagship Dummies	**Model 16** RV Revenues, Healthcare and Flagship Dummies
Intercept	**$3428.664*** ***** *256.34*	**$3234.683*** ***** *269.32*	**$3181.464*** ***** *265.09*	**$3179.136*** ***** *275.41*	**$1187.679*** ***** *236.63*	**$1408.959*** ***** *246.83*	**$1300.028*** ***** *244.17*	**$1485.957*** ***** *252.11*
State Appropriations Per FTE	**-$0.376*** ***** *0.05*	**-$0.375*** ***** *0.05*	**-$0.380*** ***** *0.05*	**-$0.378*** ***** *0.05*	**-$0.684*** ***** *0.05*	**-$0.666*** ***** *0.05*	**-$0.678*** ***** *0.05*	**-$0.662*** ***** *0.05*
Other Revenues Per FTE	**-$0.403*** ***** *0.04*	**-$0.401*** ***** *0.04*	**-$0.401*** ***** *0.04*	**-$0.399*** ***** *0.04*	**-$0.493*** ***** *0.03*	**-$0.502*** ***** *0.03*	**-$0.498** *0.03*	**-$0.505*** ***** *0.03*
Total Expenses Per FTE	**$0.553*** ***** *0.03*	**$0.553*** ***** *0.03*	**$0.559*** ***** *0.03*	**$0.558*** ***** *0.03*	**$0.757*** ***** *0.03*	**$0.737*** ***** *0.03*	**$0.748** *0.03*	**$0.730*** ***** *0.03*
Flagship	-	-	**-$457.067** *459.31*	**-$447.472** *463.33*	-	-	**$764.120*** *423.06*	**$620.282** *424.13*
Medical Degree	-	**-$203.560** *357.09*	-	**-$160.149** *359.93*	-	**$829.948*** ***** *327.26*	-	**$769.771*** ***** *329.48*
Hospital	-	**$1041.099** *833.72*	-	**$1040.700** *833.78*	-	**$767.499** *764.08*	-	**$768.053** *763.24*
R^2	0.42	0.42	0.42	0.42	0.60	0.61	0.61	0.61
Adjusted R^2	0.41	0.41	0.41	0.41	0.60	0.61	0.60	0.61

Table 5 displays eight multiple regression models based on 523 institutions, excluding the 80 outlier institutions. Models 9-12 use tuition and fee rates as the response variable, models 13-16 use tuition and fee revenues per FTE as the response variable.
The coefficient for each variable is listed in bold type, followed by the standard error in italics. For each model the R-squared and Adjusted R-squared are provided.
Significance for coefficients at the .10 level is denoted by *, at the .05 level by **, and at the .01 level by ***.

6. Conclusion

6.1. Discussion

As a whole, these analyses provide strong evidence that there is a negative relationship between state funding and tuition and fees at public four year universities. This finding is supported whether tuition and fees are measured as the rates that universities publish or as the revenues that they collect per FTE student. It also stands regardless of whether the analysis includes outlier observations, as well as dummy variables for flagship status and healthcare offerings. There is also evidence that greater spending on the part of universities will lead to higher tuition and fees. Additionally, there is evidence that growing revenue sources outside of the state and students will reduce tuition and fees.

These findings have implications for policymakers and institutions seeking to make progress on college affordability. Policymakers striving for lower tuition and fees at their state institutions should commit to maintaining or increasing state funding per student. As long as enrollment grows and inflation impacts the cost of providing an education, states may not be able to forestall tuition and fee increases by simply maintaining the absolute dollar value of their investments in higher education.

At the same time, institutions striving for lower tuition and fees should commit to responsibly controlling their expenses and working to augment their other sources of revenue. Still, these institutional strategies have qualifications. Smaller institutions often cannot achieve the economies of scale that larger institutions easily reach, which means cutting spending beyond a certain point will impact services that students and faculty want and rely on. Additionally, growing other revenues may prove difficult for smaller institutions without high-profile reputations than it is for larger regional universities. Ultimately, some institutions may simply require more support than others to maintain low tuition and fees.

6.2. Further Research

There are avenues for further investigation of the relationship between state funding and tuition and fees. First, factors outside of healthcare offerings and flagship status could be explored in order to account for outlier institutions. A further statistical analysis could be produced by employing a matched group design. Institutions would first be grouped based on similar levels of expenditures, revenues, and state appropriations. These groups would then be compared to determine whether there are significant differences in tuition and fees across the groups. Alternatively, a longitudinal study could be done in place of a cross-sectional study. Data going back several decades could be used to analyze the relationships between spending, other revenues, state funding, and tuition and fees over time.

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