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DETERMINANTS OF THE CHANGING FUNDING BURDEN OF HIGHER EDUCATION¹

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ABSTRACT

This paper analyses the political economy of public higher education funding in the United States and offers a unique conceptual and empirical approach to describe the determinants of funding sources. By evaluating the tuition proportion of revenue, this analysis estimates the determinants of the relative distribution of the funding burden between public and private sources. The empirical results show inelastic substitution between government appropriations and tuition revenue, significant demand effects on tuition revenue, and that institutional differences contribute to varying dependence on tuition as a source of revenue. The estimated determinants identify several areas where state and university policies may directly affect the relative burden of higher education costs.

Keywords: Education economics, education finance

INTRODUCTION

Public subsidization of higher education costs reached its peak in the years following World War II. However, in the second half of the twentieth century, the revenues of public universities have become more dependent upon tuition and fees paid by students. The trend toward an increasing reliance on tuition as a source of revenue for public universities accelerated at the beginning of the twenty-first century and shows few signs of slowing. Most research on this topic has characterized the increased reliance on tuition as a substitution for exogenously determined public funding. This approach neglects the complexity of public higher education funding. Of course, budget constraints limit government allocations to higher education. However, budget constraints are not exogenously determined because they are the result of political priorities and public policy goals. Furthermore, tuition revenue is subject to the pricing strategies employed by universities. This paper describes the shared cost burden of higher education as a function of institutional factors² affecting the prioritization of higher education appropriations and the willingness and ability of universities to generate tuition revenue by capturing student demand.

INSTITUTIONAL EVOLUTION AND FUNDING SOURCES

There has been a clear trend of decreased state funding and increased tuition even though some of the effects have been partially offset by federal funding and increases in direct grant-aid

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² Discussion of *institutions* and *institutional factors* with respect to higher education can cause some confusion due to the common practice of referring to the universities and schools themselves as institutions. Within economic theory, the term *institution* refers to formal and informal rules guiding social and economic interactions. Although there is no universally agreed upon definition, Douglass North provided a popular description of *institutions* as “humanly devised constraints that structure political, economic, and social interaction” (North 1991, 97). In this paper, the term *institution* refers to the definition cited above and is not used as a synonym for a college or university.

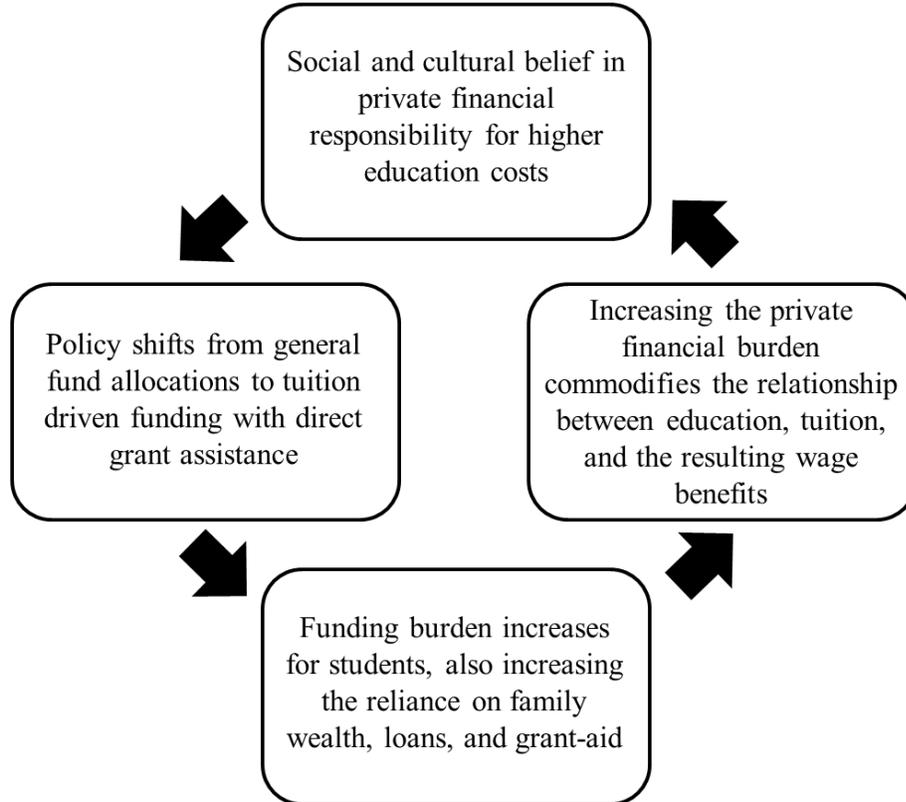
to individual students (National Center for Education Statistics 2019a). However, this does not necessarily imply decreased state funding is an exogenous determinant of the rising tuition burden. A more holistic approach, which considers the institutions that govern how higher education is funded and rationed, will help clarify the underlying relationships between funding sources. Like any other scarce good, higher education must be rationed, and price rationing has emerged as a significant factor in its allocation. Price rationing is by no means the only method of determining who attends college. For example, student merit contributes to the rationing of education and can be recognized as academic skill, athletic ability, and other desirable characteristics. Universities, students, and legislators recognize that any form of excludability can create a system of allocation that produces benefits to certain students while potentially limiting others (Rosovsky 1990; Duffy and Goldberg 1998; Winston 1999; Alon and Tienda 2007).

Whether it is price rationing, academic merit, athletic prowess, or social capital, the qualifications used to determine who receives a college education will affect social beliefs about the purposes and goals of higher education. For example, the past practice of allowing family connections and social status to serve as admission qualifications for Ivy League schools contributes to the lingering belief that these schools serve as social grooming for the elite (Mullen 2009). In recent times, the expansion of college sports and athletic scholarships may contribute to the social view that universities have become overly engaged in the sports entertainment business. Although higher education continues to be rationed in many ways, this analysis will focus on price rationing occurring through rising tuition rates.

The existing literature has extensively documented the shifting funding burden from public sources to individual tuition payments. However, the empirical literature on public higher education is often biased by assumptions of exogeneity between government appropriations and tuition revenue. The complex relationships between formal and informal institutions governing higher education funding create endogeneity between the various funding sources. Therefore, it is inaccurate to model one funding source as an exogenous determinate of the other.

Rather than modelling tuition as a substitute for government funding, this paper attempts to identify specific institutional variables that can be linked with observable changes in the portion of university revenue attributable to tuition revenue. Although they do not offer a specific model or methodology, John W. Meyer, et al. (2007) encourage studying the relationships between higher education and the wider institutional environment in ways that challenge the typical causality assumptions of most research. Figure 1 presents an evolutionary model of the social process of higher education allocation illustrating the interaction of beliefs, price-rationing policies, and commodity characteristics of public higher education.

Figure 1: Conceptual Model of Institutional Change in Higher Education Funding



The institutional environment of higher education funding is complex, but we can identify some important elements. The influence of the belief in a personal responsibility for higher education costs grew in the 1970s and has only become stronger in the new millennium (Best 1988; Breneman 1997; Levine 1997; Schulman 2001; Loss 2012). This belief is rooted in the idea that because higher education provides private financial benefits, it should be a fee-based service paid for by students. Belief in a privatized funding strategy leads to policies that shift the funding burden away from public sources to individualized funding such as tuition payments and direct student aid.

Along with increasing tuition levels, there has been an increase in the dollar amount of student aid available. The use of publicly funded grant money to finance education reduces the financial burden on students. However, the act of individuals choosing to spend personalized grant money still strengthens the private relationship between students and higher education even if the money spent was given to them (Barber 1992; Singell and Stone 2007; Loss 2012). The literature examining the consequences of the increasing use of student loans also supports the theory of a closer personal financial relationship between students and schools (Ozdagli and Trachter 2011; Avery and Turner 2012; Mettler 2014).

Individualized funding and a higher private funding burden likely contribute to an increased sense of private ownership over the returns to higher education. This belief creates endogeneity of government funding and tuition. Students and families who take on a large

financial burden to fund their education will likely feel they personally purchased the opportunity to earn high wages. The strength of this belief is evident in the common characterization of education as an investment.

The increased reliance on tuition revenue as a funding source compels both students and universities to recognize the exchange value of education. Universities must consider pricing strategies and student demand in order to sell their services and generate the necessary revenue to remain operational. The monetary exchange of tuition for education accentuates pecuniary elements of higher education. While entertainment, social prestige, or the joys of learning also contribute to students' demand for higher education, the financial incentives appear to be the primary motivator (Schofer and Meyer 2005; Perna 2008; Ozdagli and Trachter 2011; Avery and Turner 2012). The financial benefits are a significant contributor to student demand, and the pecuniary assessment of tuition and monetary benefits contributes to increased social relevance of the exchange value of higher education.

The commodified allocation of higher education reinforces the social and cultural belief that individuals should be responsible for their own education costs, thereby reinforcing the cycle. The literature describes an increasing acceptance of higher tuition and increased reliance on student loans, as well as an unwillingness to increase government aid or appropriations to limit the reliance on tuition revenue (Jongbloed 2003; Slaughter and Rhoades 2004; M. J. Rizzo 2006; Perna 2008; Archibald and Feldman 2011). Students and states are accepting and adapting to the changing institutional environment of higher education allocation.

Institutional changes governing the distribution of higher education funding are self-reinforcing because those students who purchased their education are likely to have a strengthened sense of private ownership over their purchase. For example, a student who personally paid for college may feel they paid a fair price and deserves the higher wages resulting from their degree. After graduation, this sense of private ownership may increase their opposition to having their higher wages taxed in order to publicly subsidize other students' college costs. This hypothesized response is supported by research showing survey respondents who completed a college degree were more likely than respondents without a college degree to say that federal spending on financial aid for college students should be decreased (American National Election Studies 2012). In a survey by the Pew Research Center (2011), those with any level of post-secondary education were more likely than those with only a high school diploma or less to say, "Students or their families should pay the largest share of a student's college expenses." The survey also showed that the source of college students' funding may affect their opinions. Sixty percent of those who paid most of their college expenses using personal or family funds and loans felt students and their families should bear most of the funding burden. On the other hand, only forty-one percent of those who relied on scholarships felt that way (Pew Research Center 2011).

The process illustrated in Figure 1 and described above is cyclical and allows for continued institutional evolution and reinforcement of policies and beliefs. This cyclical model differs from the typical linear approach which assumes tax revenue determines government funding for higher education and that tuition revenue is then used to fill in the remaining budget gap. Assuming exogenous government revenue ignores the importance of institutions affecting revenue and expenditures and their effects on funding for higher education. The assumption of exogenous

appropriations as a determinant of tuition disregards the endogeneity of tax revenue because states that desire lower tuition rates are likely to raise tax revenue to subsidize student costs.

EMPIRICAL METHODS

As described above, the institutional structure that leads to higher education funding policies is complex. The empirical specification in this analysis reduces the bias created by the simultaneity of the observed public and private revenue components in two ways. First, the following empirical model will analyze the determinants of the tuition revenue as a proportion of government funding. Also, this analysis does not assume the desire to subsidize education is constant over time or across institutional environments; therefore it includes variables that likely correlate with social beliefs concerning the appropriate level of government funding. In the last twenty years, rising student demand, university operating strategies, the shift toward federal student assistance, changing governing board structure, shifting state budget priorities, and increased private competition have exerted influence on higher education funding. This empirical analysis estimates the effects of these institutional factors and other determinants on the proportional tuition funding burden born by students. Therefore, the empirical results also relate to the conceptual model in Figure 1 describing how the institutional environment can contribute to the shift of the funding burden from publically funded sources to individualized student tuition payments.

Previous Empirical Studies

While no previous study of structural changes in higher education used a similar conceptual framework or proportional tuition measurement, there have been several previous studies which have also explored the balance between state appropriations and tuition revenues. Due to the vast amount of published work on the subject, a full review of the literature would be unnecessarily cumbersome. The literature discussed below has similarities or results that relate directly to the empirical work of this paper.

Koshal and Koshal (2000) used a state level model to simultaneously estimate the tuition and state appropriation levels for universities. Their study only uses data from 2000, does not account for federal funding, and aggregates results to the state level, but their three-stage least squares model offers an attempt to consider the simultaneous effects of changing funding sources. Koshal and Koshal challenged previous work by Hearn, Griswold, and Marine (1996) that supported the hypothesis that tuition increases were driven by regional factors such as income and the prevalence of private higher education competition. Koshal and Koshal's findings indicate that the level of state appropriation was also an important factor in determining the tuition levels even when including dummy variables to capture differences between regions. However, their simultaneous estimates for tuition and state appropriations found inelastic substitution effects between the two revenue sources. Their finding of inelastic substitution effects suggests that modeling tuition as a direct substitute for government funds may not be appropriate. In addition, the significance of regional dummy variables found by Hearn, Griswold and Marine (1996) and Koshal and Koshal (2000) suggest more detailed model specifications could identify the relevant differences captured by fixed effects. The reliance on state or regional fixed effects is also common in literature focused on modeling state higher education expenditures (Kane, Orszag, and

Gunter 2003; Okunade 2004; Ronca and Weerts 2012).

Lowry (2001a, 2001b) concluded that universities with more administrative autonomy tend to generate more revenue from tuition, indicating that political forces and state legislatures do have some influence over the tuition rates charged at individual universities. This conclusion along with studies showing price inelastic demand (Heller 1999; Shin and Milton 2005; Hemelt and Marcotte 2011) indicate that universities' ability to exploit their full revenue generating potential is held in check by institutional factors. In other words, state-level oversight and less administrative autonomy may reduce the tuition revenue collected by public universities.

Rizzo and Ehrenberg (2004) simultaneously estimated changes in tuition for both in-state and out-of-state students, the level of state grant-aid, and the share of students who pay non-resident tuition. Their study shows how demand-side pressure allowed some universities to capture higher tuition revenues. Like Koshal and Koshal (2000), Rizzo and Ehrenberg (2004) estimated very inelastic substitution between state and federal funding and tuition revenue. The inelastic substitution between government funding and tuition funding was corroborated in later work by Kim and Ko (2015) and Webber (2017). These results suggest that it is not correct to assume tuition is a direct substitute for government funding, and that the other factors explored in this research may be more important determinants of tuition.

Serna (2015) expanded the analysis of tuition rates by exploring institutional factors that may be correlated with changes to government funding such as tax and expenditure limitation rules and political ideology. Serna (2018) also explored regional fixed effects as a method for capturing institutional differences that may affect tuition rates. These studies support the conceptual model proposed in Figure 1, which describes a process where underlying social priorities may significantly affect tuition rates at public universities. However, the empirical approach of both Serna's models uses state government appropriations for universities as an exogenous determinant of tuition.

Model Specification

Prior research treating state appropriations as an exogenous explanatory variable for tuition suffer from bias in the estimates because of the endogeneity between those two sources of revenue. As described above, this endogeneity is created by the simultaneous effects on both sources of revenue from the formal and informal institutions that guide higher education funding policies. Therefore, models that do not include independent variables to capture these institutional differences are biased by omitted variables. Alternatively, models that include state appropriations along with independent variables capturing institutional differences are biased by multicollinearity between independent variables. Previous studies provide evidence that tuition and government funding are not dollar-for-dollar substitutes, which also supports the conceptual hypothesis that tuition and government funding levels are not merely the result of budget substitutions. In addition to the endogeneity, there is a lack of clear directional causality between tuition and state funding. Prior studies have shown the process of setting tuition and determining state appropriations is complicated, political, conducted with asymmetrical information, and requires sequential negotiations (Serna 2018). Therefore, it is theoretically incorrect to include either of the revenue sources as an exogenous determinant of the other.

The empirical model used here attempts to avoid the biases caused by the endogeneity of tuition and government appropriations by using a specification that includes both revenue sources in the dependent variable. By using tuition revenue measured as a proportion of government revenue as the dependent variable, changes to state funding will also be reflected in the dependent variable because state funding is included in the base value of the tuition proportion. This specification allows for testing of independent variables that may affect tuition or state funding or both. Using the proportional measurement also reduces biases due to underlying cost trends and difficulties in normalizing dollar figures across different years and states. This specification will help highlight the limitations of estimating only one revenue source. To compare the findings of this research to previous studies, the results will also contain estimations of the per student dollar amounts of state appropriations and tuition revenues.

Like most other studies, this model recognizes that unforeseen or poorly anticipated economic conditions can cause shortfalls in public funding and will likely affect the balance between funding sources. In addition, the composition of revenue will be affected by the prioritization of higher education funding and the level of student demand. For each observed university and year, tuition revenue as a proportion of government revenue is estimated using a generalized least squares panel regression with variables intended to capture state budget constraints, political institutions, and student demand, as well as fixed effects for states and years. The state fixed effects reduce omitted variable bias by capturing variations between states unaccounted for by the independent variables. This specification is more appropriate than an individual university fixed effect model because it allows for estimation of the effects of time-invariant university characteristics. The time fixed effects reduce omitted variable bias by correcting for underlying annual trends that are difficult to capture with the available data. In addition, the standard errors are clustered by schools to account for heteroscedasticity. The following equation shows the general conceptual approach of the empirical model, and the data section below includes detailed descriptions of the specific variables.

$$\begin{aligned} \text{proportional tuition revenue} = & \beta_0 + \beta_1 (\text{state budget}) + \beta_2 (\text{political institutions}) \\ & + \beta_3 (\text{student demand}) + (\text{State FE}) + (\text{Year FE}) + \epsilon \end{aligned}$$

$$\text{Where: proportional tuition revenue} = \frac{\text{tuition revenue}}{\text{state and federal funding}}$$

The proportional tuition revenue is estimated using determinants that influence the levels of both tuition revenue and government funding. The intent of this analysis is not to examine the absolute costs of higher education, but rather to evaluate how the costs are shared between privately funded tuition and public subsidization. In the dependent variable, privately paid tuition is in the numerator while taxpayer funded public revenue sources are in the denominator. Therefore, the relative size of the private and public revenue sources will determine the rise and fall of the tuition proportion. Determinants of state funding affect the tuition proportion by altering the public revenue used as the base value of the tuition proportion. Student demand and the willingness and ability of universities to capture that demand affect the tuition proportion primarily through tuition revenue. Some variables also influence the proportional tuition by affecting both tuition rates and the amount of government appropriations allocated to universities. The results also include separate estimations of per student dollar amounts of state appropriations and tuition

revenue to provide some insight into how each independent variable is affecting both the numerator and denominator used to determine the proportional tuition.

The panel regression includes determinants of the proportional tuition associated with the scarcity of government funds, political institutions, students' willingness to pay, university characteristics, and other differences between states. If the variation in the proportional tuition revenue is determined primarily by state budget limitations, then institutional factors unrelated to economic conditions should play only a small role in determining how higher education is funded. If tuition revenue is determined primarily by the scarcity of available public funds, then exogenous economic and budget conditions should be the only significant determinants. However, both political and budgetary pressures can contribute to rising tuition (Johnstone 2004). States may prioritize funding to schools based on specific university characteristics. Also, the prioritization of subsidizing higher education costs may vary due to changing political beliefs over time. Stronger beliefs in the personal responsibility for higher education costs should produce a shift in funding priorities, and will lead to increased reliance on tuition as a revenue source. University characteristics and variations across the institutional environments of the states that increase the ability of universities to capture students' willingness to pay should positively correlate with higher proportional tuition. Also, demographic characteristics that are associated with higher or lower preferences for higher education will also likely be correlated with tuition revenue.

DATA

This study focuses on public universities in the United States offering degrees at the baccalaureate level and above. The data set comprises a panel of 479 public universities observed annually over the years 2001 to 2015, and yields 7103 observations across the multiple variables and years of interest. Although it would be ideal to include data from earlier years, data collection methods and changing variable definitions render data collected before and after 2000 incomparable for the objectives of this research. Some schools do not report data for all years, but the bias due to an unbalanced panel is likely less consequential than the bias created by dropping the schools with incomplete data because the missing data is not randomly distributed. For example, only the top-tier research schools, University of Kansas and Kansas State University, reported data for all years while the smaller Kansas campuses did not. Similarly for New York universities, dropping schools with missing observations would have excluded all schools within the SUNY system while retaining nearly all of the CUNY schools.

As described above, the main dependent variable of interest in this model is tuition revenue measured as a proportion of government allocations. Figure 2 shows the percentage of total revenue from tuition along with the percentage attributable to state grants and appropriations, and federal grants and appropriations.

Figure 2: Average Percentage of University Revenue by Source. Source: National Center for Education Statistics (National Center for Education Statistics 2019b).

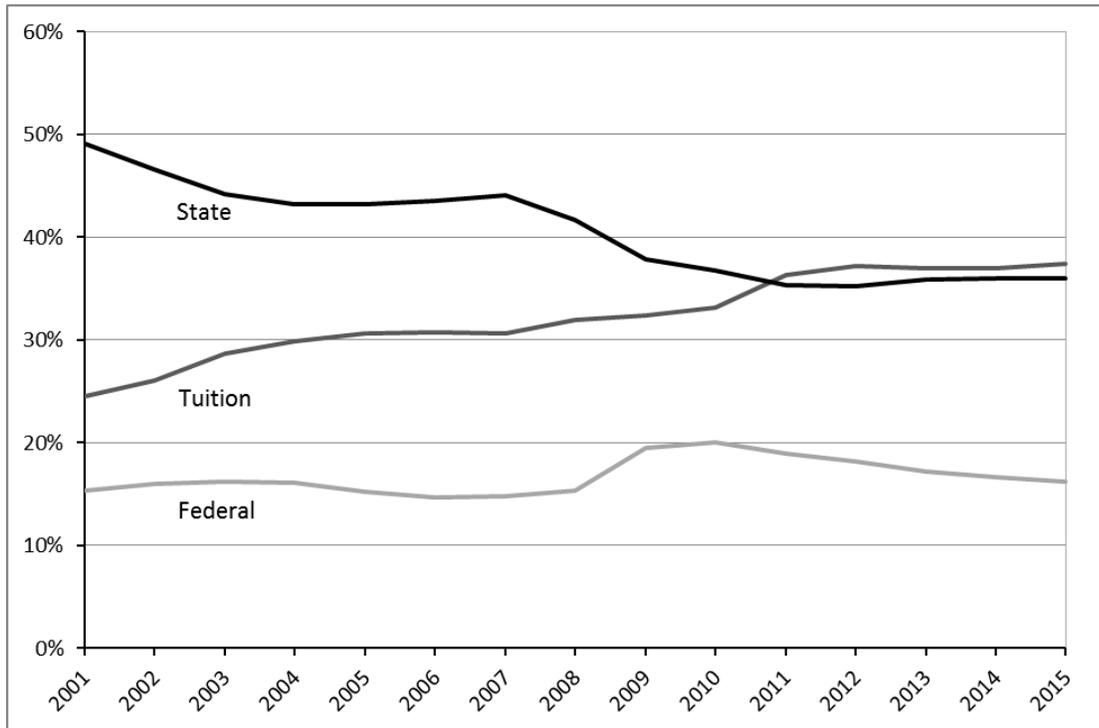


Figure 2 shows the percentages of the three main sources of revenue, but excludes from total revenue investment income, hospital revenue, sales from auxiliary enterprises, and other undefined and volatile revenue sources. After subtracting those unstable and extraneous sources of revenue, tuition, state, and federal sources of revenue consistently compose nearly ninety percent of remaining revenues for the universities in the sample. The remaining ten percent of revenue consists of local grants and appropriations, private gifts, and other revenue generating operations of the university.

In this dataset, tuition revenue measures only tuition and fees paid by students or their benefactors. Tuition revenue does not include any revenue billed as tuition but paid through federal, state, or university grants and scholarships. Therefore, the proportional tuition measures the extent to which universities have shifting to selling their goods and services directly to students rather than relying on taxpayer funded government allocations and other university funds.

The independent variables are comprised of both university specific and state-wide observations and can be organized into four categories. The panel regression specification allows the model to estimate the effects of these variables as they vary between states, universities, and years. To help reduce the error correlation due to the potential for endogeneity between funding sources and certain right-hand-side variables, one-year lagged terms are used to eliminate the possibility of a reversed direction of causality in the estimated relationships. The descriptive statistics of the variables are shown in Table 1 and descriptions of each variable follow.

Table 1: Descriptive Statistics of the Regression Variables. Data Sources: National Center for Education Statistics (2019a, 2019b), National Conference of State Legislatures (2019), U.S. Census Bureau (2011, 2017, 2018), and U.S. Bureau of Labor Statistics (2018).

	Mean	Std. Dev.	Min	Max	Frequency	Percent
Dep. Var: State appropriations per student (1000s 2016\$s)	6.331	3.567	0.260	32.453		
Dep. Var: Tuition revenue per student (1000s 2016\$s)	4.909	2.778	0.304	22.488		
Dep. Var: Tuition as a % of government funding	65.555	49.835	1.463	755.535		
State budget constraint variables						
State unemployment rate L	6.152	2.029	2.3	13.7		
Per capita K-12 state spending (1000s 2016\$s)	1.845	0.399	1.247	3.645		
Poverty rate L	13.259	3.219	4.5	23.1		
Public post-secondary students as % of state population L	4.577	0.851	2.762	7.306		
Political institution variables						
Party control of state legislature						
0 = Republican or split					4,282	60.28
1 = Democratic control					2,821	39.72
Independent board of governors						
0 = does not have an independent board					5,137	72.32
1 = has an independent board					1,966	27.68
Number of boards of governors	6.257	5.082	1	18		
Student demand variables						
Federal funding per student (1000s 2016 \$s)	3.004	3.190	0	32.815		
Open admissions						
0 = some restrictions or competitive admissions					6,608	93.03
1 = open enrollment					495	6.97
Percentage of out-of-state students L	15.319	14.174	0	94		
Carnegie Rank of the University:						
0 = baccalaureate colleges, diverse fields					675	9.5
1 = baccalaureate colleges, arts, and sciences					361	5.08
2 = master's colleges and universities, small programs					458	6.45
3 = master's colleges and universities, medium programs					840	11.83
4 = master's colleges and universities, large programs					2,368	33.34
5 = doctoral / research universities					426	6.00
6 = research universities, high research activity					1,054	14.84
7 = research universities, very high research activity					921	12.97
Public university students as % of all university students L	66.373	14.790	22.124	100		
Youth percent of population	27.098	1.900	21.806	35.875		
White, non-Hispanic percent of the youth population	60.569	16.783	13.528	94.428		
Other control variables						
Total student enrollment (1000s) L	15.858	12.731	0.627	81.789		

Median state income (1000s 2016 \$s) L	55.832	8.352	33.310	81.023		
7,103 observations from 479 colleges over 15 years (2001-2015), unbalanced panel						
L indicates variable is lagged one year						

State funding for higher education is a large component of state budgets but is not immune to competition from other state funding priorities. The U3 annual state unemployment rate (U.S. Bureau of Labor Statistics 2018) provides a measure of the economic conditions in each state and year. Economic downturns and higher unemployment may reduce tax receipts, increase spending on automatic stabilizer stimulus programs, and lead legislators to prioritize other budget items, thereby reducing funding to public universities. In addition, universities may raise tuition rates in order to substitute for the falling state appropriations.

State appropriations for primary and secondary schools are also a competing budget item for higher education funding. Higher allocations to public K-12 education may leave less money available for public higher education, and therefore could be positively correlated with proportional tuition revenue. However, the same social priorities that lead certain states to provide higher than average K-12 funding may also lead to higher state allocations to post-secondary education. Therefore, it is possible that state spending on K-12 education could either be a substitute or a compliment to higher education funding. In order to characterize K-12 spending as a general funding burden for state governments, and to account for states and years with differing student and non-student populations, the analysis will use K-12 spending per capita rather than per pupil. This ratio is calculated using data from the National Center for Education Statistics (2019a) and the U.S. Census Bureau (2011, 2017).

The poverty rate, collected from the U.S. Census Bureau (2018), provides an indicator of the structural and cyclical spending used to alleviate the hardships of poverty. State portions of Medicaid and SNAP (Supplemental Nutrition Assistance Program) funding, along with other spending aimed at assisting the poor, may compete with higher education funding. If state funding for higher education is crowded out by other funding obligations, then higher poverty rates will likely positively correlate with the tuition share of revenues.

The percentage of the population attending public post-secondary schools, calculated with data from IPEDS (National Center for Education Statistics 2019b) and the U.S. Census Bureau (2011, 2017), is intended to capture the ability of states to subsidize students' college expenses. If higher education subsidies are simply determined by a scarcity of funds, then more students attending college will likely increase the proportion of university revenues generated through tuition. On the other hand, state government funding may follow the priorities of the people in the state. Proportionally larger student populations may correlate with prioritizing higher education funding.

The next three variables are intended to capture the political and social prioritization of subsidizing higher education costs. The policy platforms of the two major political parties tend to place a different priority on education funding. Therefore, a correlation between proportional tuition share and political majorities would indicate that funding priorities vary across states and years and contribute to the distribution of the funding burden. Compiled using data from the

National Conference of State Legislatures (2019), a categorical variable describes the majority control in the two houses of state government, where 0 indicates Republicans control both houses, 1 indicates each party has a majority in one house, and a 2 indicates Democratic control of both houses. One notable exception is the non-partisan, unicameral structure of Nebraska's legislature. The observations from the state of Nebraska were given values of 0 for all years due to the state-wide dominance of the Republican Party during the observed time period.

Some states have large systems of public universities with many campuses represented by a common board of governors. When universities concentrate their bargaining power into fewer boards of governors, they may be more successful when lobbying for government funds. Similarly, universities with their own separate board of governors may have limited lobbying and bargaining power when competing for government funds against other campuses. In addition to the total number of governing boards in the state, the regression includes an indicator variable identifying universities that have an independent board representing only that particular university. The data for these governing board variables is from the National Center for Education Statistics (2019b).

The remaining variables capture a range of factors relating to student demand, although some of these variables may also simultaneously influence the state's prioritization of providing funds. On average, the federal government supplies the third largest percentage of universities' revenues. The federal revenue variable, from the National Center for Education Statistics (2019b), is measured as a per student average and is adjusted to 2016 dollars. Most of this revenue is received by universities in the form of student grant-aid although some of the federal money is also allocated to research. Unlike state funding for higher education, federal funding can be assumed to be an exogenous determinant due to both how federal funding is received by universities and also by the federal legislative process used to set federal appropriations and grants. As noted above, tuition payments made by students using grant-aid is not included in the measured tuition revenue. If all other sources of revenue are constant, an increase in federal revenue should decrease the percentage of revenue received through tuition payments. However, it is also likely that federal funding to universities may affect state funding levels.

The selectivity of admissions, from the National Center for Education Statistics (2019b), may correlate with elements of both student demand and government funding priorities. Schools with minimal prerequisites and admission criteria are described as having open admissions. These schools are often pressured by state officials and legislators into adopting these admissions practices as part of a state effort to increase the accessibility of higher education and can be paired with higher state subsidization and lower tuition. In contrast to open admission universities, students may have higher demand for selective schools and those schools may be able to capture students' willingness to pay.

The percentage of out-of-state students, collected from IPEDS (National Center for Education Statistics 2019b), is included to adjust for the higher tuition rates paid by those students. The percentage of out-of-state students also likely correlates with the level of student demand for attending that particular university. In addition, universities with larger percentages of out-of-state students may be viewed by state legislators as less deserving of state funding.

The National Center for Education Statistics (2019b) also provides data on the Carnegie ranking of each school, defined as a discrete ordinal variable with values 0-7, where 0 is a non-specialized baccalaureate college and 7 is a doctoral degree awarding, top-tier research university. While the Carnegie rankings are determined by many factors, higher rankings are mostly attributable to the level of research activity on the campus. While this variable is somewhat correlated with other university characteristics, its inclusion is necessary to estimate any potential revenue effects due to varying levels of research. In addition, the ranking of a school may also contribute to student demand for that particular school.

State level data from the National Center for Education Statistics (2019b) is used to calculate the percentage of public university students among all university students. This variable shows the market share of public universities, and therefore also provides a measure of the relative market share of and competition from private higher education providers within the state.

The youth percent of population and the white, non-Hispanic percent of the youth population are calculated using data from the U.S. Census Bureau (2011, 2017). The youth population is defined as the percentage of the population under the age of twenty. These variables are included to capture the relative differences in demographic characteristics across states as well as changing demographics within states over the observed years.

The model also includes two additional control variables that aid the general accuracy of the model and reduce omitted variable bias. Total student enrollment, from the National Center for Education Statistics (2019b), is included to account for size differences between schools and the potential correlations with student demand and differences in state funding priorities. A squared enrollment term is also added to account for a non-linear enrollment effect likely to occur with large campuses. Lagged annual median state income, from U.S. Census Bureau (2018), is adjusted to 2016 dollars and may partly capture the willingness and ability of students and families to pay for college costs. Household income will likely capture other demand effects as well, such as a greater preference of children from wealthier households to attend college. States with higher or lower income may also prioritize higher education subsidies differently. Income also serves as a general economic indicator and may help account for fluctuations in macroeconomic conditions. In addition, a squared income term is added to allow the model to identify the likelihood of a non-linear relationship.

RESULTS

The results of the panel least squares regressions are presented in Table 2 and are consistent with expectations and the conceptual model. Table 2 includes a preliminary regression estimating per student revenue without attempting to capture the effects of variables related to differing political institutions, funding prioritization, or student demand. These effects are therefore likely falling into the estimated state and year fixed effects where they cannot be identified and interpreted. Comparing the results of the reduced regression to the full model shows Comparing the results of the reduced regression to the full model identifies the differences in institutional environment as well as the varying levels of student demand as influential and their addition to the model helps explain the mix of public and private revenue sources of higher education funding. As seen in the R-squared estimates, the inclusion of political institutions and student demand variables also

contributes to the overall fit of the model. A Wald Chi-squared test rejects the null hypothesis that all of the estimated coefficients in the political institutions category are zero. Similarly, the null hypothesis that all of the estimated coefficients within the student demand category are zero is also rejected. These statistical tests provide empirical evidence that variables related to the prioritization of state subsidies and student demand offer an improvement to the model of higher education funding.

The table also displays the estimated effects on per student dollar amounts of tuition revenue and per student state funding to show how the determinants affect components of both the numerator and denominator used to calculate the tuition proportion. The fourth regression shown in the table is the estimated effects of the dependent variables on tuition measured as a percent of government revenue. Comparing the results from the three fully specified regressions highlights the limitations of only estimating the effects on one source of university revenue and the benefit of estimating the proportional tuition revenue. In addition, the estimated effects of the dependent variables on the dollar amounts of state appropriations and tuition revenue support the prior research indicating inelastic substitution between these revenue sources, and offer additional details to explain those prior findings. This research shows several instances where state appropriations and tuition do not respond inversely to changes in an independent variable. This supports the hypothesis that state appropriations and tuition should not be modelled merely as budget substitutes and that a more complex model is necessary to understand higher education funding levels.

Table 2: GLS Panel Regression Estimates

Independent variables	Dependent variables (standard errors in parenthesis, clustered by school)			
	State appropriations per student (\$1000s)	State appropriations per student (\$1000s)	Tuition revenue per student (\$1000s)	Tuition as a % of government funding
State budget constraint variables				
Unemployment rate L	-0.090 ** (0.035)	-0.084 *** (0.032)	0.165 *** (0.025)	0.203 (0.557)
Per capita K-12 state spending (\$1000s) L	2.901 *** (0.371)	3.194 *** (0.382)	-0.951 *** (0.260)	-36.385 *** (5.223)
Poverty rate L	-0.039 *** (0.012)	-0.036 *** (0.012)	-0.002 (0.013)	0.161 (0.214)
Public post-secondary students / population L	0.734 *** (0.182)	0.720 *** (0.174)	-0.858 *** (0.182)	-14.940 *** (3.250)
Political institution variables				
Democratic Party control of state legislature		-0.014 (0.076)	0.023 (0.052)	2.204 * (1.226)
Independent board of governors		0.143 (0.368)	0.236 (0.325)	-0.933 (5.148)
Number of boards of governors		-0.427 ***	0.053	2.710 *

		(0.106)	(0.102)	(1.514)
Student demand variables				
Federal funding per student (\$1000s)		0.408 *** (0.049)	0.163 *** (0.045)	-3.589 *** (0.806)
Open admissions		-0.080 (0.139)	-0.228 ** (0.115)	-1.516 (2.169)
Percent out of state students L		-0.002 (0.005)	0.028 *** (0.004)	0.284 *** (0.076)
Carnegie rank		0.291 *** (0.074)	0.148 ** (0.060)	-0.390 (1.064)
Public university students / all university students L		0.022 *** (0.006)	-0.021 ** (0.010)	-0.257 ** (0.128)
Youth percent of population		0.255 ** (0.107)	-0.259 *** (0.099)	-4.543 ** (2.131)
White, non-Hispanic percent of the youth population		0.011 (0.035)	-0.019 (0.037)	1.190 * (0.640)
Other control variables				
Enrollment (1000s) L	-0.223 *** (0.027)	-0.203 *** (0.026)	0.043 (0.027)	2.585 ** (1.050)
Enrollment ² (1000s) L	0.002 *** (0.0003)	0.002 *** (0.0003)	-0.0003 (0.0004)	-0.039 * (0.022)
Median state income (\$1000s) L	-0.013 (0.060)	0.019 (0.055)	-0.069 * (0.036)	-0.607 (0.726)
Median state income ² (\$1000s) L	0.0002 (0.0005)	-0.0001 (0.0005)	0.0007 ** (0.0003)	0.003 (0.006)
R- squared (overall)	0.149	0.4717	0.6296	0.5140
Significance levels: * > 90%, ** > 95%, *** > 99%				
State and year fixed effects and a constant term were included in the estimation, but the coefficients are omitted for brevity.				
Total number of observations: 7,103 from 479 schools over 15 years (2001-2015), unbalanced panel, L indicates one year lag.				

The results suggest that the rising proportional tuition burden is not simply the result of higher education losing funding due to competition from other state funded programs. State and university characteristics appear to affect tuition revenues, indicating that demand is a significant determinant of the tuition proportion. The evidence showing that demographics and political institutions contribute to varying dependence on tuition revenue indicates a nuanced legislative process of funding allocation where political priorities and social beliefs affect the distribution of the funding burden.

State unemployment is negatively correlated with state funding and positively correlated with tuition revenue at universities within the state; however, the regression results did not produce a statistically significant relationship with tuition revenue measured as a proportion of government funding. The correlation with dollar amounts of revenue are consistent with the literature and

support the intuitive theory that higher education funding is at least partially determined by exogenous economic conditions and state budget pressures. There is little doubt that budget shortfalls contribute to lower levels of subsidization for higher education. However, the other results from the model also show that different institutional environments and funding priorities between the states, and changes to these factors over time, also have significant effects on the funding of higher education.

The unemployment rate captures the effects of unanticipated changes to funding competition between public programs. Spending on primary and secondary education is a large component of state budgets. But unlike state spending related to economic fluctuations, K-12 spending is relatively stable and foreseeable. K-12 funding is correlated negatively with the proportional student funding burden, indicating that changes to K-12 funding do not crowd out higher education funding. In other words, states that spend more on K-12 education also subsidize higher education at a higher rate despite the fact that these budget items are in direct competition for available state funding. This supports the theory that beliefs about the value of education and the desire to subsidize it may be more important in determining higher education funding than budgetary competition from known and anticipated state programs.

The poverty rate is negatively and statistically significantly correlated with the state funding. However, the poverty rate does not have a statistically significant effect on tuition revenue per student or tuition as a proportion of government funding. This offers additional evidence to explain inelastic substitution between state funding and tuition.

Higher levels of post-secondary education attendance among the population are correlated with higher levels of state funding, lower tuition revenue, and lower proportional tuition revenue despite the associated budgetary challenges. States seem to be altering their budgets to fund higher education rather than funding it in accordance with existing budget constraints. Politicians and university governing boards may increase state appropriations and decrease tuition as a response to the political pressure created by a larger constituent group with a personal interest in lowering the tuition burden.

In contrast with Koshal and Koshal's (2000) and Rizzo's (2006) findings, Democratic party control of the state legislature was not correlated with a lower tuition. This contrasting result is likely due to recent changes in both tuition policies and state legislative control. If data from 2013-2015 is omitted, the estimated effect of Democratic Party control is similar to the prior findings showing lower tuition burden in states and years with Democratic majorities.

Schools with independent governing boards do not appear to receive their revenues from a significantly different proportional mix of sources. This result contrasts with prior research suggesting that schools with independent governing boards may be crowded out of budget allocations when competing against multi-campus governing boards (Lowry 2001b). Also, it does not support the hypothesis or prior research (Kim and Ko 2015) that increased administrative autonomy leads universities to raise more revenue through tuition. However, another related result from this analysis corroborates with the prior research. The number of university boards of governors in the state is negatively correlated with state appropriations per student allocated to universities and is positively correlated with the proportional tuition revenue. Universities in states

with many boards of governors may have more difficulty lobbying for state appropriations. This result again suggests state funding for universities is the result of a more complex negotiation process than a simple budget item subject to available revenue.

When estimated at mean values of all variables, an additional \$1000 in federal revenue per student is estimated to reduce average tuition by approximately \$356. This is similar to previous findings in the literature that show federal grant-aid is relatively inefficient at lowering average tuition. When federal grant-aid is increased, not all students receive the aid. If universities raise tuition rates to capture the increased grant-aid, then the students who do not qualify for the aid will pay more out-of-pocket tuition while the students receiving the aid will see their out-of-pocket expense remain relatively constant. The idea that universities will raise tuition rates in response to increases in grant-aid was first suggested by Secretary of Education William J. Bennett (1987) and is referred to as the Bennett Hypothesis. Several previous studies have found mixed evidence of the Bennett Hypothesis. Singell and Stone (2007) found little evidence from public universities to support the theory, while other studies suggested the relationship does exist (M. Rizzo and Ehrenberg 2004; Epple, Romano, Sarpca, and Sieg 2013). The positive correlation between federal funding and the dollar amounts of tuition revenue per student found in this study supports the Bennett Hypothesis. However, the evidence also shows that increasing federal funding correlates with increased state appropriations as well. These simultaneous effects lead to the negative coefficient for federal funding's effect on tuition measured as a proportion of government revenue.

The model indicates that schools that are less selective in their admissions receive a significantly lower dollar amount of tuition revenue per student than universities with more restrictive admissions policies. The ability of schools to be selective in their admissions indicates a high level of student demand. The observation that schools with restrictive admissions are capturing student demand through their tuition payments supports the theory that public higher education revenues are not merely determined by state allocations. Universities appear to be actively considering student demand in the pricing of their services, which as outlined in the conceptual framework for this analysis, reinforces the shift toward increasing reliance on tuition as a source of university revenue. As discussed earlier, open-admission policies are usually a component of state policy intended to increase the accessibility of higher education. However, schools with open admissions did not receive a statistically significant difference in the amount of state appropriations. Schools with open admissions also did not generate a statistically significant effect on the proportional measurement of tuition revenue.

An unsurprising result is the positive and statistically significant relationship between the percentage of out-of-state students and tuition revenue. Rizzo and Ehrenberg (2004) also found evidence that out-of-state students contribute to increases in tuition revenues, and Jaquette and Curs (2015) suggest universities may actively pursue out-of-state students as a revenue generating strategy. A higher percentage of out-of-state students is an indicator of high student demand for the university, and this result offers support for the argument that student demand is a critical factor in determining the sources of university revenues. It also suggests that universities are actively considering student demand in their pricing and revenue generating strategies.

Compared to other schools, top-tier research schools take in higher dollar amounts of

revenue by charging higher tuition, but also receive much higher levels of state funding. Student demand for high-ranking schools may explain the ability of these schools to generate more tuition revenue, again giving evidence that student demand is a critical determinant of higher education funding. Since higher Carnegie rankings are associated with research focused universities, the higher state appropriations to these schools may indicate a desire to receive a return from funding to higher education rather than simply subsidizing student costs.

Tuition as a proportion of government funding is higher at public universities when and where there is a larger private college market presence. The estimations of the per-student dollar amounts indicates that public universities may be strategically altering their tuition rates with respect to the relative market share of private schools. Additionally, states allocate fewer dollars per student in states with a higher percentage of private school attendance. These results support the narrative that a higher market share of private schools contributes to the shift toward a tuition driven system of funding. That this relationship is observed while accounting for both state and year fixed effects shows that the commodifying effect of private competition varies not only over time, but also across the different higher education markets of the states.

A higher youth percentage of the population correlates with higher state appropriations, lower tuition revenue, and lower tuition as a proportion of government funding, which supports the theory that constituent priorities affect how states spend. This result is partially mitigated by the estimated effects of racial demographics within the youth population. White, non-Hispanic youth tend to attend four-year colleges at relatively higher rates (National Center for Education Statistics 2019a), so a higher percentage of this demographic is likely correlated with higher demand. Universities appear to be capturing this demand effect, which increases tuition as a proportion of government funding.

CONCLUSIONS

The results of the regressions give evidence to support a model of higher education funding where the institutional environment guiding public policy and student demand effect the relative funding burden between public and private revenue sources. This analysis describes higher education funding not as a simple annual budgetary issue, but as a dilemma where complex institutional factors contribute to the distribution of the funding burden. Despite the general trend, the reliance on privately paid tuition as a revenue source for public universities is not universal or unavoidable. The evidence from this study shows that states and universities can effectively aid or resist the shift toward an increased reliance on tuition revenue. Shifting higher education funding toward tuition revenue can reduce state spending and the tax burden. On the other hand, resisting the shift toward tuition as a source of funding may have significant policy implications in addition to reducing the financial burden placed on students. Declining public funding and an increased reliance on tuition revenue may also increase stratification between types of universities (Hoxby 2009). The evidence of the importance of demand in this analysis and prior research (Hemelt and Marcotte 2011) show that not all universities have the same ability to raise revenue through increased tuition rates. If all schools shift toward a tuition-based funding structure, those that are less successful in generating tuition revenue may experience declining total revenues leading to lower quality education.

Policy makers should also note that the institutional shifts leading to a rising tuition burden are not solely the result of government policies or an anti-student bias. Students and student advocates have consistently called for curricula shifts toward career-oriented education, and the increased emphasis on the financial benefits of higher education has increased the demand for higher education (Loss 2012; Thelin 2011). As shown in the empirical results here, universities are willing and able to capture student demand in the form of higher tuition revenue. The demand-side pressure on tuition rates has also been noted by others (Brown 2000; Kerr 2001; Newfield 2008). Therefore, policies focused on alleviating the tuition burden for students at public universities should not ignore the effects of student demand and the ability of public universities to capture that demand.

This research provides evidence that identifiable institutional differences affect state appropriations, tuition revenue, and the proportional tuition burden. The empirical results also show that universities are effectively capturing student demand in order to generate higher tuition revenues. These results show that the typical practice of modeling higher education funding as a series of annual, exogenous, budgetary decisions neglects the complexity of the institutional environment surrounding higher education funding policies.

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