LINKING UNIVERSITY EXPENSES TO PERFORMANCE OUTCOMES:
A LOOK AT DEPARTMENTS, COLLEGES, AND INSTITUTIONS

By

Justin Cole Shepherd

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Approved:

William R. Doyle, Ph.D.

Stella M. Flores, Ph.D.

Christopher P. Loss, Ph.D.

Michael K. McLendon, Ph.D.

Alisa Hicklin-Fryar, Ph.D.

To Nicci. ILY L&L F&A.

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CHAPTER I

INTRODUCTION & PROBLEM STATEMENT

Background

One of the core difficulties confronting higher education policy is determining whether the outputs of higher education are public or private in nature. Proponents of the private good viewpoint stress human capital development as the primary outcome of higher education and subsequently propose the use of tuition as the preferred funding mechanism. Alternatively, those with a public good viewpoint highlight the positive economic benefits that accrue from an educated workforce and recommend using state and federal subsidies to offset out-of-pocket expenses. In practice, higher education is both public and private, requiring policymakers to determine the proper mix of public support with private investment.

This instability over who should pay for college leads to policymakers and taxpayers asking what returns they are getting on their investment in higher education. This includes three components of financing higher education. First, how much should be contributed by the state and how much should students pay themselves? These questions regarding the sources of funding are directly connected to the public-private discussion on the nature of higher education. Second, how do institutions spend the money they receive from their various funders? This looks at the question of accountability and ensuring that public and private funds are being spent on items that promote institutional and statewide goals. Finally, the accountability concerns turn into questions of economic efficiency and whether institutions are using the funds effectively and producing high quality returns on investment. These questions of efficiency have become commonplace, measuring outputs in relation to the various sources of inputs and increasingly using these performance measures to evaluate institutions and allocate future funds.

However, a major concern of these efficiency measures is that they are frequently difficult to calculate and understand since the outputs of higher education are so intangible, diverse, and often ill-defined in relation to institutional goals (Gove & Floyd, 1975; Harvey, 1973; Kershaw & Mood, 1970). For example, the core missions of higher education are primarily split between instruction, research, and service. While measures of one output could show tremendous promise, another could be lacking, complicating the interpretation of whether an institution is acting efficiently. Additionally, measures are of varying importance to different constituents. Students, parents, administrators, legislators, and other stakeholders all have different perceptions of value and success. Each group is invested in a different way, financially and otherwise. This mix of interests results in differing viewpoints on where the institution should be focusing its attention. In this way, the public-private balancing act extends not only to the sources of inputs, but also to the outputs of institutions and institutional focus.

In addition to the questions of funding and the public and private returns on investment, higher education has long been subject to scrutiny over high costs (Alexander, 2011; Dumont, 1980; Ehrenberg, 2002a; Fincher, 1975; Franklin, 1952; Glenny & Schmidtlein, 1983; Hossler, Lund, Ramin, Westfall, & Irish, 1997; Levin, 1991; Massy & Wilger, 1992; McPherson, Schapiro, & Winston, 1989). One of the drivers of these cost increases has been attributed to unbridled aspirations. Institutions compete for the best and brightest students in order to raise their prestige (Massy & Wilger, 1992). In order to recruit these students, institutions must build new dormitories, classrooms, and sporting arenas to stay competitive and attractive. Similarly, institutions frequently seek to move to higher Carnegie classifications (Morphew & Baker, 2004). Again, the push for prestige involves an investment in research facilities and faculty to win grants and private funding. Finally, institutions compete with the private business sector, requiring high salaries and benefits in order to prevent the loss of talent to private enterprise. These competitive forces consume large amounts of inputs, driving costs up and diminishing per unit output ratios of productivity.

Given the multitude of interests by the various stakeholders in higher education, institutions must prioritize their competing foci and create processes that maximize returns. Yet herein lies the problem. Unlike the private business sector, higher education has no profits or monetary outputs to create financial ratios of success. Unlike government, higher education is unable to levy taxes. Instead, the higher education sector is situated at a crossroads between private and public sectors, operating as a non-profit organization (Geiger, 1985). To further complicate the situation is the fact that public institutions are not only non-profit institutions, but arguably state agencies or, at the very least, public corporations, receiving large amounts of revenue through state legislatures (Lane, 2007; Thackrey, 1971). This organizational makeup means that institutions set prices through tuition – like private business – yet they also have the potential to receive large amounts of taxpayer funding through government appropriations. However, they find difficulty in measuring non-monetary outputs.

Instead, institutions measure intangible outputs and attach intrinsic value to these results. This means that traditional evaluation methodologies used in business or government are insufficient for measuring performance in higher education.

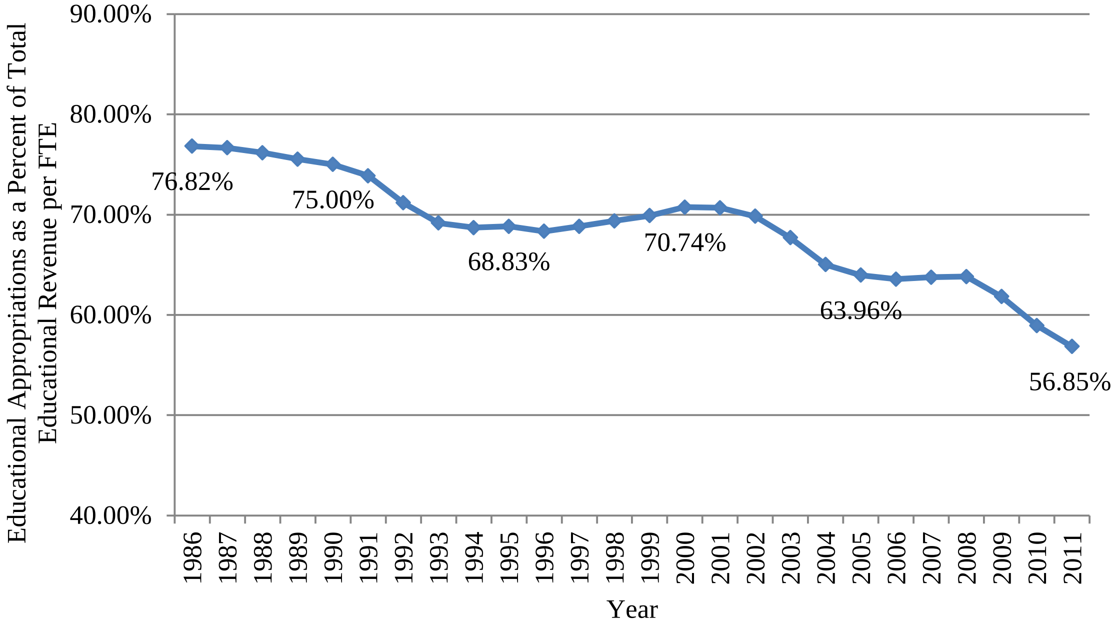
Traditional models of economic performance promote operating at a level where supply equals demand or where marginal benefits equal marginal costs (Rosen & Gayer, 2010). However, these models operate on maximization functions based on per unit measures of price and quantity. While these values can loosely be attributed to tuition and enrollments in higher education, they fail to fully incorporate the non-monetary intangibles of higher education, namely, quality (Atkinson & Massy, 1996; Baumol, Blackman, & Wolff, 1989; Bowen, 1977; Enarson, 1960; Massy, 1996; Massy & Wilger, 1992). Furthermore, they fail to account for the positive externalities that accrue to society through an educated workforce. Finally, they operate on the assumption of people acting rationally in their higher education enrollment decisions, which is likely not the case. These shortcomings necessitate the development of a production function where mission, funding source, processes, outputs, and outcomes are tailored to the intricacies of higher education. This need to develop a model for higher education motivates the conceptual framework that will be explored in more detail in Chapter 3.

Public Colleges & Universities (PCUs)

As illustrated, the higher education environment is a complex mix of public and private stakeholders frequently in competition over how best to manage institutions. For public colleges and universities (PCUs), this debate has been exacerbated by unprecedented financial challenges in the modern era of higher education. State

Figure 1.1

Educational Appropriations as a Percent of Total Educational Revenue per FTE



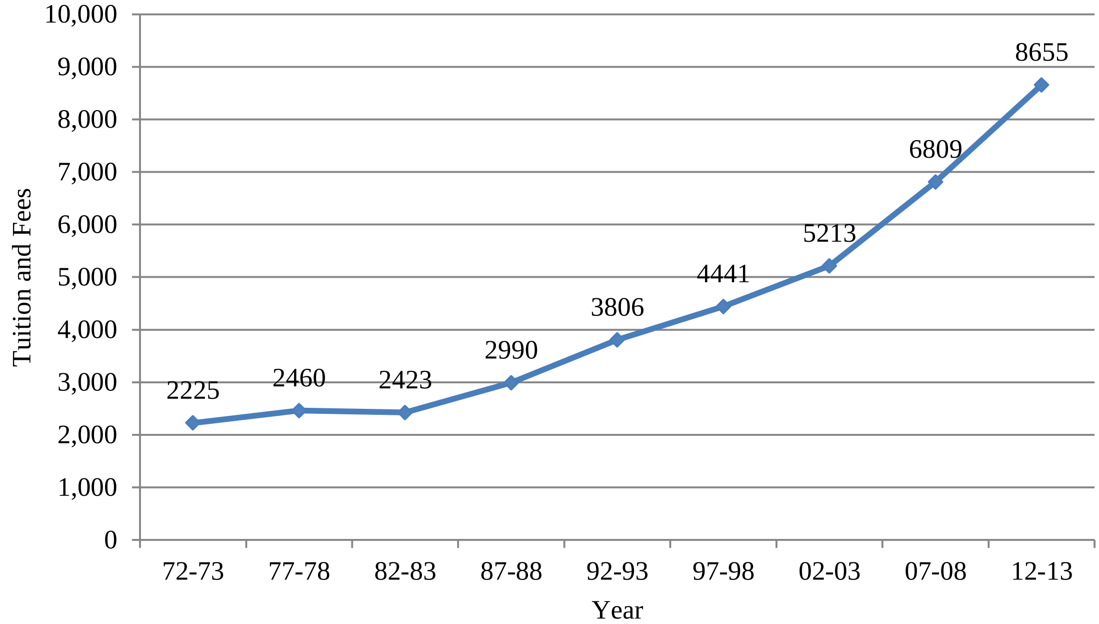
Source: State Higher Education Executive Officers, 2012 appropriations, as a percent of total revenues, have declined rapidly (Lowry, 2007). Figure 1.1 illustrates this decline. The percent of total educational revenues per full time equivalent student (FTE) that is supported by appropriations has fallen from 76.82% in 1986 to 56.85% in fiscal year 2011. This shows a shift in educational revenues away from public sources. There are two primary explanations for this change. State appropriations per student could have fallen or tuition could have risen. The figures that follow show that both explanations are taking place simultaneously. Tuition, as seen in Figure 1.2, has increased dramatically and consistently while the state appropriations in Figure 1.3 fluctuate cyclically with a general negative trend. In the context of these figures, support for education has shifted from being financed by the state to consisting of an increasing responsibility of the student.

From an institutional perspective, this has changed the makeup of revenues, resulting in institutions relying more heavily on tuition as a funding source. At many institutions, tuition has surpassed appropriations as the primary revenue source. As of 2009, 44% of public four-year institutions reported tuition revenues that exceeded state allocation revenues (IPEDS, 2013).

At the state level, public higher education has been further challenged by recent changes in the economy and growing enrollments. The poor economic climate during the early 2000s has stiffened the competition over state resources. As tax revenues decline, entitlement programs crowd out discretionary spending (Kane, Orszag, & Gunter, 2003; Okunade, 2004; Tandberg, 2010). Policymakers, acknowledging that higher education, unlike most public services, has an alternate revenue source in tuition, have cut funding for PCUs (Delaney & Doyle, 2007, 2011; Hovey, 1999). In turn, tuition has risen, both

Figure 1.2

CPI Adjusted Tuition and Fees



Source: College Board, *Trends in College Pricing 2012*, Table 2A
Note: Adjusted to 2012 dollars

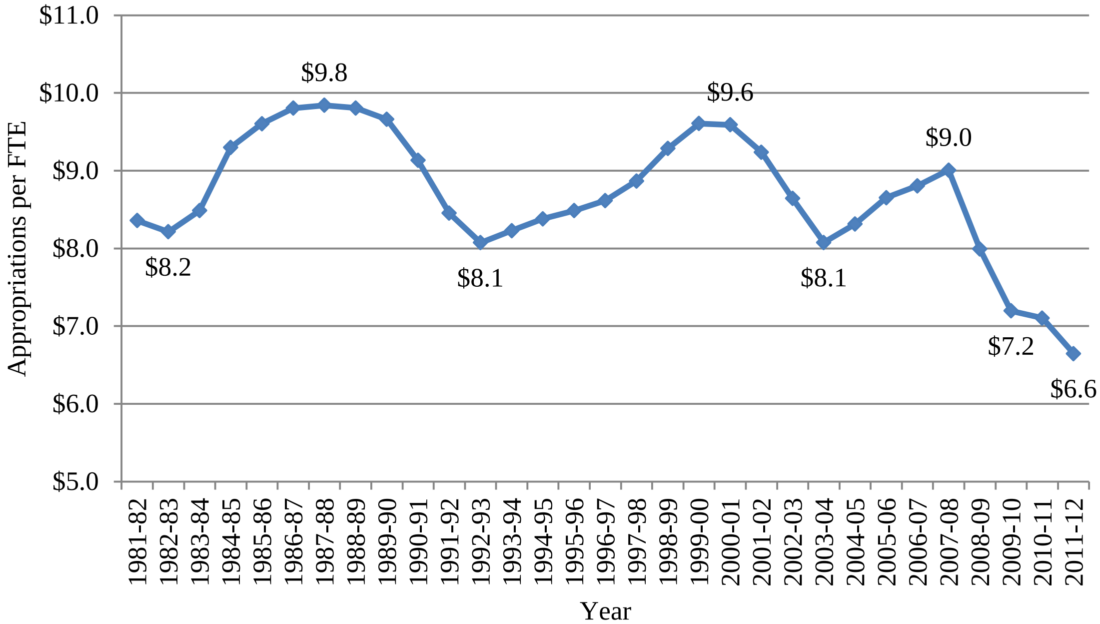
as a percent of institutional budgets and in terms of prices for students. Figure 1.2 depicts inflation adjusted tuition over time; showing 2012 tuition and fees nearly four times that in 1972.

It might be expected that tuition would have a temporary and fixed relationship with state appropriations as a short-term mechanism to smooth fluctuations in state funding. As state appropriations decline, tuition would be expected to increase while a rebound in state funding could lead to a decline in tuition. Instead, this graph depicts a constant increase in tuition over time, illustrating that tuition operates in one direction. It freely ratchets up, but it never falls back down.

However, another stress on public higher education is growing enrollment. While the Grapevine Project (2013) shows that overall state appropriations have remained relatively stable over time, increasing slightly and only falling in recent years, the per student spending has fluctuated much more dramatically. Figure 1.3 illustrates these peaks and valleys over time as states reduce per student allocations during times of economic struggles and increase spending as more resources come available. As can be seen, appropriations per FTE are now at a low of roughly $6600 per student after tumbling from over $9000 per FTE in 2007. This conforms to the earlier idea that state funding is a function of the economic climate, showing a large slide in 2007 as a result of the Great Recession. The fluctuations in per student funding from this graph is also related to growing enrollments. Even if total state appropriations remain stable, growing enrollments cause the per student appropriations to fall. This declining per student funding from the state can further motivate institutions to use tuition as a funding source.

Figure 1.3

CPI Adjusted State Appropriations per FTE (in Thousands)



Source: College Board, *Trends in College Pricing 2012*, Table 12B
Note: Adjusted to 2011 dollars

High demand with high costs and falling state funding per unit can result in the increase in tuition seen in Figure 1.2.

While issues of tuition and appropriations are of concern for institutions from a revenue standpoint, financial aid[1] could be used to offset the sticker price for students. However, loans have replaced grants as the primary form of personal financial aid, minority and low-income students are reluctant to take out loans for higher education, and loan defaults have increased (Tuby, 2012). These state, institutional, and personal shifts in paying for higher education are resulting in students and families becoming increasingly burdened with the cost of financing their own postsecondary education.

Accompanying these changes in paying for higher education are concerns about access, affordability, efficiency, equity, and the very definition of what it means to offer state public higher education. The public has a multitude of interests, discussed in Chapter 2, in ensuring that the opportunity to go to college is available for all students, regardless of race or economic background. Furthermore, there is an interest in ensuring that everyone who is prepared to go to college can afford to do so. Therefore, the public higher education sector is designed to offer students the ability to attend some sort of postsecondary institution at an affordable price. However, these two goals are being threatened by declining public financial support.

As illustrated, public higher education is a competitive environment. There is competition between higher education and other state functions, between institutions within a state for funds, and between institutions for students. Additionally, there are questions about how to support public higher education, what the institutional focus

[1] Institutional aid is commonly budgeted as negative revenues or miscellaneous expenses.

should be, how institutions should be evaluated, and how to balance access, affordability, efficiency, and equity. While many of these topics are value laden, subjective, and often political in nature, a problem remains that many of these questions are only discussed at the state level. This has left many questions unanswered as to how institutions operate within state contexts, within the higher education sector, and internally using established business practices. In essence, the field is lacking an understanding of the modern higher education production function in turning inputs into outcomes in a time of economic decline. This production function involves tracking inputs as they move through institutional processes that result in outputs and their associated outcomes[2] (Baumol, Blackman, & Wolff, 1989; Burke, 1997; Craven, 1975; Harvey, 1973; Hopkins, 1990; Kershaw & Mood, 1970; Massy, 1996; Massy & Wilger, 1992; Titus, 2009; Zumeta, 2001).

Problem Statement, Research Questions, & Goals

The problem with previous research in higher education finance and production functions is fourfold. First, much of the research is dated, stemming back to organizational and financial studies of the 1970s (Adams, 1977; Bowen, 1970; Bowen, 1977; Cogan, 1980; Dumont, 1980; Kershaw & Mood, 1970). Second, there is no conceptual framework or comprehensive theory of finance in higher education, particularly one that applies to the current economic and technical climate of higher education in the new millennium. The closest proxy has been Bowen's (1980) *The Cost*

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[2] Outputs are frequently defined as numeric counts of production while outcomes depict larger societal benefits. Because societal benefits are difficult to quantify, measures of efficiency or productivity through the creation of ratios of outputs to inputs and the relationship with institutional goals are frequently used as proxies for outcomes.

of Higher Education or Massy's (1996) often cited *Resource Allocation in Higher Education*, both written well before the Great Recession. Third, most research focuses on revenues, neglecting institutional expenditures and outputs (De Groot, McMahon, & Volkwein, 1991; McPherson & Schapiro, 1994). This has entailed examining appropriations and tuition, or using states as the unit of analysis, without looking at institutional behaviors or mechanisms involved in producing outputs. Only recently have studies begun to look at the expense side of institutional ledgers in relation to sources of revenues (e.g., Leslie, Slaughter, Taylor, & Zhang, 2012), however relating revenues, expenses, and outputs throughout the entire production function has received scant attention. Finally, much of the institutional research that does exist draws from the U.S. Department of Education's National Center for Education Statistics and their Integrated Postsecondary Education Data System (IPEDS), an aggregated look at institutional finances which contains no information on what happens in budget offices and academic departments within the institution.

To address these limitations in existing research, this study focuses on institutional accountability and production processes by looking at the relationships between institutional revenues, expenses, and outputs. While others have thoroughly researched the tradeoffs in funding between tuition and state support (Delaney & Doyle, 2007, 2011; Hovey, 1999; Hossler et al., 1997; Kane & Orszag, 2003; Massy, 1996; McPherson, Schapiro, & Winston, 1989; Santos, 2007), this study looks at institutional budgeting and the efficiency involved in the production of student outcomes. In addition, policymakers tend to take a business-like approach to higher education. Their focus is on efficiency, return on investment, and the relationship between inputs and outputs. State legislators are especially interested in institutional performance, particularly when it comes to state resources and the rising costs of higher education (Alexander, 2000; Hearn & Griswold, 1994; Hearn & Holdsworth, 2002; Hines, 1988). This high level of scrutiny for higher education manifests in the form of efficiency evaluation, examining the linkages between state funding and institutional performance and using this performance to determine future levels of state support. More specifically, the term "efficiency evaluation perspective" in this study focuses on the manifest policies of state policymakers[3] in measuring and evaluating institutional level outputs and using these measures of performance in making decisions regarding state appropriations. This perspective makes the assumption that these policymakers are most interested in ensuring maximum efficiency[4] at the institutional level in educating students and achieving the highest levels of performance on indicators such as graduation rates, retention rates, and degree completions. Indeed, even other stakeholders such as the Lumina Foundation, National Council of State Legislators, and National Association of State Budget Officers, have expressed a recent interest in improving the productivity of higher education as can be seen in their call to design new business and financial models in order to improve efficiency (Eckl & Pattison, 2011; Lumina Foundation, 2013). Utilizing this efficiency evaluation approach, I use a classic input-output production function (Burke, 1997; Craven, 1975; Kershaw & Mood, 1970) to examine the processes involved in turning inputs into outputs and, ultimately, outcomes. While such a business model may not be

[3] Particularly state legislators and statewide consolidated, coordinating, and governing boards.
[4] What Labaree (1997) terms social efficiency.

the ideal framework to evaluate higher education, its widespread use by state officials in evaluating, funding, and overseeing institutions makes it an appropriate model to test.

Using this framework, I seek to evaluate the higher education production function for public, four-year universities. The focus on public, four-year institutions is for two primary reasons. First, there are likely different production models between four-year and two-year institutions, particularly with two-year institutions having separate focuses on vocational studies and transfers to four-year institutions. Therefore, two-year institutions are not included. Second, the public nature is particularly important in this analysis because it uses a framework that recognizes the importance of the state and federal government in using higher education as a public policy tool and the associated accountability that accompanies this public investment in higher education. Furthermore, I examine the production function across three levels of analysis: the institutional level, the school and college level, and the departmental level. While institutional level data is available through the Integrated Postsecondary Education Data System (IPEDS), I incorporate data from the University of Texas System (U.T. System) and Texas Higher Education Coordinating Board (THECB) to conduct an empirical case study of the nine member system at these more detailed levels. This analysis leads to four primary research questions.

RQ1: What is the relationship between institutional revenues and institutional expenses?

This question seeks to explore descriptively and correlationally where institutions allocate their funds once they are received from their various funders. To do so, I use IPEDS data to look across different institutions to see how they are funded in comparison to each other and examine differences in funding categories such as instruction, research, and public service. Using longitudinal data, I develop regression models with institutional fixed effects to explore how institutional spending changes in relation to changes in revenues over time. This approach is very similar to that taken by Leslie and colleagues (2012), but extends the analysis beyond just looking at research institutions and instead includes all types of public four-year institutions and uses updated data to examine the potential changes to the relationships between revenues and expenses that have emerged as a result of the Great Recession.

RQ2: What is the relationship between institutional expenses and student outcomes?

With this second research question, the concepts of decision making and efficiency are introduced. This research question looks at the relationship between the budget items and the student outcomes for which institutions are increasingly evaluated. Again, I employ regression models with institutional fixed effects to explore how student outcomes are affected by changes in institutional spending. The data from the U.T. System and THECB includes information at the school and departmental level on both institutional budgets and student outcomes. This level of detail allows me to conduct these analyses at all three levels of analysis: at the institutional level, school level, and departmental level. Furthermore, I also look at the relationship between revenues and outputs to see if there is an indirect relationship in the production of outputs that exists beyond that of direct expenses.

RQ3: What is the relative efficiency of the various units in the analysis in producing outputs in relation to inputs?

With the third research question, I directly address the higher education production function by using data envelopment analysis and stochastic frontier analysis to develop measures of efficiency. These methods examine technical efficiencies, whether outputs are being maximized given their inputs, in relation to peer units to see which units are operating most effectively and which units can use improvement. In addition, the model provides recommendations for units to emulate. Much like the previous research question, I am able to incorporate multiple levels of analysis to examine not only institutional performance nationwide, but also school and departmental performance across the University of Texas System.

RQ4: How do these relationships change based on type of institution and over time?

Finally, the longitudinal nature of the various data sources, the nationwide reach of IPEDS, and the detail provided in the Texas datasets allows for comparisons across Carnegie classification and time. This will allow for examining effects that might be attributable to differences in institutional mission, type, or size. This longitudinal approach is especially important in examining whether institutions are becoming more efficient over time or whether they are becoming less efficient as a result of the Great Recession.

These research questions, and the associated production function approach, introduce four main techniques that are conducted at the three levels of analysis. First, descriptive analyses will be presented to describe the data and provide insight into institutional revenues and expenses[5]. In addition, this will highlight changes that occur over time and the differences that appear based on Carnegie classification. Second, regression models will be employed to determine the relationship between funding and expense items. Fixed effects (Wooldridge, 2009) will be used to control for time effects and help to look for differences that appear based on institutional type. In the first model, expense categories act as the dependent variable with various revenue streams acting as regressors. The second model is structurally similar to the previous model but looks at the relationship between expense items and performance. Again, it uses fixed effects to control for time trends and compare based on institutional type. The final model uses data envelopment analysis and stochastic frontier analysis (Coelli, Rao, O'Donnell, & Battese, 2005) to look at measures of efficiency. This model develops a production possibility frontier based on the variation in the performance of the units and measures each unit's performance in relation to the frontier.

Dissertation Plan

The plan of the dissertation is as follows. The subsequent chapter is a review of literature providing background and context regarding the purpose of higher education. This chapter sets up the argument that higher education is a blend of public and private purposes and therefore accountable to multiple audiences. This draws on concepts such as human capital theory, social mobility, and externalities. Institutions are discussed in terms of their competition for funds and prestige through the lenses of institutional

[5] Instruction, research, public service, academic support, student services, institutional support, plant maintenance, scholarships, auxiliary expenses, hospital services, independent operations, and other.

isomorphism. This background information is introduced to set up the use of the higher education production function from the standpoint of policymakers utilizing the framework of efficiency evaluation in their financing and management of public higher education. Namely, higher education provides both private and public benefits; therefore both students and the public are responsible for funding institutions. Given this split responsibility and the partial funding provided by taxpayers, institutions are accountable to the state and the public for how they spend their money and the outcomes they produce. This discussion of the sources of funding, how funding is used, and what outcomes institutions produce is therefore the preferred framework for this analysis. This necessitates the modification of the traditional business production function for higher education in the third chapter.

The third chapter presents the conceptual framework for the analysis. The framework draws on theory from political science, public management, finance, economics, and organizational theory. The full model incorporates an organizational theory based production function of inputs, processes, outputs, and outcomes. External actors are incorporated through principal-agent theory. Theories of budgeting, public administration, and non-profit management outline the connection between financial resources, planning, and performance. In addition, these theories discuss the inherent difficulty in measuring outcomes in institutions lacking financial outputs. Definitions of efficiency, utility maximization, and satisficing bring concepts from economics. Finally, organizational theory and management are used to detail the processes involved in institutional decision making and turning inputs into outputs. These concepts are all applied to the production function and tailored to the higher education environment in the production of teaching, research, and service outputs.

The fourth chapter reviews empirical literature most closely related to the context and production function of higher education. In particular, this looks at studies related to the revenues in higher education, with a particular focus on state appropriations and tuition. In this section, literature on politics and governance is presented in respect to state allocations while the section on tuition includes an examination of literature related to tuition, financial aid, and out-of-pocket expenses. The second section looks at studies addressing expenses. These studies look at the relationships between revenues and expenditures as well as the relationships between expenses and student outcomes. The limitations with these studies are that they are dated, frequently focus only on research institutions, or define inputs and outputs in ways counter to what policymakers might be interested. This section is especially important because it forms the foundation of the present study and the questions raised in producing outputs through expenditures and their funding sources. The final section reviews the literature in higher education on data envelopment analysis and stochastic frontier analysis. A majority of these studies emanate from institutional analyses in the United Kingdom and Australia, but the focus of this dissertation is in applying these methods to American higher education across different levels. Again, this section is especially important because it motivates the work I present using these methods in the U.S.

In the chapter on data and methods, the chapter begins with the research questions that arise given the literature and theory found in the preceding chapters. The sources of data are then outlined along with information relating to the variables collected. This includes a description of the selection mechanism, the data collection process, and the resulting datasets. I then describe the variables across the different datasets. The section on methodology follows, focusing on describing why each model was chosen and how the associated tables and graphs are meant to directly address the research questions.

In Chapter 6, the descriptive statistics and the results of the various analyses are presented. This focuses on identifying statistically significant results from the analyses and the interpretation of the various coefficients and the key relationships. First, this looks at whether the source of funding is associated with how money is spent. The second set of analyses examines the impact expenditures have on institutional outputs. I then look at the indirect relationships between revenues and outputs. Finally, I conclude with models of technical efficiency to determine if units are operating efficiently when compared to peers.

In the chapter following, Chapter 7, these results are broken down to create a discussion of the results, the importance of the findings, and implications for policy and research. Finally, I conclude with a chapter summarizing the contribution to the field, the limitations of the study, and suggestions for future research.

CHAPTER II

BACKGROUND AND CONTEXT

The Purpose of Higher Education

Higher education originated from a need to educate clergy, followed thereafter by professional training in medicine and legal studies (Perkins, 1984). These practical training programs founded what eventually grew into postsecondary education. Training focused around a profession, teaching future clergy, doctors, and lawyers the intricacies demanded in their field of work. Higher education was centered around creating knowledge and sharing this knowledge with students (Corson, 1971). This demonstrates a private purpose of higher education in the form of job training. Yet this apprenticeship model[6] was only for students willing and able to devote the time and resources to this type of an education. Most of the populace was filtered out of higher education, unable to support the requirements of undertaking such study (Perkins, 1984).

Through the ages, higher education became criticized for living in an ivory tower, isolating itself from the world (Alexander, 2000; Corson, 1971). The original protectionist policies were meant to protect faculty and students by giving them academic freedom from politics and society at-large. Eventually, the walls came down as institutions became more involved in their communities, the demand for higher education increased, and public financial support increased following World War II (Corson, 1971).

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[6] Others (Pasque, 2010) have argued that the apprenticeship model is actually a public good wherein the elite students were trained to be leaders that contribute to the rest of society.

Moving into the civil rights era, higher education was at the forefront of national policy attention as debates raged surrounding minority enrollments, women on campus, affirmative action, access, and affordability. Rather than being simply a means of job training, higher education had turned into a public good and right. It had transformed from a collection of scholars and apprentices into the main mechanism for economic and social mobility.

These two arguments, economic and social, formed the foundation of the debate between the public and private purposes of higher education. Rather than looking at how an individual institution was supported financially or legally, this debate was a question about the field: whether the entire sector is for the benefit of society or the personal benefits of those who attend.

The Private Purpose

Human capital theory (Becker, 1964) argues that higher education is a private investment by those attending an institution. Students enroll at an institution with the knowledge that they are foregoing current salaries in exchange for a college degree. This degree is meant to raise future salaries above and beyond what they would have received if they had not gone to college. If the returns to the degree exceed the loss of current salary and the price of tuition, then the investment is thought to be worthwhile (Hoenack, 1982; Paulsen, 2001). Indeed, much research on this subject has revealed that obtaining a college degree is financially sound advice. In one study looking between 1971 and 1997, the wage difference of those with a college degree and those with only a high school education was roughly $20,000 per year in 1997 and showed that the gap had been increasing (Heller, 2001b). More recently, the 2011 American Community Survey by the U. S. Census Bureau revealed an average lifetime earnings differential of over $1 million between those with a high school degree and those with a bachelor's degree.

The premium paid to those with a college degree is attributable to two main mechanisms: human capital development and the sheepskin effect. Going to college is meant to help individuals develop their skills. The years spent in postsecondary education tells employers that those individuals have received additional training, improving their knowledge and thereby producing more effective workers. This knowledge makes up skills for an individual, holding value and creating the individual's resource pool known as human capital. However, if this were truly the case, human capital could be measured by credits, semesters, or years of education. The more an individual invests, the more they would be likely to receive in terms of their compensation. While this is somewhat true, much of the salary premium has been attributed to a sheepskin effect (Bowen, Kurzweil, & Tobin, 2005; Turner, 2004). This means that there is only marginal monetary value to any sort of postsecondary education until a degree is obtained. Employers do not reward based on a strong linear function of the time spent at college. Rather, the compensation tends to come in a large premium after passing the threshold of obtaining a degree.

The sheepskin effect is closely tied to cultural[7] and social capital[8], concepts popular in sociology. Much like human capital in the field of economics, cultural capital

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[7] See the work of Pierre Bourdieu: Bourdieu, P. (1977). Cultural Reproduction and Social Reproduction. In J. Karabel & A. H. Halsey (Eds.), *Power and Ideology*, Oxford Press, Chap 29.

involves an individual's worldview as established by their background, values, and beliefs. In terms of the sheepskin effect, the hiring managers are likely to have a college degree. Therefore, they are looking for employees who come from a similar background, have similar values, similar connections, and similar experiences. This simplifies to finding someone who shares having a college degree. Therefore, employers may not be interested in finding someone with the greatest number of credits, or possibly even the best skillset, but more so in seeing credentialing through a document declaring a person as qualified and possessing high cultural capital, a college degree.

Given this argument, higher education can not only be viewed as providing knowledge and skills, but also credentialing and social capital. In this case, social capital involves an individual's network and connections. It is very much a collection of "who you know" and the associated connections available to that individual. This gives greater incentive for individual investment in higher education. If an individual can move from one social strata to another through higher education, then the social mobility, in and of itself, holds value beyond even that of financial compensation. This social mobility can involve connections made while attending college, those made in the workplace, or those made outside the workplace as a result of increased income. In each of these cases, the choice to attend college offers an individual intangible benefits that boosts societal standing. In most situations, societal standing rarely changes. The process of social reproduction from one generation to the next keeps families rooted in a fixed place in society. A college education is the hope of many of these families to break out of a cycle

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8 See the work of James Coleman: Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, F., Mood, A. M., Weinfeld, F. D., et al. (1966). *Equality of educational opportunity*. Washington, DC: U. S. Government Printing Office.

of poverty and move into a more middle-class lifestyle. For those already in the middle class, college is a way to maintain their status while simultaneously giving them the education and resources to pursue even greater benefits.

These ideas of human capital, the sheepskin effect, cultural capital, social capital, and social mobility all blend together resulting in economic mobility. This plays to the very origins of higher education, preparing individuals for careers in the workforce and improving their economic and social standing. As travel and technology have improved over the years, higher education has become important not only in moving into the American middle class, but internationally as well. The universities in the United States are a shining example of higher education excellence, drawing thousands of international students to American campuses each year. These international students not only receive knowledge and a highly valued American degree, but also produce "ambassadorial effects" (Bowen, Kurzweil, & Tobin, 2005). When the students return to their home country, they bring back knowledge of their field, of higher education, and of American culture. This knowledge then contributes to their standing in their own society as well as improving international relations. As with social capital, the connections these students make while in the United States provides new opportunities for business, economic progress, and international collaboration. Furthermore, their training can then be shared with the citizens of their home country, again improving more lives and contributing to global economic and social mobility.

Similarly, there are more private benefits to higher education beyond classroom learning and social connections. While international students benefit in taking knowledge back to their home country, all students benefit from attending an institution hosting individuals from a variety of backgrounds. The U. S. Supreme Court, in their decision on *Grutter v Bollinger* (2003), affirmed that higher education provides skills in dealing with an increasingly global economy. It is on these campuses that students, faculty, and staff engage in sharing experiences, debating, and discussing topics regarding culture, religion, politics, and other ideas. These interactions are not taught, but are a substantial byproduct of creating an atmosphere that fosters both academic and non-academic learning. The personal experiences of students contribute to their worldview and contribute to their ability to engage in the modern workplace. The Court claims that this personal development can then lead to leadership opportunities as individuals are able to utilize their experience interacting with people from all walks of life. Furthermore, higher education can also improve personal satisfaction, leading to an improved quality of life that extends beyond economic returns (Hoenack, 1982).

The private returns to higher education are many and diverse. The intangibles include knowledge, skills, life experiences, and new viewpoints. These can then be translated into economic and social capital resulting in monetary returns and an elevated place in society. Furthermore, they are transferrable with the individual across boundaries and time. In addition, society benefits from having an educated workforce beyond the aggregation of individual returns, leading to a discussion on the public purpose of higher education.

The Public Purpose

Not only do individuals have a motivation to invest in higher education, but society does as well. Individuals can improve their own lives through going to college, simultaneously raising their own relative position in society as well as the average attainment in their community. However, the benefits of higher education are not simply restricted to raising average education levels. Increasing higher education in society can create a multitude of positive externalities that result from improved skills, knowledge, and worldviews. These externalities include democratization, teaching civic responsibility (Dee, 2004), and improving diversity, all of which reach well beyond the economic benefits of higher education through improved economic development. It is this argument for economic growth, combined with the benefits that accrue to society, which forms the main justification for public funding of higher education.

Economic Development. The economic justifications for classifying higher education as a public good are just as substantial as the private economic claims. States first invested in public higher education shortly following the American Revolution. The University of Georgia was the first public institution founded in the new American states in 1785, and the University of North Carolina was the first public institution to open its doors to students in 1795. While the initial job training for clergy, lawyers, and doctors comprised the origins of higher education hundreds of years before, this mission for training and educating students soon spread beyond the boundaries of college campuses. Rather than having students come to campus for professional training, institutions were charged with taking their training out to the fields. The Morrill Land-Grant Act of 1862 marked the federal government's entrance into higher education by setting aside resources for PCUs to teach to the public. Following the Civil War, the United States set out to rebuild the country and turn from the field of battle and return to the field of crops. Higher education was one of these tools for nation-building. In particular, land grant institutions were meant to reach out through agricultural extension programs and teach farmers and ranchers how to produce the best yield (Loss, 2011). These agricultural workers in the south and mid-west were quite different from the upper-class apprentice-style students that had gone to elite private universities in the northeast. Indeed, the entire mission of these institutions differed from that of the past. This began the major shift in American higher education, building a public infrastructure supported by the federal government and the states to bring additional education directly to citizens.

Following the turn of the century into the 1900s, higher education further expanded. By the end of World War II, the growth turned exponential as the federal government passed a series of legislation tying the federal government to higher education. Similar to the Morrill Land-Grant Act following the Civil War, the federal government again used higher education as a mechanism of rebuilding and readjustment after World War II. These congressional bills included the Servicemen's Readjustment Act of 1944, National Defense Education Act of 1958, and Higher Education Act of 1965. Subsequently, states were forced to respond to this federal legislation in their own dealings with public higher education. The federal and state infusion of money to support higher education following World War II was born out of a belief by policymakers that higher education could be used to produce skilled workers (Kerr, 1994; Kezar & Eckel, 2004). This led researchers to conclude that higher education was arguably the primary driver of the economic growth that occurred in America during this period in the 1900s (DeLong, Goldin, & Katz, 2003).

Additionally, states themselves have long adopted a view that investment in their higher education sector will lead to economic growth and development (Hearn &

Holdsworth, 2002). Indeed, previous studies have found that higher education not only increases the skills and productivity of those who attend college, but can also raise wages for workers without a college degree (Acemoglu & Angrist, 2001; Moretti, 2004). These workers add to the tax base for states to generate additional revenues and then re-invest in the state and higher education. This has resulted in a number of state policies to assist students in attending in-state PCUs, including financial aid and reduced in-state tuition. This approach not only helps to pay for students who want to go to college, but also helps motivate others to go to college who might not have otherwise. In essence, the human capital model relies on the assumption that the actors are rational in their decision-making. However, this is not a realistic assumption for many individuals, resulting in an overall underinvestment in higher education. State support through reduced tuition and financial aid lowers the immediate cost of higher education in the hope that these individuals will see the increased long term benefits that might be realized through the investment of higher education the subsidized price.

Not only are universities producing educated workers which benefit the economy, but they also produce research. Federal research funding grew from $1.1 billion in 1953 to $32.6 billion in 2009 (National Science Foundation, 2010). As research has expanded, so has the institutional role in its development. Federal funds support approximately 60 percent of research that happens on university campuses (Association of American Universities, 2011a; AAU, 2011b). This funding contributes to an overall output by research universities of 31 percent of all research conducted in American and 56 percent of the nation’s basic research (AAU, 2011a; AAU, 2011b). Basic research, in particular, plays an important role in the understanding of some of the great mysteries in the world.

While not for commercial value, basic research contributes to the field of knowledge and is, arguably, one of the major contributions to society (Bowen, 1970).

Furthermore, PCUs are a large beneficiary of federal research funds with 67.2 percent of federal money going to public institutions (NSF, 2010). This large public investment in research, especially that undertaken by public research institutions, shows the importance placed on higher education in developing and distributing knowledge and innovation. In addition, a number of reports are also quick to point out that universities are the training location for researchers who eventually take jobs in government, academia, and business, both domestically and internationally (AAU, 2011b; Bowen, 1977). This blends both research and education, creating a common goal focused on development. For example, training graduate students contributes to the education of these future leaders in society who then use their specialized, advanced training to manage government, create innovation in business, generate knew knowledge in academia, and contract between the sectors to create new endeavors that benefit society as a whole. Again, this supports the need for public investment in higher education to foster economic growth.

Benefits to Society. Moving beyond the economic benefits of public investment in higher education, much has been written about the benefits that accrue from having an educated citizenry (Bowen, 1977). Not only do those who attend college benefit from the private investment in higher education, but so do those who do not attend college (Acemoglu & Angrist, 2001; Heller, 2001a; Moretti, 2004). Knowledgeable leaders, economic development, and having an educated citizenry regarding civic duty (Dee, 2004) and the benefits of diversity all contribute to society, not just to those who went to college. For this reason, higher education can also be thought of as a public good, providing positive externalities to society and benefits to those freeriders who never invested in the product itself.

One of the first movements to acknowledge this public purpose in the modern era was the Servicemen's Readjustment Act of 1944 – better known as the G.I. Bill. While much of the motivation behind the G.I. Bill was to educate returning veterans and help prepare them for making a living as citizens instead of soldiers, a large portion was also about democratization, readjustment, and gratitude for their service. Following the 1944 State of the Union Address where President Roosevelt declared education a right, Congress passed the G.I. Bill to offer returning veterans access to higher education (Loss, 2011). This transition program rewarded veterans for their service by offering four years of college education and made loans available for homes and business. More subtly, it helped re-acclimate veterans to peacetime occupations and ease the psychological burdens they encountered while in battle. Higher education became about training these men and women as citizens and functional members of a democracy. The idea was to help them to think, to form opinions, and to use their talents to improve and defend America, this time with their critical thinking and labors rather than with weapons.

Shortly thereafter, a number of reports and commissions were established, all making the same claim that education is a right and democratic in nature. Conant's (1945) *General Education in a Free Society* and President Truman's 1947 reports, *Higher Education for American Democracy* and *To Secure These Rights: The Report of the President's Committee on Civil Rights*, all echoed the right of individuals to higher education and the need to exercise this right in order to be a functioning member of

American democracy. Indeed, going to college was a patriotic gesture, taking the time to better oneself and apply these to improving America as a civically responsible citizen.

This civic responsibility for higher education further extended into the presidency of Eisenhower. In 1958, the same arguments for democratization were used during the passage of the National Defense Education Act. Rather than focusing on the readjustment of veterans, this legislation focused on ensuring American dominance during the Cold War. Psychologists found that education was linked to greater knowledge of what was happening in the world (Loss, 2011). Therefore, policymakers argued that education was a national security tool that could help keep citizens informed of global politics and events during the Cold War. This legislation offered federal funding for defense related fields including language and what are now commonly known as the STEM fields[9]. The increase in federal funding and subsequent increases in federal research money over time, showed a clear commitment by the federal government in supporting higher education for macro purposes beyond individual earnings potential.

By the time of civil rights reform in the 1960s, higher education had come under fire for making promises of access to all without demonstrating policies that made these promises possible. The large public support from federal and state governments in the name of nation-building and democratization had escaped a large portion of the American population: minorities and women. Truman's 1947 report on civil rights stated that education should be available to all. It was a right of the people and this right extended to higher education as well. However, only 3 percent of women veterans claimed their benefits under the G.I. Bill and African American veteran claims were even worse off, a

[9] Science, technology, engineering, and mathematics.

result of both overt and veiled racism (Loss, 2011). In 1965, the Higher Education Act was passed by Congress and later extended through the 1972 reauthorization. These measures, coupled with the Civil Rights Act of 1964, legally outlined the right to open access to higher education regardless of race or sex. However, the right to higher education has never fully extended to the ability to pay, a frequent topic of discussion in debates on open access, affordability, and the public nature of higher education.

More recently, the issues of public access to higher education have been taken up by the courts. The four landmark U. S. Supreme Court decisions stemming from *Bakke* (1978), *Hopwood* (1996), *Grutter* (2003), and *Gratz* (2003) have all challenged admissions for higher education and the policy implications for PCUs. In *Bakke* (1978), Justice Powell points out one of the major public benefits of higher education: exposure to diverse lifestyles, ideas, and cultures. Justice Powell declared the state to have a "compelling state interest" in diversity, stating that in order to function in American society and democracy, individuals will be confronted with dealing with individuals from diverse backgrounds and therefore higher education provides a venue for developing these skills. This argument set the foundation for subsequent arguments and while not all of the admissions criteria were upheld, diversity has been consistently seen as having benefits and merit, not only for individuals but for the state and society as well.

Throughout the history of American higher education, arguments have been raised that postsecondary education provides substantially more than just a means of personal advancement. In addition, higher education provides much needed research and training for state and national economic development. It prepares individuals for how to function in society and democracy, improving their knowledge of the world, sense of civic responsibility, and ability to make decisions. It improves educational outcomes and fosters out-of-class learning through fostering interactions with people from a diverse background by race, sex, socioeconomic status, and nation of origin. In this manner, higher education has demonstrated a history of beneficial societal returns, thereby justifying public investment in higher education, not only for the betterment of students who attend PCUs, but for all, so they may have competent and capable leaders and thinkers, enacting economic, political, and social change for the betterment of society.

Background on the Public Funding of Higher Education

The previous section outlined the private and public advantages to higher education, illustrating that there are a multitude of beneficiaries which include students, businesses, and the macro state and national economies. Given the positive returns for non-student stakeholders, the argument can be made that society should contribute to the public provision of higher education. This creates a number of difficulties in determining the value of higher education. To begin, what is the optimal mix of support from private and public stakeholders? In order to determine this mix, stakeholders must be willing to disclose the value they place on higher education. Unfortunately, the benefits to society are externalities, resulting indirectly from the processes of educating students. This makes the quantification of their benefits difficult to measure. Additionally, citizens may hold value for living in an educated society, regardless of their own personal investment in higher education. However, they are tempted to hide the utility they place in higher education if it means they are likely to be asked to contribute to funding public higher education through higher taxes. Therefore, they become freeriders, taking advantage of living in an educated society without expressing the value they have in public higher education, hiding their utility functions instead to protect them from having to pay more (Hoenack, 1982). This creates an economic public good problem because of asymmetric information with hidden preferences that makes it virtually impossible to determine the optimal mix of financial contributions. Without a clear indication of how public higher education should be supported, debates have raged over how much the state should allocate to PCUs and, subsequently, how much tuition these institutions should charge.

State Allocations

Following World War II, states were the primary benefactor of higher education, allocating large amounts of money to keep out-of-pocket expenses low. These legislative appropriations made up the largest part of institutional budgets as states took a low-tuition, low-aid approach. This meant that tuition was inexpensive; some institutions actually offered free tuition in order to promote access and quality (Archibald & Feldman, 2006). Focusing on access and cheap tuition mirrored the federal aims to promote higher education under the G. I. Bill and National Defense Education Act. The various state and federal initiatives to keep costs of attendance low had a direct result in the rapid expansion in enrollment. Modern applications of Say's Law (Adams, 1977; Say, 1803) explain that high levels of federal and state and support result in greater demand for higher education. Had government not invested so heavily in subsidizing the price of education, demand would be much lower. Therefore, this theory posits that government intervention drives up demand rather than high demand driving government action. Indeed, the favorable government policies passed following World War II resulted in substantial growth in student enrollment.

Moving into the 1970s, states and institutions were forced to deal with a declining economic climate and the passage of tax and expenditure limitations (TELs) (Archibald & Feldman, 2006). TELs restricted states and local governments from raising taxes by inordinate amounts and limited their ability to spend money. This shrank the amount of revenue that states were able to raise and thereby restricted the amount they could spend on public services. As the overall pool of resources shrank, states were forced to prioritize amongst services, including health care, prisons, and education (Glenny & Schmidtlein, 1983; Hossler et al., 1997; Kane, Orszag, & Gunter, 2003). The limited state resources, brought on by TELs, resulted in two forces acting on higher education: crowding out and the balance wheel.

The concept of crowding out explains that higher education receives lower public funding during times of economic decline because they are "crowded out" of allocations decisions (Kane & Orszag, 2003; Kane, Orszag, & Gunter, 2003; Okunade, 2004). States have a multitude of federal and legal mandates they must fund every year. Some of these are entitlement programs, such as Medicaid, which must provide a service for all of those eligible. Other programs, such as prisons and roadway infrastructure, are required by the federal government or encouraged by the federal government through the offer of matching funds or federal grants. Still others are specifically allocated to a certain purpose through special taxes and separate funds. The money that is left over is discretionary, money that is not earmarked for any single purpose and can be allocated for any purpose the state legislature deems fit. This pool of money is quite small in proportion to the overall state budget. Therefore, there is extreme competition from a variety of interest groups for this money (Tandberg, 2010; 2013). This competition, along with the restriction of entitlement programs, ends up crowding out higher education from state funds. State resources end up going to programs other than higher education, and in particular, Medicaid (Glenny & Schmidtlein, 1983; Hossler et al., 1997; Kane, Orszag, & Gunter, 2003; Lowry, 2007; Okunade, 2004).

A similar proposition to the concept of "crowding out" is known as the "balance wheel". This concept was found empirically by looking at state allocations for higher education during periods of economic fluctuation (Delaney & Doyle, 2007, 2011; Hovey, 1999). These studies found that higher education tends to be the public service receiving the largest cuts during times of economic struggle. As stated with crowding out, overall state resources decline and legislators are forced to prioritize amongst different public services. These studies posit that higher education tends to be lower on the priority list because of two reasons. First, college students are not the neediest population in the state. When confronted with choosing between funding welfare programs, children services, homeless prevention, and the like, college students simply do not make up the population most at risk. Second, higher education is unique when compared to most public services in that it can charge a fee for services. Therefore, state legislators make the decision to cut funding for higher education with the assumption that institutions will be able to make up for lost state allocations through higher tuition. However, while higher education is found at the bottom of state priorities during an economic recession, it nears the top of the list during periods of economic growth. When the economy is doing well, higher education is quick to rebound, receiving larger increases in allocations than most other state services.

During the 1970s, these concepts were evident as states cut allocations for higher education and switched from a policy of low-tuition and low-aid to a policy of high-tuition and high-aid (Archibald & Feldman, 2006; Hearn & Longanecker, 1985; Hossler et al., 1997; St. John, 1991). This move was meant to keep a focus on access by asking students who could afford higher tuition to pay more and using the additional revenue to offset the tuition for low-income students. However, the Bennett hypothesis (1987) took a different approach. Rather than viewing higher tuition as driving aid, this hypothesis outlined that increased aid and state support was responsible for the increase in tuition. Institutions raise tuition because students are receiving higher aid and therefore would pay less if tuition remained fixed. Instead, they raise tuition, which keeps out-of-pocket expenses stable, maximizes revenues, and exploits the generosity of federal and state aid programs. However, this hypothesis has been tested and found to be inconsistent with actual behavior (McPherson, Schapiro, & Winston, 1989).

Since this time, state allocations have declined in relative importance in higher education funding. While annual appropriations have increased, marginal gains have declined from year to year, relative purchasing power has decreased, and the funding per student has declined, due in large part to increasing enrollments. In short, states have been unable to keep pace financially with the growing numbers of students and increasing costs associated with higher education.

Now, state allocations are no longer the primary source of institutional budgets. Tuition has overtaken state appropriations as the largest source of revenue at many PCUs and is on a trajectory to become the new major source of revenue at the remaining institutions.

Tuition

Since the economic decline of the 1970s, higher education has struggled to regain its public perception. Public support of state services, including higher education, waned. Originally, states had a policy of low-tuition and low-aid. This involved high state appropriations. During the 1970s, states cut allocations to higher education, consistent with the balance wheel hypothesis. Institutions responded by raising tuition and using a high-tuition, high-aid policy. While the balance wheel points out that state higher education funding rebounds during times of economic prosperity, tuition acts as a ratchet, easily going up but rarely, if ever, coming down.

Institutions were focused primarily on maintaining or improving quality but policymakers were less interested in quality than they were budgetary constraints. This conflict over the institutions focusing too heavily on quality versus states not agreeing that marginal increases in quality warranted the additional expense led institutions to adopt the higher tuition policy (Archibald & Feldman, 2008a; Lowry, 2007). The initial move to this high-tuition, high-aid policy was meant to provide aid to high-achieving, low-income students to attract them to campus and keep quality high despite lower state appropriations (Alexander, 2000). This need-based aid was meant to be supported by the increased revenues stemming from tuition hikes, but need-based aid quickly turned into merit-based aid during the political and economic shifts that followed.

In the 1980s, as states recovered from the economic recession, new policies surrounding merit-based aid were introduced. The most famous of these policies is Georgia's HOPE (Helping Outstanding Pupils Educationally) Scholarship. This scholarship, instituted under Georgia governor Zell Miller, created a scholarship funded through statewide lottery revenues. These scholarships would be awarded to students with a history of academic success, measured by high school GPA and standardized test scores. As arguments of using merit-based aid gained favor, similar programs spread[10] to other states throughout the country (Doyle, 2006). These programs were meant to be more equal than need-based aid, targeting all students willing to work hard enough in high school rather than focusing on inequities by social class. The merit-based programs implemented more market-oriented incentives for highly qualified students. In practice, these programs ended up rewarding middle-income students rather than low-income students who lacked school, neighborhood, and family resources. Without the social capital of more well-to-do students, such as access to test preparation programs, lower-income students ended up at a disadvantage. Instead, middle-income students are the ones who received state merit-aid and, ultimately, the reduced tuition (Adams, 1977; Hansen & Weisbrod, 1969; Hoenack, 1982).

More recently, PCUs are adopting a high-tuition, low-aid policy due to ever increasing financial burdens on the states and higher education sector (Archibald & Feldman, 2006; Hossler et al., 1997). Rather than using higher tuition revenues generated from wealthier students to offset the sticker price for low-income students,

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[10] Doyle's (2006) event history analysis found no evidence of diffusion or political ideological significance, but rather posits the spread of merit-based policies are likely tied to other educational policies such as low state attainment levels.

institutions are choosing to use tuition revenue to offset declines in state appropriations. These funds are being used to support general operations rather than being dedicated for financial aid. This, combined with the poor targeting of state merit-based aid, means that tuition is rising but aid is not keeping pace, particularly for those most in need.

In addition, the structure of aid has changed. Previously, financial aid took the form of grants and scholarships, particularly those offered by institutions, states, and the federal government. These forms of financial aid required no repayment by the student and simply offset the cost of tuition. Now, financial aid is primarily driven by loans that require students to pay back the balance. This means that rising tuition prices are not being offset by government subsidies, but are requiring greater out-of-pocket expenses by students. Student loan availability is simply deferring tuition from the present to a later time when the increased income from a degree is hoped to cover the costs incurred while in college.

State Funding & Higher Education as a Public Good

The public funding decisions surrounding state allocations and tuition depict a change in the view of higher education's purpose in society. As outlined in the first section, higher education provides benefits to both public and private parties. However, states have shifted their view from a public standpoint to more of a private approach (Kezar & Eckel, 2004) as is illustrated through their shift from public support of higher education to a reliance on tuition. This shift, coupled with the changing nature of financial aid, has greatly affected out-of-pocket expenses for students and families.

During the economic struggles of the 1970s, the Carnegie Commission and the Committee for Economic Development both released reports in 1973 calling for higher out-of-pocket support for higher education (Hauptman, 2001). These reports focused on the private benefits of higher education, particularly the increase in financial compensation that is associated with a college degree. As stated previously, if the benefits of higher education were limited to private returns, then a move to personal investment would seem logical. However, this approach overlooks the benefits of an educated society and disproportional access to higher education for low-income and minority students. These major societal issues, which were at the forefront of educational discussions in the 1950s and 1960s, had lost their place on the public agenda as issues surrounding the status of the economy triumphed.

In the forty years since these reports, states have increasingly turned their attention to private returns of higher education and the need for students to support their own education. This is demonstrated in declining public financial support per student and an increasing emphasis on students using loans to support themselves rather than being subsidized through grants from the government. The result of this has been higher out-of-pocket expenses for students. Furthermore, the cost of higher education extends beyond the stated sticker price. The higher education cost index has increased rapidly, faster than inflation. In addition, the cost of higher education as a percent of total household income has increased as well. This combination of rapidly increasing costs, declining aid, and larger expenses as a percent of income has threatened the affordability of higher education.

Higher education, as a means of entrance into the middle class through social mobility, is simply not affordable for low-income students. Even middle-class students are, arguably, now being threatened in terms of access to higher education and maintaining their social standing. These limitations in the current personal funding model of high-tuition and low-aid are bringing attention to the failures of higher education to stay affordable, provide service to society, and operate efficiently. As the media devotes more attention to these issues, states are being forced to address their management of higher education.

State Management of Higher Education

States have gone through three periods of management for public higher education since the end of World War II (Shepherd & McLendon, forthcoming). In the first period, states created governing boards to manage the enrollment growth accompanying the federal passage of the G.I. Bill. These boards were meant to add coordination between campuses to reduce redundancy. Earlier studies suggested higher education was acting inefficiently, with large amounts of duplication in services and no cooperation between campuses that resulted in wasted resources (Dykstra, 1948). In the second period, the economic decline forced states to look for efficiencies and areas to cut costs. Boards were strengthened to oversee institutions and make financial adjustments across the system in order to save money for the state. Since the 1980s, the last period has involved rapid decentralization of authority, giving institutions more autonomy over their own financial planning. This period of re-privatization was meant to allow institutions to manage their own money and find efficiencies internally through increased managerial authority. Most recently, states are experimenting with voucher systems in Colorado and public charters in places like Virginia and Ohio where higher education is managed not by states, but by market forces. This section follows the political line of research undertaken to explore state characteristics such as governing boards, politics, and policy adoption. It will focus on the aforementioned three periods of state management, the public view of higher education, and the associated impacts on funding.

In the first period of the 1950s and 1960s, states created governing boards to manage the large influx of students demanding access to higher education (McLendon, 2003b). The federal government passed four major pieces of legislation during this period which greatly bolstered the public investment in higher education. The Serviceman's Readjustment Act of 1944, better known as the G.I. Bill, provided generous benefits to returning veterans of World War II. One benefit in particular, was improving access to higher education. Shortly thereafter, the National Defense Education Act of 1958 greatly increased the financial resources made available to higher education as education became a national defense issue following the Soviet scientific advancements seen in the successful launch of Sputnik. Moving into the 1960s, access to higher education again improved as the Civil Rights Act of 1964 and Higher Education Act of 1965 protected minority students and women from discrimination on college campuses. This period of access and growth was addressed by states in two main ways. First, states invested heavily in higher education. There was extremely high public support and states responded by maintaining a low-tuition policy to ensure students were able to access and afford higher education. Second, states created coordinating boards to better manage their public higher education sector. Previously, institutions had little interaction with state actors or other institutions (Glenny & Schmidtlein, 1983). Instead, they were largely left alone and managed their own operations much like how a private institution might operate. With the influx of students and financial resources, states made it a policy to oversee the operations of higher education and ensure there was no duplication of services or overlap between institutions within a state. Therefore, these loose governing boards were meant to foster cooperation between institutions and report more directly to state policymakers (McLendon, 2003b).

As the economy turned in the 1970s and citizens imposed TELs on state and local governments, the relationships between the states and higher education changed (Archibald & Feldman, 2006). States were no longer able to afford the high financial support they had provided during the previous period. Public support had started to fade, the overall state budget began to shrink with the imposition of TELs, and a variety of entitlement programs such as Medicaid took up large portions of what budget remained. This crowded higher education out of state support, forcing them to adopt a high-tuition, high-aid policy. This high-high relationship was meant to charge higher tuition for students who could pay in order to support low-income students with greater aid packages. In addition, states during this time took a more active interest in higher education and the efficient management of its operations. Indeed, the very beginning of the efficiency evaluation perspective can trace its roots to this period of economic struggle and the associated shifts in the attention of state policymakers from access and affordability to efficiency and productivity (McLendon, Deaton, & Hearn, 2007). The coordinating boards of the previous period were given more power and states with multiple boards ended up combining these into a consolidated board with increasing jurisdiction on tuition, state allocations, and the management of higher education affairs (McLendon, 2003b). Accompanying this shift was the beginning emergence of monitoring outputs rather than inputs to ensure accountability and high performance in higher education.

Since the 1980s, states have adopted a more market-driven view of higher education (Johnstone, Teixeira, Rosa, & Vossensteyn, 2006; McLendon, 2003b; Slaughter & Leslie, 1997; Slaughter & Rhoades, 2004; Taylor, Cantwell, & Slaughter, 2013). This has involved dismantling strong governing boards and giving more authority to institutions. This move was meant to make institutions more directly accountable for their actions and to give them the managerial resources for managing their own operations. In order to maintain some sort of oversight, states adopted new performance based management systems in exchange for this increased autonomy (Ferris, 1991; Rabovsky, 2013; Tandberg & Hillman, 2013). Institutions became more directly responsible for their efficiency and outcomes, including on measures such as graduation rates, time to degree, and cost per student. In some states, the re-privatization of public higher education has gone beyond public funding and state management to institutional and system-wide reform.

One of the recent fads in the state management of higher education has been the introduction of public charters. These legislative actions were meant to mimic legislation in places such as California and Michigan, where public institutions receive tremendous autonomy from the state. In these locations, the University of California (UC) system and University of Michigan are protected from legislative and gubernatorial meddling by their state constitutions. The UC system, in particular, has been called a fourth-branch of government in the state, largely isolated from both executive and legislative influence. Both of these systems have been considered examples of public higher education excellence, with consistently high academic measures, large public endowments, and major research funding. In Virginia, the state legislature undertook a similar move, passing legislation[11] to give charters to their public institutions (Leslie & Berdahl, 2008). The University of Virginia, in particular, was seen in the eyes of legislators as being competitive with the top public and private institutions in the country. Therefore, if they were competing with elite institutions, they should be managed like an elite institution. To legislators, this meant giving them the ability to manage their own operations. While this initiative was not as strong as constitutional protection, the charters allow institutions to set their own tuition, create their own purchasing agreements, and manage their own personnel. In return, they forego a percentage of state funding. In theory, the managerial flexibility and ability to set their own tuition is meant to offset the loss of state funds. By freeing institutions from the "red tape" of state oversight, institutions are hypothesized to save time and money. In other states, Wisconsin has discussed introducing charters for the University of Wisconsin at Madison and Milwaukee while Ohio recently adopted a charter program in 2011 with the passage of House Bill 153.

Similar reforms have been seen throughout the United States to varying degrees. Texas passed legislation[12] deregulating tuition and allowing institutions to set their own price. This popular measure typically sets an administrative ceiling above which public institutions cannot increase their tuition. If the annual change in tuition exceeds this

[11] Restructured Higher Education Financial and Administrative Operations Act of 2005 and Virginia Higher Education Opportunity Act of 2011.
[12] House Bill 3015 in 2003.

ceiling, 5 percent in Virginia, institutions are penalized through a loss of state aid. Other reforms have received attention in Louisiana with Bobby Jindal's GRAD Act and in Oregon with the move to create P-16 governing boards.

In Colorado, states eliminated public funding for higher education. Instead, they switched to a voucher style system, awarding funding directly to students. Institutions then were forced to compete for students and the funding associated with their enrollment. This created a market for students, like with any other commodity, and competition between institutions was intended to force them to act efficiently or students would self-select to choose elsewhere. Initially, states proposed a $4000 stipend for every enrolled full-time student on a four-year campus in Colorado. By the time of actual implementation, this amount had nearly halved to only $2400 per student. Additionally, the competition for students was meant to put pressure on institutions to keep tuition low for fear that students would go elsewhere. Instead, tuition rose 13.5 percent in two years following the implementation of the voucher system (WICHE, 2009). There were other unintended consequences, including a decrease in overall enrollments as students chose to study out of state, a decrease in underrepresented students, and a decrease in the number of Pell recipients (WICHE, 2009).

Overall, these market and efficiency based state reforms have had mixed results. In terms of cutting money for the state, they have been successful. However, these cuts may have occurred otherwise and the reforms may simply be the easy explanation to justify reduced allocations to the public. In general, the reforms of the past thirty years all share a common motivation to implement market-based reforms in order to oversee higher education. However, this focus on private returns and the use of market initiatives has had unintended consequences for the public returns. In determining that higher education should be a privately financed investment, public benefits have suffered, minority students have been displaced, and access has been restricted due to the lack of affordability (Flores & Shepherd, in press; Kezar & Eckel, 2004). However, institutions themselves have taken a different approach in their management of operations, focusing less on financial aspects and efficiency and more on self-interest and aspirations.

Institutional Administration

While competition has been promoted as a state solution for higher education reform, it has also driven up costs as institutions compete for students. Not only are institutions after enrollment numbers, but they are after the best and brightest students, seeking to reach performance benchmarks to receive additional state funding. Similarly, they are in competition over research funding and the desire to attract prestigious faculty. Finally, they compete against each other and with other state services for public funding. This competition, especially the competition for funding and prestige, has been a primary driving force behind institutional behavior.

The relentless pursuit of prestige in higher education has caused the costs to increase throughout the entire sector (Massy, 1996; Massy & Wilger, 1992). This competition for prestige is largely driven by rankings lists (Brewer, Gates, & Goldman, 2002; Ehrenberg, 2002b; Morphew, 2002; Morphew & Baker, 2004). Reports such as those issued by *U. S. News and World Report, Forbes,* and *Times Higher Education*[13] have pushed institutions to increase their ranking or, if nothing else, to maintain their

[13] For worldwide rankings.

standing. Institutions have responded to these lists by focusing on the formulas that derive their relative position (Brooks, 2005). They attempt to improve their standing on these measures regardless of if these moves are in the best interest of the institution or its students, because an improved ranking boosts publicity and notoriety (Ehrenberg, 2002b). In some cases, institutions have been criticized for this approach since the motivation to game the system in order to improve rankings has led to false reporting. Recently, a number of professional and law schools have come under fire for false reporting on measures such as job placement rates in order to boost their institutional ranking on these types of lists[14].

Furthermore, many institutions are continually expanding to try to move up to higher institutional classifications (Morphew & Baker, 2004). These categories, such as Carnegie classification and Barron's selectivity index, divide institutions into groups of similar peers. Institutions granting master's degrees seek to grant doctoral degrees. Those granting doctoral degrees want to become research universities. This motivation to move into a higher classification is meant to bring notoriety and funding, much like moving to a higher standing on rankings lists. Therefore institutions undergo capital projects to renovate dormitories, gymnasiums, stadiums, and recreation centers that are used to attract prospective students. Attracting better students would raise measures such as average SAT score and graduation rates, helping to improve an institution's rank. Similarly, building new labs are meant to attract new faculty and generate grants from various foundations and government agencies. Again, this improves an institution's

[14] For examples, see the *Chronicle of Higher Education* (De Santis, 2012; 2013) where the *U. S. News and World* Report removed rankings for the Tulane Business School and George Washington University for inflating reported data.

relative rank. The difficulty with this competition is that almost every university is striving to achieve the same vertical move. This shared aspirational motivation is part of the isomorphic tendencies seen from campus to campus. Institutions tend to follow the lead of an aspirational, elite institution, such as Harvard (DiMaggio & Powell, 1983; Morphew & Baker, 2004). Therefore, institutions will try to replicate the example set by their aspirational schools. This causes many features of institutions to spread from one school to another and explains why departments and programs, such as academic advising and freshmen orientation, are mimicked nationwide. Therefore, each institution sinks more and more money into these aspirational and isomorphic goals, causing overall costs to rise across the entire industry.

While the competition for students and prestige fosters conversations about costs, efficiency, and markets, the business model analogy fails in the details. In particular, public higher education suffers from difficulty in entering and exiting the market (Bowen, 1977). For-profit institutions have been successful in recent years in joining the higher education landscape and a number of smaller non-profit institutions have closed their doors because of the financial crisis, but public institutions rarely close. This stagnation of public institutions and the large influx of for-profit institutions could be contributing to an oversaturation in higher education. However, the other side of this conversation presents the case that steady increases in the demand for higher education is driving this expansion, and that the market is simply changing its character.

Competition extends beyond the relative rank in national publications. Within a state, higher education as a sector competes for limited public resources (Franklin, 1952). The balance wheel concept (Delaney & Doyle, 2007, 2011; Hovey, 1999), as previously discussed, is further supplemented with interest group politics. Higher education makes up a large interest group within a state. In New York, California, and Pennsylvania, over 100 public four-year institutions make up sizeable higher education sectors (IPEDS, 2013). However, other states only support a handful of schools. In Wyoming, there is only a single four-year institution. Yet, scholars (Baldridge, 1971; Dumont, 1980; Tandberg, 2009, 2010, 2013) have posited that higher education is failing as an interest group because of internal competition and the structure of governing boards. Rather than working together, institutions are self-interested. This may be attributable to the decentralization and re-privatization that has occurred in higher education since the 1980s. As states have eliminated or downsized governance structures, institutions have become more self-interested rather than being managed by the state or oversight board. This could extend beyond the management of their operations to their funding requisitions and, ultimately, the coordination between campuses as they lobby the state for funding. Indeed, previous research has found that consolidated governing boards have been found to have a negative effect on the statewide support of higher education because the single governing structure limits the ability of institutions to coordinate and advocate directly to the legislature (Tandberg, 2013).

One of the measures of an institution's worth to the state is their budget success rate. This is the ratio between the amount of funding an institution requests and the amount they actually receive from the state (Cogan, 1980). However, success at one institution means failure at another since funds are limited and institutions frequently request funding well above the amount they actually expect to receive. In addition, the interests of higher education are so diverse that it becomes difficult to create a unified voice. Instead, the interests of higher education are split between faculty, students, administrators, and the public, making bargaining at the state level difficult (Henderson, 1969). However, the study of interest groups in higher education is relatively new and requires additional research into topics on politics and political decision making (Lowry, 2007; Tandberg, 2009, 2010, 2013).

Finally, institutions have two unique features that affect both their public nature and funding requirements. The first feature is mission creep, or academic drift (Aldersley, 1995). Much like the problems with competitive aspirations above, institutions have been criticized for losing sight of their educational mission. Critics allege that institutions are focusing too heavily on research, public service, and internal support services, resulting in a rapid expansion of administration and increasing costs (Massy & Wilger, 1992; Zemsky & Massy, 1990). Instead, these critics argue that institutions should remain focused on educating undergraduate students, thereby reducing per student costs as these, arguably, auxiliary services are cut (Levin, 1991). This mission creep not only affects costs but the public nature of higher education. On the one hand, offering public services helps institutions become more involved in the community, targeting needy populations and providing a service beyond the borders of the campus. On the other hand, if the mission creep is causing education to suffer, then the public financing of higher education is possibly not being used for the intended purpose and most effective manner. The second aspect of institutional management that is unique to college campuses is the belief in academic freedom. PCUs offer an environment to conduct research free from judgment, politics, and fear of job insecurity. The concept tying all of this together is academic freedom. This, along with the associated institutional mechanics of tenure, departmental autonomy, and faculty boards, provides the ability to create, develop, and conserve knowledge. These characteristics foster the principles of public higher education.

Summary of the Higher Education Context

This chapter has provided a description of the history, background, and context of higher education. The main theme throughout the chapter has been examining the public and private components of higher education. This has included a description of the public and private benefits of higher education, making the case that since there are positive externalities that benefit society, that society is therefore responsible for partially funding higher education in return for these benefits. In addition, states and institutions both struggle with this question of who receives the greatest returns and who should pay for higher education. As the public perception of higher education has changed over time, policymakers have adjusted legislation to reflect the newly adopted sentiments of society given the economic and political leanings of the time. State and institutional management of oversight, funding, accountability, efficiency, and performance have all been modified to reflect the perceived nature of higher education. In general, a clear shift has emerged towards considering higher education as being a private good (Kezar & Eckel, 2004). This has resulted in policies reflective of this private view: higher tuition, lower state funding, and increased autonomy for institutions. In the next chapter, a conceptual framework is outlined using this background on the public and private aspects of higher education, with particular attention paid to the inputs, processes, and outputs.

CHAPTER III

CONCEPTUAL FRAMEWORK

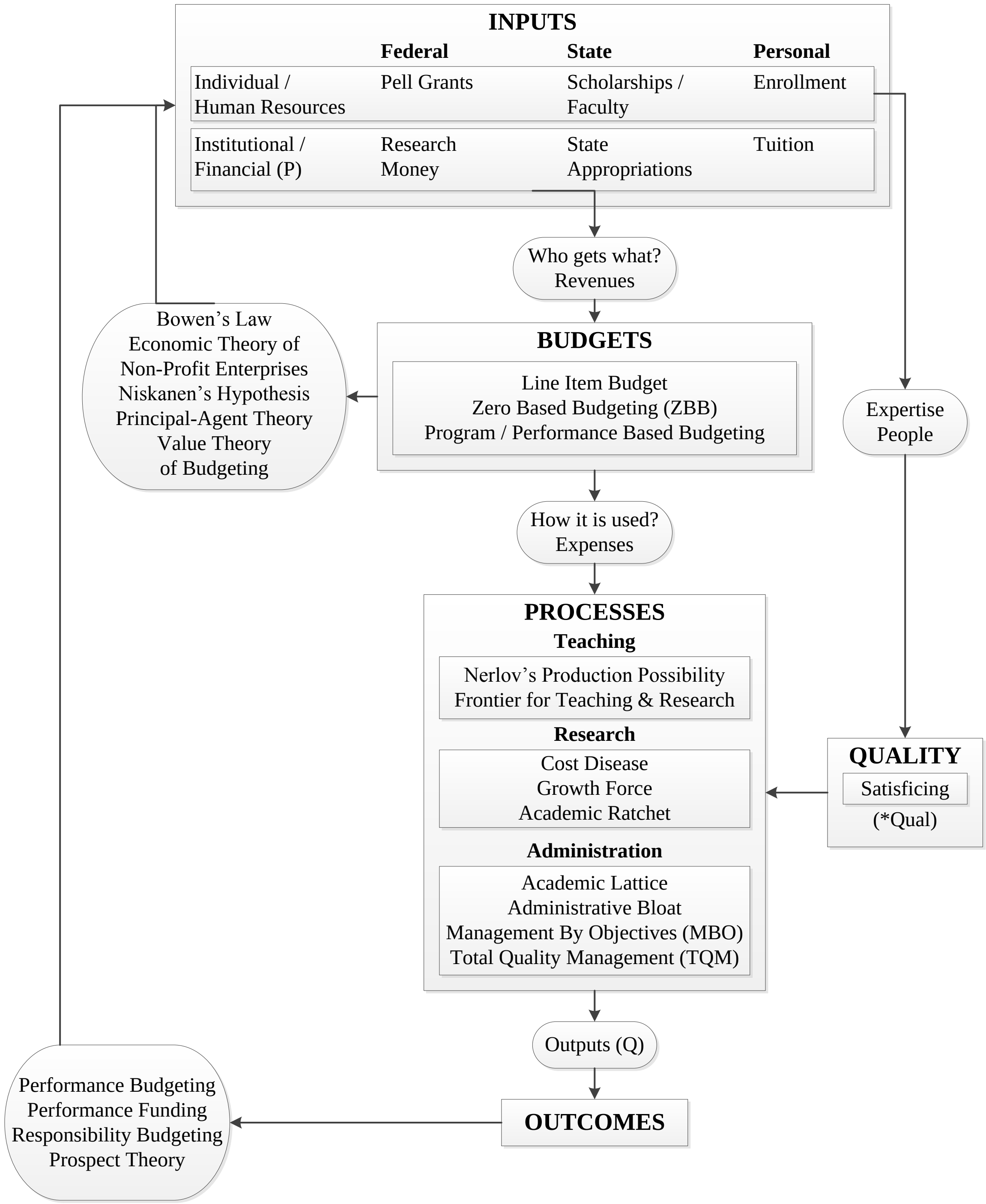
One of the difficulties in researching higher education finance is that there is no comprehensive conceptual framework for hypothesis testing. This chapter develops such a framework by drawing on literature and theory from a variety of fields including political science, public management, non-profit finance, higher education finance, economics, and organizational theory. This framework examines the actors, actions, and motivations involved in the financial support of higher education[15]. Consistent with the research questions examining institutional decision making, budgeting, and expenses at the institutional and subunit levels, the framework modifies existing economic production functions to fit the landscape of higher education. Figure 3.1 illustrates the conceptual framework, building the foundation from previous descriptions of input-output production functions (Burke, 1997; Craven, 1975; Hopkins, 1990; Kershaw & Mood, 1970).

These theories describe a production process from inputs to processes to outputs and outcomes. The inputs are raw materials which then undergo processes to create outputs. Raw materials in manufacturing might include steel, lumber, or other materials that are transformed into a finished product. In higher education, this assumption is particularly sensitive. While products on an assembly line are uniform and consistent, the raw inputs in higher education are students. This is problematic since age, race,

[15] Public higher education, in particular.

Figure 3.1

Conceptual Framework



socioeconomic background, academic preparation, and other characteristics of students make them inherently different. Therefore, treating them like a resource commodity, and institutions like factories, is a weak metaphor, at best. In order to take this type of a perspective, characteristics of students and institutions must be taken into account in the analyses, controlling for these characteristics in an attempt to reduce student and institutional variation so that meaningful comparisons might be made based on quantity and capacity rather than other attributes. This assumption, and its limitations, will be discussed in more detail in the following chapters, particularly how certain student populations and mission oriented institutions might produce differential effects.

The processes in a production framework typically involve routine activities such as those seen in manufacturing. In the case of higher education, a service oriented industry, the processes are services related to the core operations involving teaching, research, and administration. In both instances, the processes turn raw materials into a final product. Again, in the business sector, this is a tangible product while in higher education, it is an intangible service that contributes to human, social, and cultural capital.

Outputs are distinguishable from outcomes in that outputs are simply measures of quantity. Outcomes are instead measures of outputs in relation to inputs and the contribution to greater goals. Unfortunately, most outcomes that directly benefit society are incredibly difficult to measure. Instead, ratios of outputs to inputs are frequently used as proxies for outcomes. These consist of ratios reflective of efficiency and the greater impact on the institution and sector. To illustrate, a simplified economic equation for revenues typically consists of price (P) multiplied by quantity (Q). In this equation, Q is a measure of output. It is simply a workload count of production and commonly known as gross productivity (Baumol, Blackman, & Wolff, 1989; Massy, 1996). However, outcomes take a long-term look at how the outputs are affecting business practices and helping institutions achieve goals (Craven, 1975). This could be a profit margin ratio, effectiveness at achieving goals such as a stated graduation rate, cost per unit change in productivity, or meeting certain benchmarks. Early examples of looking at inputs in relation to outputs in higher education, or costs in relation to benefits, include the decision to admit women to Princeton in 1969 and the examination of medical schools in California (Kershaw & Mood, 1970).

The model in Figure 3.1 modifies the input-output model for higher education in three main ways. First, budgeting is included as a separate step in the sequence. This helps to distinguish the separate processes of turning revenues into expenditures. In particular, higher education is reliant on states and the federal government for a large portion of its revenues. This creates a disconnect between revenues and expenditures wherein expenditures are subject to change based on the decisions of third-party funders rather than internal processes. These funders typically allocate block sums of money to institutions rather than budgeting for specific subunits. In addition, university budgeting is a multi-step process whereby states must make allocation decisions, the federal government must make funding decisions, and students must decide where to enroll and bring their tuition money. Once these third-party funders have made their decisions, institutions must then decide internally how to allocate the various sources of revenues. Because of this process in higher education, this step was included to differentiate between the sources and uses of funding.

The second noticeable inclusion is a multiplier for quality. The outcomes in business depend on revenues and ultimately profits. In higher education, price and quantity are less meaningful. There are no profits, and any revenues or unspent money must be reinvested in the institution or forfeited back to the state. Instead, higher education is judged on quality. This affects both inputs and the processes that lead to outputs and outcomes. In terms of inputs, quality is judged by the educational offerings of the school, which manifests through the caliber of faculty and students. These high-caliber individuals then provide quality service which produces improved outputs. Better outputs, once related to outcomes, improves an institution's standing, which then attracts even more high-quality faculty and students. This circular loop, affecting both inputs and outcomes, is interrelated to the price and quantity formula for production functions. Therefore, it warrants inclusion as a multiplier in the higher education production function (Atkinson & Massy, 1996).

Finally, there are two feedback loops included in the model which are somewhat unique to higher education. The smaller feedback loop between budgets and inputs is reflective of the dependent relationship between institutions and their third-party funders. Institutions must make decisions regarding how to allocate funds internally once they know their revenues. However, they can also try to influence the relationship with their funders. Rather than only looking further down in the production process, institutions can act strategically, employing methods from principal-agent theory to lobby for additional funding.

The larger feedback loop connects the outcomes of higher education with inputs. This occurs through two main mechanisms parallel with the different types of inputs:

human inputs and financial inputs. Faculty and students are not only the producers of higher education but also the consumers and inputs. They teach classes, produce research, learn from fellow faculty members and students, are instrumental in institutional rankings, and aid in the recruitment of other quality academics and students. This links the human resources as both inputs and producers of output that further improves inputs. The financial loop is reliant on the fact that profits must be reinvested in higher education. Additionally, given the increasing attention at the state level paid to institutional efficiency and performance, financial funding has become increasingly dependent on outputs. States are using performance funding and performance budgeting in their allocation decisions. This initiative has created a direct relationship between institutional performance on outcomes and the funding allocated to them by the state.

It should be noted that this framework relies of the aforementioned efficiency evaluation perspective. The focus of this framework is evaluating institutional performance from the viewpoint of those most interested in ensuring that institutions are acting efficiently. In particular, it focuses on the core processes at institutions in producing outputs related to service, research, and, most centrally, instruction. This framework is not meant to address the many auxiliary services at an institution, such as athletics, nor its auxiliary sources of funding. Finally, while this framework looks at institutions and its subunits in producing these outputs, it does not specifically address students, who play a large role in institutional mission, services, and outputs. For example, I do not make any assumptions about students themselves and how they are affected by certain programs nor their probability of being retained or graduating on time. Instead, I use the efficiency evaluation perspective to look at the performance of institutions on the whole rather than the behavior of individual students. The remainder of this chapter is devoted to the description of the theory and processes involved in this conceptual framework and, ultimately, how this framework will be used to explore institutional budgets and outcomes.

Inputs

The production function for higher education begins with a look at inputs. In public higher education, many inputs come from fellow public sources, namely the government. More specifically, taxes are levied on citizens that then go to support higher education functions. This approach makes the case that higher education is a benefit to the state and makes its services available to in-state citizens who then receive a discount because of their contribution through taxes. This is, for example, why there is a large difference in the price of in-state versus out-of-state tuition. This relationship can be quite complicated. Institutions receive their funding directly from the state, making them agents of both the state legislature and governor (Gerber & Teske, 2000). This relationship varies from state to state as gubernatorial power varies[16], particularly in setting the state budget. In strong executive states, institutions function more as state agencies tied directly to the governor (Thackrey, 1971). In legislative states where the lower house has more budget authority, institutions may be more responsive to the legislature and their subcommittees. However, relationships with governors and state legislatures vary within states as well. Governors tend to focus on higher education as a mechanism of economic development while state legislatures are more focused on

[16] For example, the use of line-item vetoes and the development of executive budgets.

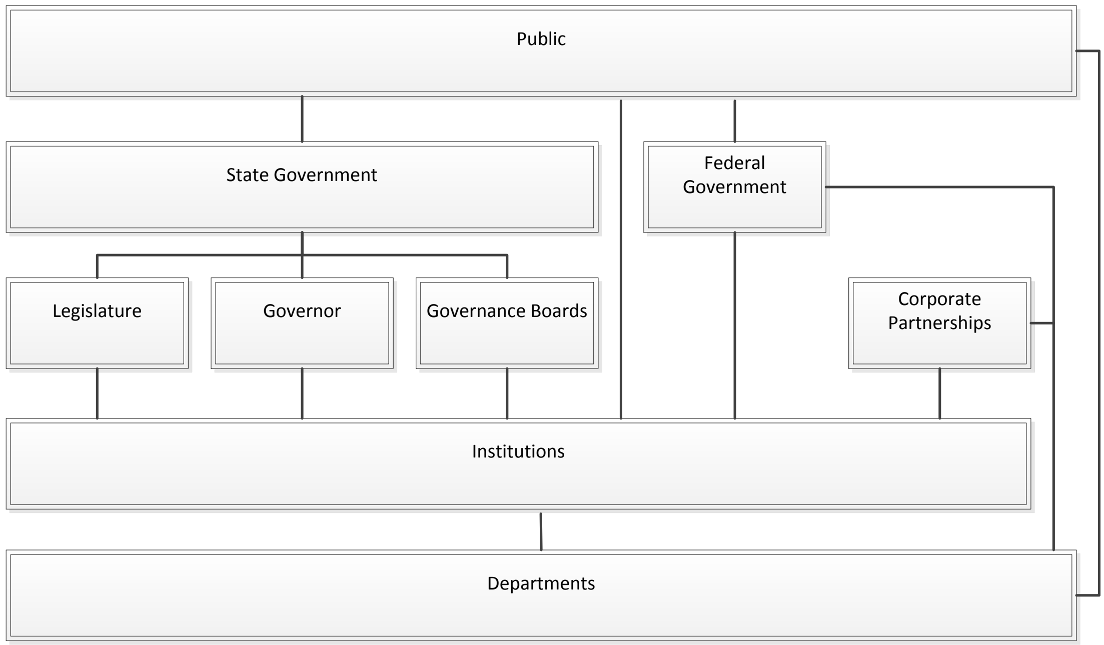
maintaining accountability and assessing institutional performance (Hearn & Holdsworth, 2002; Hines, 1988). Regardless of the relationship, this creates a principal-agent relationship between institutions and the state government (Ferris, 1991; Gerber & Teske, 2000; Lane, 2007). In addition, institutions are responsive to state governing boards. Strong governing boards have been delegated authority by the state government to oversee higher education and manage its functions. This can include setting tuition, making budget recommendations, hiring executives, among other varying powers from state to state. Again, a principal-agent relationship happens in this situation with a direct link between a governing authority and the institution.

Figure 3.2 visually displays this relationship. Each row operates as an agent of the principal in the row above. For state government, elected officials and state boards operate as agents of the public. Moving down, institutions operate as agents of these state actors and they, in turn, become principals. This type of arrangement is also seen with the federal government, who operates as an agent of citizens. Businesses, non-profits, and foundations all operate as principals, but have less direct connection to citizens due to the nature of their operations. Finally, departments within institutions follow a similar path, accountable to the institution but also to the public and the field of study. Each of these relationships will now be detailed with more specifics.

The federal government also plays a role in principal-agent relationships for institutions. As the primary funder for research money, institutions rely heavily on their relationship with the federal government to support institutional goals for generating and disseminating knowledge. Similar relationships exist with private non-profits, corporate partners, and foundations, though these are less accountable to citizens directly. All of

Figure 3.2

Principal-Agent Relationships in Public Higher Education



these offer new sources of inputs but include additional requirements and expectations for institutions. In this situation, each of these principals delegates higher education with a research objective and requires certain outputs in exchange for their funds.

There also exists a principal-agent relationship between institutions and citizens. On the one hand, this relationship is indirect, tying institutions to taxpayers through public allocations. On the other hand, the relationship is more direct as citizens are the immediate consumers of higher education and pay tuition directly to the institution. This operates independently of the relationship through other state and federal actors and their subsequent relationship with citizens.

Finally, institutions themselves can act as principals of their subunits and these subunits can be actors beholden to outside actors as well. Research funding from the federal government, businesses, non-profits, or foundations can go directly to departments to support research interests. This can deter departments from acting in the interest of the institution in favor of acting in the interests of their other principals. This could especially be true if departments see themselves as being more beholden to the public and contributing to the field of knowledge rather than creating direct outcomes for the institution.

This means that PCUs and their subunits are agents of multiple actors, sometimes in conflict with one another (Behn, 2001; Gerber & Teske, 2000; Lane, 2007). Each managing principal is able to provide different inputs and looks for a different type of performance. The complexity in such relationships makes congruence, a key aspect of principal-agent theory, quite difficult. Congruence is the strength of alignment between a principal's and agent's goals. The more aligned they are, the stronger the congruence and the higher the probability that an agent's behavior will lead to favorable outcomes for the principal. Alternatively, economic agency theory speculates that resources can be used for self-interested goals of agents rather than those of the principal (Massy, 1996; McLendon, 2003a). In the case of higher education, congruence is low since behavior is dictated by multiple principals. Aligning tightly to one principal could put the relationship with others at risk. This is especially true when the relationship is more general. Tight requirements, such as those found in research grant contracts or through the use of line item budgets, leave little room for interpretation or non-congruence. However, the looser relationships with states and citizens, with fewer explicit conditions, leave institutions with more flexibility to pursue their own goals. This is similar to behavior in the government and business sectors. Tasks that are routine with lower levels of complexity offer less ability for non-congruence as the expectations are explicitly set by principals. However, more complex tasks that require more flexibility and autonomous delegation leave a disconnect between the principal and the agent wherein non-congruence can arise.

Furthermore, higher education has intrinsic motivation beyond that dictated by their principal-agent relationship. Depending on an institution's mission, leadership, and behavior, institutions may voluntarily depart from congruence in order to pursue their own self interests. This happens frequently in the study of public administration where the goals of management do not align with staff. The staff then pursues their own goals, such as professional development, or pursues their own public service motivation by foregoing managers and elected officials and directly addressing the goals they perceive as being held by the public.

In order to address the disconnect between the principal and agent, theory dictates that the principal engage in oversight of the activities of the agent (Ferris, 1991; Gerber & Teske, 2000; Lane, 2007; Massy, 1996). The problem with oversight of higher education is twofold. First, as discussed, there are multiple principals. Second, the oversight creates transaction costs that drive up costs and potentially make institutions more inefficient because of the added expense of monitoring. Institutions have more information about their operations and performance, but their performance is hard to measure and costly to report (McLendon, 2003a). The information asymmetry that arises between the institution and their principal requires some sort of feedback mechanism that requires additional time and resources to gather. Therefore, the combination of these two factors creates multiple relationships, each requiring oversight and driving up overall costs.

Lane (2007) draws on the concepts of manifest oversight and latent oversight (McCubbins & Schwartz, 1984; Ogul, 1976) to look at Pennsylvania State University and the University of Illinois to examine the oversight mechanisms in place to alleviate principal-agent problems. Manifest oversight includes formal mechanisms of oversight while latent oversight encompasses the informal mechanisms. Lane's (2007) case studies reveal that the budget process is the primary form of manifest oversight while media is used as the primary form of latent oversight. This identification of budget processes as encompassing manifest oversight is especially important in the conceptual framework for this study. Budgeting is included as a separate step for this reason: it is the mechanism used to combat principal-agent incongruence. Therefore, it is important not only for decision making, but also for accountability.

These examples of principal-agent dynamics comprise the matrix for the inputs of higher education. Each actor provides a unique source of inputs which then travels through the production function for some type of output, ideally aligned to the principal's goals and expectations. These actors have been simplified to the largest sources of inputs for higher education: the federal government, states, and students. In addition, the matrix has been divided into two components for inputs: financial inputs and those related to the human resources. This creates a 2 X 3 grid which loosely divides into separate input components that rejoin later in the process of generating outputs.

Financial Inputs

The financial inputs in the public higher education production function stem from three major sources of revenue. Historically, state appropriations have been the largest source of institutional revenue. More recently, state appropriations are increasingly being replaced by tuition revenue as comprising the largest share of revenues, particularly at elite institutions with very high research activity (IPEDS, 2013). Both of these sources of revenue have been directly linked with enrollment in the past with appropriations and tuition both being measured on a per student basis. This depicts a shift in out-of-pocket support. If appropriations and tuition are both based on a per student basis, then declining relative state support per student and increasing tuition per student results in a higher out-of-pocket expense. This not only appears in raw numbers as tuition has increased, but also as a percent of household income as tuition has increased despite a flat, if not declining, time adjusted measure of income.

These financial inputs, in terms of an economic model of production, make up the price component of the equation where output is determined by price multiplied by quantity.

$$\text{Revenue} = \text{Price} * \text{Quantity} \quad (3.1)$$

The price is the cost of education, subsidized by state appropriations and aid[17], to create a tuition price. Note that this is a simplified model and does not include indirect costs or non-educational costs such as research. The aid in this model offsets the out-of-pocket expense at the student level.

$$\text{Tuition} = \text{Price} - (\text{Appropriations} + \text{Aid}) \quad (3.2)$$

Rearranging the equation yields:

$$\text{Price} = \text{Tuition} + \text{Appropriations} + \text{Aid} \quad (3.3)$$

Revenue in equation 3.1 is replaced by output in the higher education context since higher education is a non-profit organization and revenues are not as reflective of outputs. In addition, the price in this equation is the overall price of education. Substituting in the price equation in 3.3 to the economic equation in 3.1 yields:

$$\text{Output} = (\text{Tuition} + \text{Appropriations} + \text{Aid}) * \text{Quantity} \quad (3.4)$$

This forms the beginning foundation of the financial portion of the economic formula for the input-output production function for higher education.

The third major source of institutional revenues comes from the federal government for research support. This is different from the previous sources of revenues in that it supports research rather than education. While there is a sizeable investment in research by non-profit foundations and private corporations, the investment by the federal

[17] With aid acting as a negative revenue whereby Tuition Paid = Published Tuition – (External Aid + Institutional Aid)

government at the largest research institutions in the nation comprises a much larger portion of institutional budgets. This is especially true depending on the field of study and strength of the relationship with government agencies and functions. For example, there is large federal support through agencies such as the Department of Defense, National Science Foundation, and National Institutes of Health.

These financial resources, from the varying external funders, then flow into an institution's budget. If the revenues are not dedicated for special purposes or funds, then they deposit into a general fund to support the operations of the institution (Hearn, Lewis, Kallsen, Holdsworth, & Jones, 2006). For educational operations, the sources are much more flexible than research funding. Appropriations and tuition are typically budgeted as blocks, with no dedicated purpose. The general fund is a large pool of money and institutional decisions must be made as to where these funds should go. This flexibility, while useful for management, introduces the potential for funds to be misappropriated to purposes that are unproductive. The multitude of differing higher education functions introduces mission creep and subsequently reduces efficiency (Levin, 1991). Federal research funds, on the other hand, are typically tied to individual projects, restricting flexibility in use and ensuring the inputs are directly linked to designated projects. External funders make separate decisions in funding institutions. Once the institution receives these funds, they pool together and institutions are largely free to distribute the funds internally as they see fit. This varies from institution to institution based on the state and legal framework as to the discretion the institution possesses, but institutions still must determine the best way to spend the money they receive from their various sources. This internal decision process moves the financial inputs down the vertical flow stream through the decision making process of determining who gets what resources. The "who" in this question, for the purposes of this study, include functions and institutional subunits. In essence, this requires institutional budget officers to determine the level of funding for each area. This feeds into the budget process of how budgets are developed, turning funding decisions into a formalized document of budgetary priorities.

Human Resources

The second category of inputs in the public higher education production function comprises the human sources of inputs. In Craven's (1975) framework, these are identified separately as "resources." In the service oriented industry of higher education, outputs are determinants of the people working for the organization. The better the human resources as inputs, the better the service outputs. There are two determinants of the human resources at an institution. The first is the inputs for attracting and supporting the human inputs while the second is the people themselves and the expertise they bring to the institution.

The inputs for attracting the faculty and student resources to an institution are supported by federal and state policy. At the federal level, Pell grants, along with other sources of federal financial aid, are a major factor in attracting high quality students who are financially burdened and would otherwise be unable to attend college. At the state level, scholarships, both need-based and merit-based, help attract students to an institution over competing schools. This also plays into the price component of the economic output equation. These sources of aid offset the price of an education as depicted in the previous equations 3.2 – 3.4. Note that internal grants and scholarships are not included as aid since they are not external sources of revenues and are more appropriately classified as either expenses or negative revenues.

At the individual level, faculty at public institutions are typically considered state employees in some capacity. In some states they can contribute to state retirement funds or are paid by the state legislature, either directly or indirectly. Therefore, faculty are included as state inputs. The other human resource includes the students themselves. These students make the individual decision to attend an institution, comprising enrollment and paying tuition. In a simple measure of outputs, the enrollment could be thought of as the quantity measure for equation 3.4. This would result in an equation for institutional revenues:

$$\text{Revenues} = (\text{Tuition} + \text{Appropriations} + \text{Aid}) * \text{Enrollment} \qquad (3.5)$$

However, since revenues, or profits, are not the key output for higher education, and the fact that states are moving away from student based funding to performance based funding (Tandberg & Hillman, 2013), this means that equation 3.5 lacks information about the educational outcomes. Furthermore, it lacks information on quality, which is a key component to higher education outcomes. Instead, these human resources should not be thought of simply as a measure of quantity, but as a contributor to another factor in the economic production function, that of quality.

This tie to quality, through the quality of the people working at the institution, is depicted by the right-hand flow relating the human resources to quality through their individual expertise. Higher quality individuals are expected to yield higher quality results for the institution. Therefore, equation 3.4 would need to include a multiplier for quality in the context of non-profit, public higher education.

$$\text{Output} = (\text{Tuition} + \text{Appropriations} + \text{Aid}) * \text{Quantity} * \text{Quality} \qquad (3.6)$$

This multiplier then interacts directly with the financial inputs, budgeting, and processes in determining what kind of outputs are created in the production function.

Quality

Continuing with the human resources inputs, the conceptual framework extends along the right side of the model down to quality. As described above, quality is a multiplier that has a direct impact on output. Quality is so important to higher education that Pestieau & Tulkens (1993) posited that quality is the only valid measure of performance for higher education. Indeed, quality is especially important in this production function type framework given the inherent differences in students, faculty, and institutions. However, quality is difficult to quantify, let alone capture by a single measure (Ehrenberg, 2002b; Zhang, 2005). Frequent measures of quality include rankings such as *U.S. News and World Report*, Barron's index, Carnegie classification, SAT scores of entering freshmen, admissions rates, and tuition and fees. Brooks (2005) examines the factors related to *U.S. News and World Report* rankings including reputational surveys and research productivity, and concludes that all measures are somewhat flawed. For example, research productivity varies between the disciplines, between journals and other publications, by journal impact factor, by federal research awards, and can be difficult to attribute faculty publications to a single institution. However, Zhang (2005) tested the relationship between institutional quality and a graduate's earnings. The results revealed that the different measures of quality – Barron's, Carnegie, tuition, and SAT scores – were all positive and statistically significant in their impact on earnings. He concludes that quality matters, regardless of the measure of quality utilized.

The quality multiplier in this production function is a representation of the expertise that students, faculty, and staff bring to the institution. For students, expertise is measured in aptitude. The highest quality students have the potential for greater educational outcomes. By improving the quality of students, institutions are directly increasing their potential outcomes. Not only is this because of individual student characteristics, but also because of interactions that take place between students and faculty, fostering a learning environment. The difficulty with such a measure of student quality is that it not only includes the individual quality components but also the institutional environment. Traditionally, student-faculty ratios have been used as a proxy for quality (Enarson, 1960; Glenny & Schmidtlein, 1983; Levin, 1991). This measure assumes that interactions are of higher quality when this ratio is low. Yet institutions are challenged by this arrangement. Adding more students would increase revenues but simultaneously increase this ratio, causing quality to arguably decline. Adding more faculty would decrease the student-faculty ratio, improving quality but adding substantial costs. More recently, this is bringing new challenges about quality in public higher education as the student-faculty ratio has increased while private institutions have seen a decrease (Kane & Orszag, 2003). Alternatively, entering SAT scores, the percent of freshmen graduating in the top 10% of their high school class, and institutional admissions information is now frequently being used as proxies for quality (Archibald & Feldman, 2008b; Breu & Raab, 1994; Zhang, 2005).

For faculty, quality is expressed by notoriety, publishing experience, and high quality teaching. In particular, the focus has traditionally been on faculty research outputs in the form of grant funds and publications. However, experience can also work in the reverse, resulting in lower quality as faculty age and productivity declines (Glenny & Schmidtlein, 1983). Finally for staff, expertise has grown in recent years as higher education administration has become more professionalized with advanced degrees and competition with the private sector for quality workers. By increasing quality, the potential outcomes for an institution are also expected to increase. Whether the actual outcomes increase is determined by the processes involved at an institution, but the potential outcomes are based on this concept of quality.

However, quality can also limit potential outcomes. The classic discussion of bounded rationality and satisficing posits that humans are bounded in their decision making process by information asymmetry and resource constraints forcing them to decide based on imperfect conditions (Cyert & March, 1963; Simon, 1965). In this sense, they make the best decision they can given their circumstances. Satisficing is this concept of trying to maximize utility under conditions of constraint. Individuals know they are unable to achieve perfect information and obtain unlimited resources. Therefore, they must come to a conclusion without spending too much time or money in the process. This prevents an efficient outcome, which, under perfect economic assumptions, would be situated along the utility maximization curve. Instead, they are situated within the curve, at an inefficient point compared to if situations were perfect.

This concept of satisficing is included in the section on quality because it affects optimal outcomes. First, the students, faculty, and staff are bounded in their decision making process for becoming part of an institution. They must decide whether to enroll or take a job at an institution and this decision is imperfect. For example, students must weigh issues of cost, family ties, distance, institutional fit, and other factors in deciding where to go to college. While brochures and campus tours can help to educate a student, there is still imperfect information between the student and the institution. Therefore, students must make a decision based on the information they have and consider external factors and family preferences in their decision process. This decision ultimately influences their enrollment and contribution to an institution's quality. In addition, it can have a meaningful impact on student outputs. For example, if the quality of the information provided to students is poor, their enrollment decisions may be based on imperfect information and may ultimately lead to poor measures of student success such as low retention rates. Second, satisficing also factors into institutional processes. Even if one were to assume a fixed student body and faculty composition, these actors have imperfect information in institutional operations. Administrators must make institutional decisions with limited time and resources. These constraints also can limit potential outcomes if the information they use to make the decisions is imperfect.

These two quality concepts of quality people and quality decision making act as a multiplier in the input-outcome production function. Higher quality people will improve the potential for better outcomes. However, even if the best people were in place, the decision making processes involved are limited by resource constraints and, therefore, the need for satisficing. Thus, these two factors of quality both directly impact potential outcomes and the quality of processes in transforming inputs into outputs.

Budgets

Moving down from the inputs, and more specifically those inputs from external funding sources, is a sub-process for budgeting. The budget development process is separate from other institutional processes in that it is a determinant of the uses of inputs but has no direct link to the creation of outputs other than through its decision making. Rather than turning inputs into outputs, budget processes develop short-term and long-term plans about how inputs are to be used throughout the organization (Atkinson & Massy, 1996; Kotler & Murphy, 1981). Despite the lack of output generation, it is instrumental in subsequent organizational processes in determining funding priorities and the amount of resources available to subunits. Furthermore, as discussed previously, it is instrumental as the primary form of manifest oversight (Lane, 2007). Therefore, it doubles as a decision making mechanism and as an accountability mechanism.

The budget process itself is analogous to institutional policymaking. Departments submit requests for funding much like the institution does to the state government. Administration reviews requests and ultimately determines the funding levels for each department. In essence, the budget becomes the communication tool between administration and its subunits about institutional priorities and focus (Cogan, 1980). In what Cogan (1980) calls the "Normative Design Characteristics for Desirable Internal Budget Processes", he outlines five suggestions for ideal budget procedures. These include minimizing conflict, quickly identifying critical issues, making multiyear projections and using these to develop long-term plans, ensuring short-term fluctuations do not threaten long-term plans, and dealing with departments directly. Most budget planning systems incorporate these suggestions into their processes in one form or another, indicating that budgeting is a complex process with multiple actors, competition, and multi-year timeframes that requires sensitivity in budget formation.

The classic budget is the line item budget listing individual lines for every expense category. This is the most detailed budget with each line set up like an accounting workbook. Budgets, which determine funds available, are itemized by department and then by each line item, such as office supplies. These budgets require micro level decision making for each unit but tie directly to accounting categories from where the money is actually expended, ensuring accountability and specificity in oversight. Therefore, rather than having to look into such detail, budgets became incremental policy documents. Every budget was based on the previous year's allocations and typically received some inflator based on the price of goods or inflation. This incremental rate is known as the budget growth rate, the ratio between the amount of money allocated in one year as compared to the amount allocated in the next year (Cogan, 1980).

In the 1970s, Jimmy Carter introduced a popular RAND proposal to government budgeting in the form of Zero Based Budgeting (ZBB). With ZBB, units started each year with zero allocations. They were required to make the case every year for their financial support from the ground up. The ZBB system required departments to look at all of their expenses and defend their budget requests each year. This attempted to eliminate incrementalism by challenging programs to justify their support and, ultimately, their very existence. However, ZBB failed because of the managerial burdens it placed on the departments. Collecting the information required to justify building a budget from the ground up every year was simply too expensive and time intensive, resulting in massive transaction costs that doomed ZBB to failure.

Alternatively, budgets can be formulated at a more macro level. In this approach, funds are allocated in blocks to individual departments or programs. Rather than focusing in the individual items, budget officers allocate large chunks to programs to use as they see fit. This process developed into a series of budgetary systems including program and performance based budget systems. Under such systems, budgets are reported more directly in terms of their stated goals rather than their functions. Rather than reporting allocations for budget objects such as office supplies, this system reports performance indicators and their associated activities. These budgets, linking funding to activities and performance formed the foundation for state performance reporting and implementation of performance funding.

Budgets, once developed, operate as institutional policy documents. They specify how much money is allocated to each unit and indirectly, through the budgetary formulation process, determine high priority programs and departments. The budget then becomes an organization's guide for operations and how to turn inputs into outputs through these departmental level programs and processes. This moves the higher education production function further down into the processes involved and, more specifically, the sub-processes for higher education of teaching, administration, and research.

Budgetary Feedback Loop

While inputs are allocated through budgets to subsequent processes, there also exists a feedback loop emanating from the budget process back to inputs. Much like programs and departments are required to justify their budget requests, institutions can do the same with their various sources of funding. In this feedback loop, institutions can go back to their funders and request additional money through lobbying and interest group politics. This behavior draws on resource dependency theory (Froelich, 1999; Pfeffer, 1997; Pfeffer & Salancik, 1978; Scott, 1995) which outlines that organizations do not attempt to act efficiently, but instead try to maximize and secure their various sources of inputs. Institutions, in this regard, can be seen as revenue maximizers, trying to always increase the amount of inputs made available to them regardless of the relationship with their processes, outputs, or outcomes.

A classic hypothesis of this sort is Bowen's revenue theory of costs (1970, 1980). This posits that higher education focuses all of its efforts on revenues rather than expenses. Institutions are always seeking to increase the amount of money they receive in order to improve their prestige, whether or not these funds are needed or being used most efficiently (Alexander, 2011; Ehrenberg, 2002a). This lack of focus on expenditures creates a naturally occurring inefficiency in higher education with maximized revenues and a disconnect with expenses. Instead, higher education simply seeks to spend all the money they raise on whatever program they see fit, resulting in an always expanding model for higher education. Similarly, the value theory of budgeting states that non-profit organizations, including higher education, are utility maximizers (Hopkins & Massy, 1981; Massy, 1996; Massy & Wilger, 1992). Since they do not measure performance by monetary returns, as in the private sector, they must measure utility differently. This comes in the form of prestige, which again prompts institutions to maximize their inputs in order to improve the amount of money they have available to boost their prestige and institutional utility. Therefore, institutions will continually try to increase programs, quality, and prestige so long as the expansion and associated gains continue to exceed the additional costs.

The economic theory of non-profit enterprises outlines a maximization framework similar to Bowen's law, but from an expense point of view. This theory posits that decision makers will try to maximize total benefits subject to a limit on expenses (Massy, 1996). In this framework, institutions are constrained by resources. Once revenues are established, institutions will use them in a manner that maximizes the returns to the institution. This is especially important in this input-output model because of the assumption of fixed resources. Given that expenses in non-profit organizations are constrained by the amount of revenue generated, the model assumes that expenditure decisions are made after revenues are identified. Therefore, this theory postulates that institutions will use the fixed resources in a manner that maximizes benefits. In this case, the institutions are likely using the resources to maximize outputs and subsequent outcomes. When institutions are not maximizing their returns, they are likely to engage in growth by substitution (Massy, 1996). In growth by substitution, resources are shifted from one area to another when greater returns are identified.

These maximization models are not unique to higher education. Niskanen's hypothesis (1971) applies to government agencies, also lacking financial outputs. In this context, rather than operating at the efficient point where marginal benefits equal marginal costs, institutions operate where average benefits equal average costs. In a situation with diminishing marginal returns and increasing marginal costs, this puts them at an inefficient position with higher costs than necessary given the benefits. In essence, every additional dollar beyond where marginal costs equal marginal benefits yields a lower output than what is being input. Niskanen's hypothesis posits that institutions will try to maximize their budgets based on these costs. Furthermore, in government organizations, institutions with additional funds at the end of the year are forced to relinquish those funds back to the general fund budget. Having additional funds remaining opens these organizations up to budget cuts with the understanding that since there was money left over, they do not need the funds in future budget requests. Therefore, similar to Bowen's revenue theory of costs (1970, 1980), institutions will spend everything they receive, in a naturally inefficient manner, in order to avoid future budget cuts. Both of these theories are about institutional positioning. They both maximize revenues in relation to their importance and relative standing, whether in comparison to other institutions or in regards to the relative portion of budgets. In this regard, they compromise a feedback loop wherein institutions strategically try to manage their position with their funding agency in order to maximize the potential inputs they might receive.

Processes

Once the financial and human resources are established for an institution, budgets are prepared to distribute the resources internally to a variety of processes intended to produce certain outputs. Craven (1975) posited that higher education excellence would become more about the effective reallocation of resources rather than the acquisition of new resources. This makes budgeting and processes in this framework arguably the most important step in producing quality outputs. However, because higher education is a service oriented industry, resources are somewhat constrained in their allocation to processes. Salaries are, by far, the largest expense item for higher education (Glenny & Schmidtlein, 1983; IPEDS, 2013; Santos, 2007; Shepherd, forthcoming). Therefore, a shift in resources from one department or program to another has the potential to impact jobs more than resources.

There are three levels of decision making that St. John (1991) outlines in state management of higher education. However, these three levels can be applied internally as well. First, strategic planning involves developing objectives, allocating resources to achieve these objectives, and monitoring progress. Second, management control is the process used by managers to obtain resources to meet their outlined objectives. Finally, operational control is meant to ensure that processes are conducted efficiently and effectively. In the conceptual framework outlined in this dissertation, the first level is assumed to be under the purview of the state and other third-party principals. This leaves the second and third levels to the jurisdiction of the institution. This conforms to the dissertation's goals of identifying internal resource allocation (level two) and evaluating performance (third level).

The budget step, as discussed previously, is a type of sub-process intended to take a macro look at institutional resources and outputs and decide the extent to which departments and programs warrant funding. These departments and programs are the direct processes involved in turning their budgets and human resources into outputs.

There are three main types of processes in higher education, all linked closely to institutional mission. This includes teaching, research, and administration.

Teaching

The teaching aspect of higher education, particularly for undergraduate students, is one of the most important functions of an institution. There are a number of different research avenues for academics in higher education including academic integration, persistence and retention, diversity, graduation, value-added, and remedial education, among others. These studies largely look at students and seek to understand correlations with performance or make causal claims based on various treatments. However, this conceptual framework with the input-outcome education production function is interested in the institutional level effects of financial inputs and quality multipliers in the production of educational outputs. Rather than looking at treatment effects, the interest in this model is an understanding of how resources are being used. This involves looking at institutional resources and tracking how they are distributed internally and their associated outputs.

From this institutional perspective, there are a number of organizational changes that have the potential to impact outputs. Nerlov's (1992) Production Possibility Frontier for Teaching Quality and Research (Massy, 1996) depicts faculty outputs in relation to teaching and research. The model argues that including research requirements for faculty increases teaching quality because faculty are able to incorporate research into their teaching, thereby improving the quality of education by updating and challenging critical thinking. This is depicted by a positive relationship between teaching and research.

However, the returns are diminishing and develop a negative relationship as research overwhelms a faculty member's time, resulting in lowered teaching quality as research increases. Therefore, institutions must identify the point on the production possibility frontier that maximizes both teaching and research, without sacrifice to either.

Research

The second main product of institutions is research. Given, this is not universal as certain institutional types place less emphasis on research than they do on teaching. Research inputs and outputs could have the most direct relationship as inputs are often dependent upon promises of certain outputs. Research grants are proposed by faculty and once approved, the funding is dedicated specifically for the project and investigators involved. Therefore, there is less flexibility in how grant funding can be used. Additionally, there are dedicated research faculty, post-docs, and staff at research based institutions dedicated strictly to research. These components comprise a parallel input-output function to that of teaching, but with clear differences in assumptions. The issue with such a close relationship is the issue of causality. Research funds are frequently used as research outputs because they reflect a market value of the research that is being conducted at that institution (Abbott & Doucouliagos, 2003, Ahn, 1987; Brooks, 2005; Cave, Hanney, & Kogan, 1991; Izadi, Johnes, Oskrochi, & Crouchley, 2002; Johnes, 2006). Yet in other studies, research funds are treated as inputs (Beasley, 1995; Johnes & Johnes, 1993; 1995). For the purposes of this study, I take the outputs based approach where research funding is used as a proxy for productivity and, therefore, outputs. Instead, faculty are treated as inputs for both teaching and research.

One of the factors influencing research processes is cost disease. This idea posits that the reliance on labor causes wages to increase in the competition for workers and inability to substitute for technology (Archibald & Feldman, 2008a; Levin, 1991; Massy & Wilger, 1992). It further explains that this phenomenon is especially relevant in service oriented industries, such as higher education, which rely more heavily on labor for inputs rather than materials. Stated otherwise, cost disease drives up per unit costs because of this reliance on labor and the ever rising costs of labor inputs. Higher education relies heavily on its labor inputs and therefore suffers from a continual upward pressure on wages, driving costs upwards. While the theoretical framework for cost disease could explain some of the increase in institutional costs, the empirical results have only shown a small relationship between cost disease and the rapidly growing costs of higher education. Indeed, cost disease has only been attributed to explaining roughly 1% of the increase in costs (Massy, 1996).

A somewhat related theory, growth force, introduces quality as a component. This explains that higher education is in a constant state of expansion, trying to generate new knowledge and research (Massy & Wilger, 1992). In order to stay competitive in terms of research outputs, institutions spend money to hire experienced researchers who might generate new research. In order to hire these elite researchers, institutions must pay a wage premium to attract them away from other institutions and private firms. In addition, the rapid expansion is accompanied by additional regulation and compliance in order to oversee the new institutional reach. These costs of expansion are the growth force components to inflating higher education costs.

Finally, faculty are heavily invested in research as a self-interested focus on prestige. Researchers posit that faculty members are more dedicated to their field of study than they are to their employing institution (Gove & Floyd, 1975; Massy, 1996). With research, faculty are directly engaging in their field and creating a personal reputation. This makes them entrepreneurial in their research activities and the associated external grants, copyrights, and prestige. This process, known as the academic ratchet (Massy, 1996; Massy & Wilger, 1992), gives faculty members job security and an argument for higher salary. However, similar to cost disease, there is little evidence of the academic ratchet driving up costs (Massy & Wilger, 1992).

Administration

Administration also plays an important part in the education production function, including areas such as orientation, advising, housing, academic tutoring, student affairs, and service. As institutions have extended their mission beyond teaching, administration has been forced to adapt. With students, administrators are pushing processes that improve quality and outputs, helping to attract better students and improving an institution's prestige. In addition, as peer institutions improve their own services, institutions must respond in order to remain competitive. This isomorphic pressure results in an ever expanding administrative structure simply to keep pace with the evolving higher education environment. This expansionist pressure has resulted in a concept known as the academic lattice (Massy, 1996; Massy & Wilger, 1992; Zemsky & Massy, 1990). This shows a growing amount of administrative staff, growing even faster than faculty during the same period of time (IPEDS, 2013). Additionally, administrators have become more professionalized with specialized training and ownership over institutional functions. The growth of institutions necessitated that tasks formerly held by faculty members be transferred to administrative staff simply because of time and resource constraints. Rather than having faculty engage in these tasks, staff is used as a more cost effective means of accomplishing administrative tasks.

More administrative staff is also needed as faculty engage in more research activity. Functions with lower relative returns are often shifted to staff in order to free up time for faculty to engage in teaching and research functions that are more directly related to an institution's mission. This professionalization in administrative staff resulted from earlier criticism that faculty were too involved in administrative tasks that had little return to the institution and their time was better spent on more high yield activities (Enarson, 1960). At the time, critics argued that faculty used the course catalogue to create job security by developing new courses that fit their own self-interests rather than those of the institution. Finally, having an established staff can be an appealing feature of an institution for attracting new faculty, who can see the personnel and policies in place that will help support their activities.

Furthermore, administration extends beyond staff to both faculty and students in its mission of service. Institutions heavily involved in local and state outreach, land grant institutions for example, have a third mission of service to the community. These involve activities, such as extension services, which are run by institutions for the purpose of service. These programs must be staffed and also often seek to involve faculty and students in helping to bring the service to the community. This requires additional financial and human resources in order to function.

Finally, administration also means structure. The institutional organizational structure and hierarchy can also play into processes and outputs. Questions of authority, management, and “red tape” can all impact the processes of turning inputs into outputs and whether the processes are operating efficiently. Birnbaum’s (2000) *Management Fads in Higher Education* explores many of the managerial experiments that occurred in higher education. These include styles such as Total Quality Management (TQM) and Management by Objectives (MBO), intended to improve institutional performance and promote efficiency. However, he challenges the effectiveness of these initiatives, pointing out the short cycle accompanying most management fads, only to be replaced by the next idea.

Outputs & Outcomes

The penultimate step in the input-outcomes framework includes the outputs created by the processes that transform inputs. In manufacturing, this is primarily measured by a quantity count. In higher education, this would entail raw figures on outputs such as the number of degrees awarded, a common measure used by the state in performance evaluation. In this case, the output is a simple quantity count. Alternatively, outputs can be a function of the inputs. For example, revenue is an output based on financial inputs per student and enrollment. This was outlined previously in Formula 3.5, reprinted below.

$$\text{Revenues} = (\text{Tuition} + \text{Appropriations} + \text{Aid}) * \text{Enrollment} \qquad (3.5)$$

While outputs can be useful for measures of short term performance, they don’t carry the meaning that outcomes have in relation to institutional goals. These outcomes are often expressed by ratios rather than quantity counts. For example, there is no numeric count for efficiency, but institutions might use an outcome ratio of the cost of education per student to compare the use of resources to outputs across different programs, institutions, and contexts. New statistical techniques have also been used to create measures of efficiency.

Outcomes are often expressed as weights, costs per unit, or other comparisons between inputs and outputs. These outcomes are useful because they provide a measure for concepts like efficiency and accountability, which are functions of the use of funds rather than a measure of output. Unfortunately, the lack of a clear definition for these concepts leaves outcome measures open to interpretation. Popular media frequently releases reports claiming to rank institutions in a variety of different areas such as value. However, the measures they use to develop a ratio for value often has very little to do with actual value and more to do with their choice of readily available data. Regardless, widely accepted measures in the higher education sector provide a face validity argument that best practices are being employed and offers a way to compare institutions against one another.

Performance Feedback Loop

After the outcomes of the higher education production function comes the evaluation process. The more popular term has become performance, which differs from program evaluation of a single initiative. There are four ways to evaluate performance based on which output or outcome measures are being examined (Craven, 1975). Extensiveness is related to outputs in that it measures quantity. Effectiveness looks at how the outputs related to objectives. Said otherwise, it looks at whether programs are doing what they intend to do. For higher education, this would entail ensuring that departments are aligning with institutional goals. The third evaluation technique is the one that has garnered the most attention in recent years. This looks at efficiency, or how inputs are being utilized in the generation of outputs. This question of efficiency is especially important because it links the financial resources dedicated by the federal government, states, and students to the perceived performance of the institution on various output measures. Indeed, the efficiency approach for this framework and the dissertation mirrors the increasing attention being paid to institutional performance and the efficiency in producing institutional outcomes. Finally, benefit is an examination of the long-term value. Again, this is an outcome based approach which looks at whether departments are contributing to the institution and whether the institution is thereby contributing to society. This is difficult to measure and essentially combines the three previous elements to determine the benefit they are creating for society given their inputs and production levels. These four evaluation techniques have been adopted by state policymakers with different measures taking precedent at different times. More recently, the efficiency evaluation perspective has taken these measures of performance and begun using them not only as an evaluation tool, but also as a mechanism for making future budget decisions.

Since the 1970s, output and outcome measures have become increasingly important as they began creating a direct link between institutional performance and inputs. Originally, performance budgeting allowed state policymakers to allocate funds based on performance. This system required institutions to submit performance reports to the state legislature and governor's office. These reports were then studied by officials and used in determining how much an institution should receive the following year. On the one hand, officials could reward an institution with additional funds for high performance. On the other hand, policymakers could give more money to struggling institutions who may need more resources in order to improve their performance.

More recently, performance funding has been a popular budgeting tool (Tandberg & Hillman, 2013). This system originally set aside a small amount of money to use as incentive funds for intuitions who met certain benchmarks. Traditionally, this bonus fund was quite small, only about 5 percent of budgetary allocations. Institutions received their typical state allocations and earned extra funds for improving their performance on outcome measures such as graduation rates. In 2010, Tennessee extended their performance funding formulas to encompass all higher education funding. Under the Complete College Tennessee Act, institutions are stratified by Carnegie classification and receive all of their funds based on their outcomes. This has been adopted in other states as Performance Funding 2.0, where performance funding is no longer a bonus, but directly ties to base appropriations (Tandberg & Hillman, 2013). Additionally, rather than setting flat benchmarks, financial benefits in Tennessee were based on incremental levels instead of just a threshold. This setup was meant not only to compensate institutions for excellent performance and efficient use of resources, but also to help curb institutional aspirations and help them focus on their own mission orientation. Instead of fostering unabated desire for rankings, this system caused institutions to pause and consider whether it was in their best interest to move to a higher Carnegie classification and therefore different funding structure. Stated otherwise, performance funding was implemented as an accountability measure to ensure that institutions aligned their mission with the goals of public higher education, which tend to focus on the instructional mission of higher education (Dumont, 1980; Ferris, 1991; Hearn & Holdsworth, 2002; Massy & Wilger, 1992).

These types of funding arrangements are designed to hold institutions accountable based on their educational delivery and performance on state mandated benchmarks. They assume that administrators are influenced by resource dependency theory and are inherently inefficient in their operations due to their focus on maximizing revenues rather than looking for efficiencies or cost-cutting initiatives. By holding institutions accountable for their decision making and quality of educational programs, the legislation is meant to curb revenue seeking behavior, improve accountability and oversight, and maximize institutional and system wide efficiencies. However, recent research (Tandberg & Hillman, 2013) has called into question the effectiveness of these types of performance funding structures, finding similar incremental budgeting patterns that emerge because of small incentives or low threshold benchmarks that replicate the previous budget system rather than reforming based on performance.

Institutions undertook similar efficiency and performance reforms internally. Responsibility centered budgeting (RCB)[18] makes departments responsible for both their revenues and expenses rather than focusing solely on the expense side of the ledger (Hearn et al., 2006; Lasher & Greene, 1993; Levin, 1991; Massy, 1996; Rodas, 2001).

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[18] Also known as Responsibility Center Management (RCM), Value Centered Management (VCM), Value Responsibility Budgeting (VRB), or Revenue Responsibility Budgeting. A slightly modified structure, Performance Responsibility Budgeting, allocates block budgets to units rather than making them directly accountable for revenues.

As students enrolled in a department's class or major, their tuition funding went to the department. They paid a share back to central administration for support services and overhead. The measure was meant to curb the budget maximization behavior described in the budgetary feedback loop. Instead of seeking to maximize revenues, departments were forced to evaluate how they were supporting their operations and instead focus on maximizing efficiencies. However, Balderston (1974) raised concerns about this type of arrangement, pointing out that decentralized budgeting such as this could make departments less responsive to institutional policies and goals.

In terms of principal-agent theory, this type of internal arrangement would posit that departments would become less sensitive to the needs of the university, their principal, because they have increased autonomy and reduced oversight. Instead, they are responsible for their own budget, which is supposed to raise efficiency through competition, but could end up weakening their allegiance to the institution. By making departments accountable for their own budgets, duplication of services could re-emerge as being problematic with the same courses being offered by different departments in order to keep revenues in-house, a move reflecting self-interest rather than institutional goals (Enarson, 1960). Therefore, while departments would be receiving additional tuition revenue for these courses, the institution as a whole would suffer since they are losing the potential for economies of scale that would happen with interdepartmental cooperation (Hoenack, 1982). In order to combat this, central administration must maintain oversight of departmental decision making to ensure there is no leakage from decentralized budgets. This means making institutional goals clear and incentivizing departments for aligning to the goals of the university over goals of their individual department (Levin, 1991). One example includes gain-sharing, combating Niskanen's (1971) inefficiency hypothesis and self-interest by allowing departments to keep a portion of the money they saved through efficiencies rather than returning it all to the institution.

As an example, the University of Minnesota implemented such a policy under the name of Incentives-Based Budget Systems (IBBS) (Hearn et al., 2006). Under Minnesota's system, only 20% of budgets were determined by their Incentives for Managed Growth (IMG) program while the rest was traditionally allocated through centralized budget offices. The structure that was established designated 75% of revenues to the course a student enrolled in while 25% of the associated revenue went to the student's designated major. Central administration also made agreements with schools and colleges within the institution about goals and plans. This structure parallels that seen at the state level, with funding components tied to outputs in exchange for some kind of autonomy. Thus, the principal, central administration, used the planning and performance agreements to maintain oversight and help curb self-interest problems that might arise by giving departments full control over budgets.

However, performance funding models suffer from limitations as well. While these models are intended to curb self-interest and produce more efficient outcomes, they typically contain a flaw in execution. By setting benchmarks, institutions and subunits fixate on hitting a minimum performance for stated metrics. Prospect theory, stemming from studies of psychology, looks at risk taking behavior (Kahneman & Tversky, 1979). It posits that in situations with equal values of gains or losses, the utility derived from a gain is smaller than the utility lost in event of a loss. Therefore, people are risk adverse and will avoid risky behavior. When applied to the context of higher education, benchmarks create such a decision. Administrators and executives want to avoid sanctions if they fail to meet benchmarks, therefore they work very hard to achieve this minimum level of performance. In essence, they are avoiding the risk of losses tied to state performance requirements. However, there is no incentive to perform any better than the minimum benchmark. Even though there may be utility derived from exceeding the minimum standard by the same degree as initially required to meet the benchmark, the utility is smaller than that from simply meeting the minimum. Thus, once the benchmark has been met, administrators and executives have no further motivation to improve performance and instead move to making sure they meet other minimum requirements.

Another budget system, one unique to higher education, is differential pricing[19]. Under this system, tuition and fees are allowed to vary by department (Levin, 1991; Yanikoski, 1989; Yanikoski & Wilson, 1984). This allows departments to determine their own fees based on their educational costs and goals. In terms of costs, departments in higher cost programs could charge more per student in order to break even and reduce the subsidy required from central administration under a traditional fixed tuition policy. Similarly, those programs with higher expected wages after graduation could charge more. Under this assumption, students consider future earnings in their decision to go to college and which major to choose. Therefore, departments could earn more revenue by charging more if there is little elasticity in enrollment based on price. For example, engineering programs, which have high costs due to high wages of faculty and the need

[19] Also known as Internal Pricing.

for expensive equipment, could charge more to students. In addition, engineering majors have higher expected earnings upon graduation, further making the case for raising tuition and fees in this field. However, engineering is a low-demand field. While those who currently enroll may not be deterred by higher prices, it may be in the department's best interest to actually reduce tuition and fees in order to recruit more students. In this scenario, the departmental goal of raising enrollment trumps revenue as a motivator. Indeed, the current educational atmosphere promoting the need for more domestically trained STEM majors could be perceived as more important than forcing these programs to sustain themselves. Thus, central administration would want to continue subsidizing these programs, or even increase their subsidies, to lower the tuition and fees for their STEM students.

These performance-based systems, both externally and internally, form the feedback loop that ties performance to funding. This has become arguably the most important part of the input-outcomes production function. Higher education is not a manufacturing plant. It is a non-profit in a service oriented industry with mixed private and public funding. Therefore, questions of accountability and efficiency abound as these components also make it highly political. Oversight is necessary in order to ensure institutions are accountable to the public and acting efficiently. This oversight, in the form of linking performance to funding, is meant to force institutions to evaluate their operations and ensure their inputs are being spent efficiently and on the best processes available.

Summary of the Input-Outcomes Production Function

The higher education inputs to processes to outputs and outcomes production function differs from that typically outlined in business or manufacturing. First, the relationships between institutions and external funders, especially state government and research funders, creates pressures that cause mission drift and drive up costs through transaction costs and diverse preferences. Second, quality is a key component for higher education that is not captured simply by measuring price and quantity. Third, there are a number of feedback loops whereby institutions interact with funders for budget allocations, both in terms of budget requests and in terms of funding based on performance. These components are included in the conceptual framework because they are well documented in higher education literature, but not fully incorporated into institutional behavior.

This conceptual framework draws on political, economic, and organizational theory to describe how inputs are turned into institutional outcomes. These outcomes are then fed back to higher levels of oversight where states and other funders use the information to determine future allocations. The modern move to performance funding and budgeting warrants deeper exploration as inputs and outcomes are more directly connected than ever before in the history of higher education. This framework builds the foundation of this study for looking into the internal processes that accompany external inputs and how they are turned into outcomes through this model.

CHAPTER IV

LITERATURE REVIEW

In this chapter I present contemporary research on measuring and evaluating the inputs, outputs, and efficiency of higher education. Unlike the previous chapters, which focused on the background and conceptual construct from a theoretical perspective, this chapter reviews the empirical literature most related to the purposes of this dissertation. In particular, I present research looking at resources, expenditures, the higher education production function, and those using data envelopment analysis and stochastic frontier analysis to examine efficiency in higher education.

Revenues

As stated previously, the largest traditional sources of revenue for public institutions have been state allocations and tuition. Previous research has focused at the state level and examined how state funding, in particular, can vary based on enrollments, politics, economics, and institutional characteristics. These studies can be roughly grouped into three sections consisting of those focusing on politics, public management, and miscellaneous revenues.

Politics

Across the studies of higher education finance is a lingering question of state action. As states change public allocations, institutions face questions regarding tuition, savings, financial aid, wealth, and private fundraising. Yet state characteristics such as party affiliation, budget strength, governing boards, and interest groups can influence the entire framework. Echoing Kingdon’s policy streams (1984/2011), politics, problems, policies, and timing all converge and can influence state higher education policy and its subsequent consequences.

In one of the earlier works looking at state characteristics and their impact on state funding, Hossler and colleagues set out to examine the relationship between these state characteristics and decisions regarding allocations and support of financial aid (Hossler et al., 1997). They began by pointing out a number of concerns about higher education finance. First, that state allocations for higher education have been declining since 1977. Second, that purchasing power has decreased while tuition and fees have increased faster than the consumer price index. Third, they point to a disconnect between tuition and financial aid policies within states. They find few linkages in policy setting for tuition and aid, raising concerns that decisions are made independently rather than in conjunction with each other. This further raises questions of access and affordability if financial aid does not keep pace with the rising rates for tuition. They therefore conclude that the model that has emerged is one of high-tuition but low-aid and hypothesize that this finding is attributable to an increase in conservative ideologies and the use of loans to support students.

More recently, researchers began to focus more specifically on the political dynamics within a state and the associated impacts on appropriations. One of the most frequently cited studies of the early 2000s is that by Archibald and Feldman in 2006. In their study, they looked at state funding levels for higher education based on political and demographic characteristics of states. They used the, now common, dependent variable of state appropriations to higher education per $1000 of personal income. They found that Democrats were associated with higher funding levels for higher education since 1980 and that the slowdown in the support of higher education following the economic decline of the 1970s could be attributed to the tax revolt and the associated tax and expenditure limitations. However, they also point out that higher education moves in the same direction as other state services. Rather than looking at the share of the state budget allocated to higher education, the common dependent variable in studies of "crowding out," they looked at the actual dollar amount and show that as the total state budget increases, higher education allocations in dollars are expected to increase as well.

Following this study, McLendon, Hearn, & Mokher (2009) extended the study of state allocations to additional political, economic, demographic, and organizational variables. Similar to Archibald and Feldman (2006), McLendon and colleagues found that Democrats were associated with higher levels of funding for higher education. In addition, they introduced interest groups and lobbyists as being important to higher education, revealing that the increased presence of these types of organizations is associated with greater levels of funding.

That same year, McLendon, Mokher, and Doyle (2009) looked at how states fund different institutions within their four-year sector, seeking to understand why some states privilege their research institutions while others are more equitable in their allocations per FTE. They explored a number of hypotheses, including that the types of students attending research institutions are more expensive to educate. They found that being a research institution was a statistically significant predictor of funding. In addition, those institutions with large enrollments in graduate school and STEM programs were associated with higher per student funding. These findings were consistent with previous research (Brinkman, 1981; Harter, Wade, & Watkins, 2005) and the hypothesis that certain types of students are more costly to educate. In particular, graduate and STEM students are costly because of the lab equipment, funding, and high salaries demanded by faculty in these fields.

Most recently, Weerts and Ronca (2012) used mixed level models to examine the intrastate variation of higher education support. They explored what variables explain the difference in state appropriations across states and sectors from 1984 to 2004. When breaking the variation out by institutional characteristics instead of simply by state, they found that Republicans are actually more generous in funding higher education at the community college level, but not for four-year institutions. This finding calls into question many previous studies that focused exclusively on research institutions or four-year institutions and supports the use of additional research using longitudinal data, nesting at the state and sector levels, and expanding the focus of research beyond just private or research focused institutions.

These studies reveal the importance that politics can play in funding higher education. While some of the results are mixed due to the years of analysis, cross-sectional versus longitudinal nature of the data, and sample, the studies show that state appropriations are indeed a political process. In the next section, I show that appropriations are not the only aspect of higher education that is political. I introduce the management of higher education and reform legislation and show that these processes are also political and can affect institutional behavior.

Public Management

The above section presented research showing that political actors and structures are important to higher education and the state appropriation process. In this section, the management of public higher education is also shown to impact revenues, expenses, and outcomes. Rather than focusing on elected officials, this section focuses on the state bureaucracy and how public institutions function as state agencies, public corporations, and are otherwise managed through governing boards and state legislation.

Richardson, Bracco, Callan, and Finney (1998) focused on the state management of higher education through the use of governing boards in California, Florida, Georgia, Illinois, Michigan, New York, and Texas. They warn that increased decentralization can weaken the state as a mediator between the institution and the public, threatening long-term planning. Indeed, this introduction of using governing structures as a state management technique was important for future work done by McLendon (McLendon, Deaton, & Hearn, 2007; McLendon, Hearn, & Deaton, 2006) and Tandberg (2013).

Motivated by this work, Martinez (2002) looked at state policies for higher education in South Dakota. There, public higher education quickly adopted efficiency based higher education reform, a move posited to be associated with a strong Republican presence in the state government. In 1995, the legislature mandated that higher education find 10% savings for instruction by eliminating low-enrollment programs and re-designing their administrative staff. They also implemented performance funding, reserving 5% of funding for meeting state set policy incentives. Martinez (2002) offered mixed results for this system of managing public higher education, indicating that the savings in 1995 were successful, but the performance funding initiatives were less successful due to easily achievable minimum standards.

Following these studies, Michael McLendon, James Hearn, and Russ Deaton published two papers looking at the determinants for the adoption of various state policies. In one study, McLendon, Hearn, and Deaton (2006) test 10 hypotheses about accountability and performance policies in higher education while in another (McLendon, Deaton, & Hearn, 2007), they test 9 hypotheses to determine how state characteristics influence higher education policy. In the first study, they found that a larger representation of Republicans in state legislatures is associated with the passage of performance policies. This differs from previous research because rather than focusing on allocations, it highlights reform legislation. This finding is not surprising given the previous assertions by Hossler and colleagues (1997) that conservative ideologies are associated with the shift to more market based reforms and the use of higher tuition and financial aid. In addition, McLendon, Hearn, and Deaton found evidence that states without centralized governing boards are more likely to adopt performance funding while states with boards are more likely to adopt performance budgeting. The findings indicate that states without boards prefer systems of formula based performance funding while states with boards prefer to use performance as a consideration in budgeting, but not as an automatic qualifier.

In their second paper, McLendon, Deaton, and Hearn (2007) use a state politics framework to look at reform. Rather than focusing on accountability and performance initiatives, as was done in the previous paper, this article treated reform more broadly. They found that a unified state government, newly elected governors, and growing

Republican representation in the state legislature are all associated with higher likelihoods of enacting higher education reform. The significant results for Republican legislators[20] are consistent across both studies, suggesting a robust relationship between Republicans and higher education reform. Thus, not only does direct public financial assistance affect institutions, but state characteristics, such as politics, can affect both higher education finance and the larger policy landscape.

David Tandberg has also arisen as a leader in the field of public management in higher education. His studies, of which I present two, have focused on the state structures and their impact on higher education finance and management. In the first study that I present, Tandberg (2010) looked at the role of interest groups in higher education. He concludes that interest groups for higher education can increase appropriations and that competition from other interests can reduce the share of a state's budget allocated for higher education. In addition, like previous scholars, he addressed the question of party affiliation and found that while Democratic governors are associated with greater appropriations in terms of dollars appropriated per dollar of personal income, Democrats are associated with lower amounts as a percent of a state's overall budget.

In one of Tandberg's (2013) more recent publications, he again raises the question of the impact that governing boards can have on the budget for higher education. As with those before him (Richardson et al., 1998; McLendon, Deaton, & Hearn, 2007; McLendon, Hearn, & Deaton, 2006), Tandberg found that governance structures impact the state support of higher education, however, they do so in conjunction with other

[20] McLendon, Hearn, & Mokher (2009) also found that Republicans spend less on higher education, consistent with Archibald & Feldman's (2006) earlier finding that Democrats spend more.

political factors. Consolidated governing boards, the most centralized system, are associated with less support in states where governors have the most budget authority. In addition, these boards magnify the existing effects of professional legislatures, the presence of Democrats in state legislatures, and political ideology. These findings of the interaction between state boards and elected officials puts additional emphasis not only on the politics of higher education or the public management of public systems, but on the interactions between politics and governance and highlights how institutions can benefit by circumventing centralized oversight boards and lobbying directly to the state legislature.

As with the section on politics, the public management of higher education has a meaningful impact on institutions. Structures, such as governing boards, are important for appropriations, accountability, and reform. Similarly, the passage of higher education reform legislation is also a political process, though the actors involved in reform legislation are different from those associated with increased funding. While Democrats tend to favor greater allocations for higher education, Republicans are those more likely to pass reform measures. This body of work has helped to shed light on the behind-the-scenes political processes involved in the funding and management of higher education. However, states are not the only actor involved in the funding, management, and operation of public institutions. In the next section, I review the literature on other sources of revenues and the impact on institutions.

Miscellaneous Revenues

While state allocations and tuition have traditionally been the focus of research due to their large representation in institutional budgets, a number of smaller revenue streams have been examined as well. For example, Kaufman and Woglom (2003) argue that public institutions are able to be more aggressive in their investments because they have a more diverse revenue portfolio due to the certainty of state financial support.

Institutional wealth, which includes endowments, is a large contributor to budgets for both public and private institutions. Bradburd and Mann (1993) explain that most institutions rely on state appropriations, tuition, research funds, and private giving, but private institutions rely heavily on endowments and investment income. However, they also point out that public institutions actually exceed private institutions in total wealth simply because private endowments cannot keep pace with the multiple sources of non-endowment income at PCUs. Their work with the Higher Education General Information Survey (HEGIS) data from 1985 also descriptively explains that the wealthiest schools in the nation are approximately 12 times richer than the bottom 10% of institutions on a per student basis. This shows a large gap between the haves and have-nots in higher education. However, the methodology and data are both simple and dated and these relationships have likely changed, particularly as endowments have produced negative returns in the early 2000s.

More recently, Carbone and Winston (2004) looked at wealth in terms of saving activity using IPEDS. They found, unsurprisingly, that private institutions rely heavily on endowments and that public institutions rely most heavily on state appropriations. Again, this relationship may be changing in recent years since IPEDS now reports that tuition has overtaken state appropriations as the primary source of revenues at many public institutions. However, the report also points out that private institutions save approximately seven times that of public institutions. While not specifically mentioned by the authors, this finding might be attributable to Niskanen's hypothesis (1971), which deters PCUs from engaging in saving because they are non-profits and receive large amounts of money from the state, which then could be returned to the state if the funds are not spent (Strauss, Curry, & Whalen, 1996). Therefore, public institutions may simply be structurally deterred from engaging in savings activities due to their non-profit nature and their relationship with the state.

One study that addresses the changing dynamics of public funding looks at how state allocations are related to private gifts (Cheslock & Gianneschi, 2008). They use a framework addressing the Matthew effect, which posits that state funds are influential in generating revenues from other sources (Merton, 1973; Trow, 1993). The findings of the study are consistent with their hypothesis, showing that a $1000 reduction in state funding is related to lower levels of private giving by $45. However, this coefficient falls to only a $19 reduction once fixed effects are introduced. Furthermore, they looked at institutional characteristics related to private giving and found that the ranking of professional schools is a significant factor in private donations while undergraduate selectivity is not. The study, while only cross-sectional, shows a correlation between different revenue sources. This indicates that the expenditure of certain revenues could result in the generation, or loss, of other types of revenues in the future.

Expenses

In shifting from looking at revenues to expenditures, the literature in this area is more scarce. Getz and Siegfried (1991a; 1991b) looked at expenses across Carnegie classification and found that expenses per student increased fastest for student services, administration, and scholarships. In addition, they point out (1991b) that increases in expenses per student were largely driven by increases in faculty salaries, non-faculty instructional expenses, and non-instructional expenses. This early finding points to anecdotal evidence that institutions are spending more on student services and salaries in order to attract quality students and faculty. In addition, the finding for non-faculty instructional expenses foreshadowed the shift to using adjunct instructors.

Following these studies, Harter, Wade, and Watkins (2005) looked at expenses at four-year, public institutions between 1989 and 1998 and found similar results. Expenditures rose fastest for scholarships, transfers, and public service over this decade. In addition, instruction was again among the slowest growth areas. However, it should be noted that while growth for instruction was slow, it still comprised the highest amount spent for these institutions. Therefore, similar dollar amount increases across the different expense categories would equate to a smaller percent increase in instruction simply because it is the largest expense item. Institutional support followed instruction as the next largest expense item, followed by academic support and plant operations. Harter, Wade, and Watkins also found similar drivers of the expenses as Getz and Siefried (1991a; 1991b), with faculty salaries comprising 42% of the growth in expenditures per student followed by non-instructional expenditures and non-faculty instructional expenses.

In another study on expenses, Morphew and Baker (2004) looked at institutions that moved to a higher Carnegie classification and the associated impact on expenses. In particular, they looked at institutions that moved into the highest research classification, finding that as they moved to the higher category, they spent less on institutional support and instruction and spent more on research. The authors explain that this shift in internal funding mimicked the behavior of existing research universities rather than exhibiting the patterns seen from their previous classification.

The final article regarding expenditures links the previous section on the politics and state management of revenues with expenses. Rather than applying the state characteristics framework to revenues, Rabovsky (2013) looked at performance accountability legislation and the associated impact on institutional spending. His study used state appropriations at an institution as the dependent variable and common performance metrics as independent variables to evaluate whether performance funding was indeed working as intended and an institution's budget was indeed based on these metrics. He identified that the most commonly used performance metric was graduation rates followed by retention rates. The results of the study did show a positive relationship between performance and funding, particularly at research universities where it showed a boost to instructional expenses and a decline in the focus on research. However, Rabovsky also warned that such measures of performance could result in the stratification of higher education as institutions could game the system to earn more money by focusing on the funding formulas at the expense of access.

Higher Education Production Function

A handful of recent papers have begun to look at the relationships between revenues, expenses, and outcomes. These studies are especially important to my dissertation because they are closely related to the higher education production function that was presented in the previous chapter. However, while these studies present individual pieces of the production function, they fail to look at the full framework, and they often only look at the relationships between states and institutions rather than the internal components of institutional budgeting and processes.

In one such paper, Leslie, Slaughter, Taylor, and Zhang (2012) present a paper closely related to my study of the relationship between revenues and expenditures, the first step in the production function process. In their study, the authors point to the conflict between revenue providers and university expenses. In particular, funders look for a particular output, but there are multiple outputs at institutions, leading to conflict when institutions focus on an area that is not congruent with the funder's wishes. Their study used neo-institutional theory, classic institutional theory, and classification theory to explore the alignment of revenues to expenses at research universities between 1984 and 2007. They found that public research institutions were most closely tied to classic institutional theory, where the institutions were stable and focused on teaching, research, and service, in that order. Indeed, instructional expenses were associated with tuition and research was associated with grants. Private research universities, on the other hand, were associated with neo-institutionalism. They focused most extensively on the production of research and emphasized publications and contributions to the field.

Moving along the production function to the stage between expenditures and outputs, Pike, Kuh, McCormick, Ethington, and Smart (2011) examined the relationships between institutional expenses, student engagement, and educational outcomes. They combined information from IPEDS and NSSE to test the mixed results from previous research and found that undergraduate educational expenses are positively related to the NSSE items of academic challenge and student-faculty interaction.

Feeney and Welch (2012) present a similar study to Pike et al. (2011), but look at the relationship between inputs and outputs instead of expenses and outputs. They examined institutions of higher education to examine the regulative, normative/associative, and cultural cognitive aspects of knowledge creation on university campuses. In particular, they looked at knowledge creation as the outcome of interest and examined the various sources of revenues to see how they might be associated with such outcomes. For the regulative hypotheses, they found that federal research funding and federal student aid were both positively associated with education outcomes. However, state support and tuition were negatively associated with knowledge outcomes. State support was only positively associated with service outcomes. However, much like the Leslie et al. (2012) piece, their study included both public and private institutions and was restricted to only research institutions. The relationships were not differentiated by public or private institutions or by the different types of institutions or students served. Regardless, this finding is especially concerning since state support and tuition are the largest sources revenues for public institutions. This could either mean that maximizing educational outcomes has already been achieved or that institutions are somehow using the additional funding on expenses that are not related to educational outcomes.

Similarly, Taylor, Cantwell, and Slaughter (2013) present another model of the relationship between revenues and outcomes for humanities degrees. They posited that research institutions are increasingly focused on research activities, which tend to favor STEM fields at the expense of the humanities. They found that public institutions are not experiencing a decrease in degrees awarded in humanities, but private institutions are seeing a decline, particularly as funding for research and development from industrial partners increases. They suggest that state appropriations help public institutions shelter themselves from the market forces that are affecting private institutions. However, the authors point out that the humanities are still heavily supported by private institutions with large endowments, revenues from fundraising, and in places where there is a high demand from students with high verbal proficiency scores on standardized tests. These studies by Feeney and Welch (2012) and Taylor, Cantwell, and Slaughter (2013) provide evidence that there are links between inputs and outcomes, but these studies still fail to address the question of expenses, an especially important question given the lack of information on how institutions are using their funds internally.

In another study tightly linked to the institutional budget questions posed in this dissertation, Santos (2007) used data from the American Association of Universities Data Exchange and Delaware Expenditure Data to examine the rate of return to teaching and research productivity in departments at 10 research universities in 1998. Santos found that quality, graduate education, and schools of engineering all increase departmental income. He also found that undergraduate teaching is used to subsidize research activities[21]. However, the study suffers from a number of limitations that are addressed in the design of this dissertation. First, the study was cross-sectional, only focused on 10 research institutions, and used OLS to pool the 152 departments. It offers no insight longitudinally or across the different types of higher education institutions. In addition, the measures of productivity are inconsistent with economic theories of efficiency and production possibilities. Instead, they simply measure workload outputs. Finally, the data is from 1998, well before the economic shift following 9/11, the Great Recession, and the subsequent challenges for public higher education.

Marvin Titus's (2006) study is stronger than Santos's (2007) in that it is longitudinal and uses individual student, institutional, and state-level data through hierarchical modeling. His institutional and state-level variables are particularly important in relation to the production function model used in my dissertation. He found that an individual's probability of completion was positively associated with an institution's reliance on tuition and the amount spent per student on education and general expenses. At the state level, completion was positively associated with state grants and need-based aid per students. Given these findings, Titus explained that the reliance on tuition could mean that institutions focus on educational expenses[22] and therefore boost educational outcomes. This is precisely the type of relationship one

[21] It should be noted that previous research (Ehrenberg, Rizzo, & Jakubson, 2007; Leslie et al., 2012; Taylor, Cantwell, & Slaughter, 2013) explains that undergraduates at public universities do not act as perfect subsidies for graduate education. Rather, they already receive a subsidy from the state rather than having to pay for the full cost of their education. Therefore, the state actually indirectly subsidizes graduate education more per student than undergraduates.

[22] A finding later confirmed by Leslie et al. (2012) for public research institutions.

would expect in a higher education production function where the inputs, expenses, and outcomes are all interrelated.

Related to the links between revenues, expenses, and outcomes is the question of efficiency. In essence, the studies that deal with efficiency are looking to ensure that the inputs are being used on expenses in a way that maximizes the output produced. These studies are the precursor to the efficiency measures captured through data envelopment analysis and stochastic frontier analysis presented in the next section. Robst (2001) examined the efficiency of institutions as they respond to changes in tuition. Using a series of regressions, Robst found that larger schools have greater inefficiencies, but these disappear with additional controls for enrollment, research, and Carnegie classification. However, he concludes that state support and tuition both affect efficiency. Institutions with large declines in state support and those with large increases in tuition, to offset said decline in state support, end up acting less efficiently. According to his model, those who maintain small tuition increases are those with the largest efficiency gains. These findings imply that revenue maximization makes institutions less efficient while those who reallocate funds internally with fixed tuition and state resources become more efficient. Furthermore, major state declines in financial support can go beyond “cutting the fat” and actually have detrimental impacts on institutional efficiency. This is especially important for the current study as internal funds are the subject of interest and could reveal additional information regarding efficient resource allocation.

Powell, Gilleland, and Pearson (2012) present another approach for measuring efficiency. They developed a model linking various outcomes, measures of efficiency, and effectiveness using structural equation modeling. They found that expenditures are indeed related to both efficiency and effectiveness, but in opposite directions. Namely, as expenditures increased, efficiency decreased but effectiveness could be improved. They conclude that there is an optimal spending level for institutions. Exceeding this optimal level could improve effectiveness on measures such as graduation rates and retention rates, but would cause a decline in efficiency at a rate that is faster than the growth to the effectiveness measures. They warn that institutions may be overspending and could potentially improve their efficiency while keeping effectiveness relatively stable and reducing expenditures.

Data Envelopment & Stochastic Frontier Analyses

As previously discussed, higher education is charged with more than simply educating students. It has an instructional component, research component, and service component. These multiple outputs necessitate the use of models that extend beyond those focused on a single output such as regression or stochastic frontier analysis. Instead, higher education can be classified as a multi-product firm (Cohn, Rhine & Santos, 1989; Johnes & Johnes, 2009; Lacy, 2010; Leslie et al., 2012) and multiple outputs are needed as dependent variables, with a balance that must be struck between producing them. Spending too much money or attention on a single output puts the other products at risk. The results of previous studies using data envelopment analysis and stochastic frontier analysis are presented below while the technical details of the methods are outlined in the next chapter on methods.

Many of the studies using data envelopment analysis (DEA) or stochastic frontier analysis (SFA) emanate from the UK or Australia. Avkiran (2001) introduced DEA to

Australian universities as a way to evaluate institutional performance on the production of multiple outputs. Avkiran introduces three sets of outputs: enrollment in relation to research, the delivery of different educational services, and the performance of fee-paying students. These types of studies result in a list ranking the relative performance of the institutions and lists peer institutions that those not operating on the production frontier might want to emulate. More importantly, Avkiran not only provided an excellent summary of previous research using DEA and SFA, but he provided a framework for future studies. In particular, the study introduced production theory as a way of choosing inputs and outputs. Avkiran argues that inputs should be constrained to physical and human capital while outputs should focus on teaching and research.

Staying in Australia, Abbott and Doucouliagos (2003) again use DEA and assert that inputs should be restricted to those which administrators can control. These include the number of academic staff, non-academic staff, operating expenses, and the value of non-current assets. For outputs, the authors use enrollments and degree completions as teaching outputs while research grants are used as the research output. As discussed in the previous chapter on the production function, Abbott and Doucouliagos share the assumption that research grants, though a revenue, are frequently used as a measure of the market value for research conducted by an institution (Cave, Hanney, & Kogan, 1991; Izadi et al., 2002; Johnes, 2006; Tomkins & Green, 1988) and therefore appropriate for use as an ouput. As with the study by Avkiran (2001), the authors also conclude that the institutions are performing with high levels of efficiency, but point out that the system as a whole may not be as efficient as possible and simply that the institutions within the system are all operating at a similar level (Johnes, 2006).

In another study, Johnes (2006) provided another set of recommendations for conducting data envelopment analysis based on her work in England. In her analysis, outputs included degrees awarded and research grants, again measuring research output by grants received. The inputs included enrollment, entrance exams, faculty and staff, expenditures on administration, expenditures on libraries, and the value of interest payments and depreciation. However, she ultimately only includes enrollment, expenditures on administration, and the value of interest payments and depreciation after conducting tests to evaluate the impact on efficiency scores with the removal of each input (Pastor, Ruiz, & Sirvent, 2002). Similar to the other studies in Australia, Johnes finds that universities in England are operating with high efficiency measures, but again underscores the concern that the sector itself may not be efficient, just that institutions within the sector are operating close to the frontier.

In the last analysis presented using DEA, Eff, Klein, and Kyle (2012) use DEA in the United States, not to measure efficiency, but to evaluate best buys in American higher education. They review previous studies using data development analysis, including those that evaluate institutions (Archibald & Feldman, 2008b; Eckles, 2010; Athanassopoulos & Shalle, 1997; Flegg & Allen, 2007), departments (Gimenez & Martinez, 2006; Johnes & Johnes, 1993, 1995; Tauer, Fried, & Fry, 2007), DEA rankings in comparison to published rankings (Sarrico, Hogan, Dyson, & Athanassopoulos, 1997; Bougnal & Dula, 2006), and use quality as a component to determining the frontier (Marshall & Shortle, 2005). The authors found that best buys are concentrated in the Southeast and that institutions tend to compete based on price, output, and geography.

Moving to stochastic frontier analysis, another model evaluating measures of efficiency, Izadi, Johnes, Oskrochi, & Crouchley (2002) use stochastic frontier analysis to conduct a similar study in Britain to those conducted using DEA. This technique is less common in the study of higher education and has received criticism from those preferring data envelopment analysis. Namely, critics point out that DEA is non-parametric and the frontier is developed by the institutions in the analysis. SFA, on the other hand, requires the development of a model with the correct functional form. They argue that DEA is superior because it does not have to make assumptions about the functional form or error term. Furthermore, DEA looks at higher education as a multi-product firm with multiple inputs and outputs while SFA only looks at a single output measure. However, Izadi and colleagues counter the criticism, saying that the use of SFA allows the error term to be decomposed into a part for measurement error and a part of inefficiency, which helps to identify the actual efficiency of institutions rather than assuming the frontier is best developed based on other institutions. The results of the SFA analysis reveal results similar to those of DEA. Namely, institutions in Britain have relatively high efficiency scores. However, there may be room for improvement through benchmarking exercises and lifting the productivity of the sector as a whole.

These studies introduced data envelopment analysis and stochastic frontier analysis as methods to evaluate the efficiency of institutions of higher education throughout the world. There are a number of key consistencies across these studies. First, these methods are susceptible to a number of assumptions regarding inputs and outputs. The decisions about the choice of variables used in the model develop the frontier and affect the efficiency scores. Economically, institutions not on the frontier should eventually go out of business because they are not operating efficiently. However, the assumption about the variables means that while they are not operating efficiently when compared to other institutions on these measures, there are other variables not included in the model where they likely succeed and are therefore able to attract students and funders. This means that the choice of variables is particularly important. For example, while research grants are a revenue and arguably an input, they are consistently used as an output measure of research, reflecting a type of market value for the research conducted at that institution. Given the introduction of performance funding and other accountability techniques, states are beginning to establish which inputs and which outputs are important to the state, a key consideration for these types of studies moving forward. In addition, these variables must be measured correctly. Otherwise, the frontier could be developed based on inaccurate information that would result in poor scores. Finally, most studies are cross-sectional and look at institutions. This leaves a gap in the literature to explore longitudinally how efficiency scores are changing, whether units are becoming more or less efficient over time based on the variables selected, and how the scores differ at the different levels of departments, schools, and institutions.

Summary

This chapter has introduced the contemporary literature that empirically evaluated the components of the higher education production function. These components include the revenues, expenses, and outputs of higher education. They vary their focus in the higher education production function and the methods used, but they have been instrumental in taking the background, theory, and framework to a new level by testing the relationships throughout the production function. However, each study is limited in some capacity. Many studies are cross-sectional, use data prior to the Great Recession, restrict the analysis to institutions or, even more specifically, only research institutions, and they tend to only focus on one relationship in the production function process rather than looking at the full process. Therefore, these limitations need to be empirically addressed. This dissertation seeks to do just that, taking the insight from the literature and empirical research presented in the last three chapters and testing the higher education production function across different levels.

CHAPTER V

RESEARCH OUTLINE, DATA, & METHODS

To empirically test the research questions using the framework illustrated in the Chapter 3, a number of details must be outlined. This chapter will outline the sampling, assumptions, and methods used to evaluate the questions raised. To begin, the research questions are re-introduced:

RQ1: What is the relationship between institutional revenues and institutional expenses?

RQ2: What is the relationship between institutional expenses and student outcomes?

RQ3: What is the relative efficiency of the various units in the analysis in producing outputs in relation to inputs?

RQ4: How do these relationships change based on type of institution and over time?

As stated previously, these questions focus on public, four-year institutions. This focus is motivated by the large enrollments seen at public institutions, their unique financial relationship with states, and accountability requirements set forth by the state and its citizens. The assumption of the models in this study requires that institutions face the same environment and production frontier. Given these characteristics of public, four-year institutions, other types of institutions are likely to have processes that differ from those of public, four-year institutions. Therefore, this study excludes private, for-profit, and two-year institutions from the analysis. The remaining public, four-year institutions will be analyzed both holistically and separately by Carnegie classification to account for differences in mission orientation and the associated differences in the production process by type. In addition, research questions 2 – 4 include models at the school and departmental level, which adds analyses of subunits within the 9 member University of Texas System. In an ideal world, these questions would be addressed at all levels through a representative sample of four-year public institutions, however, there are a number of limitations that prevent such a study.

The first limitation to a comprehensive nationwide approach is that there is variation in state laws for both open records requirements and budget systems. Sunshine laws require public agencies to be transparent, including financially transparent. However, the level of detail required for published budget documents varies from state to state, meaning that what is acceptable in one state may not meet the same level of detail as in another state. This limits the information that is available in some states. In essence, not all public institutions are required to publish departmental level budgets or performance information. In addition, there are differences in budget systems. A state with a program based budget system would report outcomes but have little detail on how money is being allocated. Alternatively, a state using line item budgets may have a lot of detail on how money is allocated, but little information on performance. This variation across state budget requirements makes comparisons virtually impossible without access to each institution's financial, accounting, and reporting systems.

The second limitation involves institutions. Again, budget systems can vary from institution to institution, which limits comparability. However, institutions also vary in their capacity. Large, research institutions tend to have formalized budget and financial offices with many professionally trained analysts. Smaller institutions may not need such a structure and their budget, financial, and accounting services may be combined, possibly under the jurisdiction of a single or few individuals. Similarly, smaller institutions may not have the technological capacity to make archived budget documents available on their websites or report any information beyond that required by the U. S. Department of Education. Therefore, there is missing information that becomes more likely as institutional complexity declines.

Finally, while IPEDS contains a wealth of financial and enrollment information, the information reported is at the institutional level and does not include any school or departmental information. This problem in the level of reporting is further complicated by the parent-child problem in IPEDS wherein institutions report information as part of a system rather than as an institution. This was especially problematic in large systems prior to 2004, such as the State University of New York. Taking into account these limitations in IPEDS, nationwide analyses are possible, but there still does not exist a single source for intra-institutional budgets or performance throughout the country that is reported at the program, department, or school level. In order to collect information at this level, each institution would have to be surveyed separately, requiring a massive investment in time and resources.

Given these limitations, three sources of data are targeted to attempt to answer the research questions. These sources include IPEDS, the Texas Higher Education Coordinating Board, and the University of Texas System. These three sources, once combined, offer departmental and school level data within the U.T. System and nationwide data at the institutional level. This limits the generalizability of the findings at the intra-institutional levels to the U.T. System, but provides an empirical case study to inform future research into higher education's production function and measures of efficiency.

Data Sources

In this section on data sources, I present the three sources of the data and describe the nuances of each. In addition, I describe the methods employed in merging and cleaning the data in preparation for analysis. This is followed by an introduction to the models used by each level of analysis and their connection to the primary research questions.

The University of Texas System

The University of Texas System (U.T. System) provides detailed, line-item budget information for their nine public institutions[23]. The uniform requirements across the system allow for easy comparability between institutions and over time. These budgets include departmental level information and have been collected from Fiscal Year 2009 (FY2009) until FY2013. These institutions and their Carnegie classification can be seen in Table 5.1.

While there are a total of 34 public four-year institutions in Texas, these are the nine contained in the University of Texas System. This may raise concerns about the generalizability of any findings since it does not encompass a full state, nor does it represent a sample of institutions from the full nation. In order to evaluate the robustness of the University of Texas System, I created scores based on what a typical state's higher

[23] Excluding health and medical centers.

Table 5.1

The University of Texas System

Institution	Abbreviation	Carnegie Classification
University of Texas at Austin	UT-Austin	Research Universities (Very High Research Activity)
University of Texas at Arlington	UT-Arlington	Research Universities (High Research Activity)
University of Texas at Dallas	UT-Dallas	Research Universities (High Research Activity)
University of Texas at El Paso	UTEP	Research Universities (High Research Activity)
University of Texas at San Antonio	UTSA	Research Universities (High Research Activity)
University of Texas at Tyler	UT-Tyler	Master's Colleges and Universities (Larger Programs)
University of Texas - Pan American	UT-Pan Am	Master's Colleges and Universities (Larger Programs)
University of Texas at Brownsville	UT-Brownsville	Master's Colleges and Universities (Medium Programs)
University of Texas of the Permian Basin	UT-Permian Basin	Master's Colleges and Universities (Medium Programs)

education sector might look like. I first created an average number of institutions by type. This yielded an average of 1.46 RU/VH institutions, 1.46 RU/H institutions, 0.56 doctoral granting institutions, 5.36 Master's granting institutions, and 2.52 Bachelor's granting institutions per state[24]. Using this information, I constructed scores for each state to measure how different they are from this hypothetical average state. The formula used is listed below as Formula 5.1.

$$y_s = \frac{\sum[\frac{1}{\sqrt{\sigma_{VH}}}(R1_S - \overline{R1}) + \frac{1}{\sqrt{\sigma_H}}(R2_S - \overline{R2}) + \frac{1}{\sqrt{\sigma_{Doc}}}(Doc_S - \overline{Doc}) + \frac{1}{\sqrt{\sigma_{MA}}}(MA_S - \overline{MA}) + \frac{1}{\sqrt{\sigma_{BA}}}(BA_S - \overline{BA})]}{5} \quad (5.1)$$

In this formula, *y* acts as a score centered around 0 for states most resembling an average state's higher education sector. The nationwide average of each type of institution is subtracted from the individual state's number. This is then divided by the standard deviation for that type of institution. In essence, this creates normalized scores for each institutional type. These scores by type are then aggregated and averaged to give the state's total score. I then separately created a numeric value for the U.T. System, treating it as if it were its own state[25]. These results are presented in Table 5.2.

As this table depicts, the U.T. System is actually very similar to what an average state system of higher education looks like. While the state of Texas itself is very different from the national average, the University of Texas System looks similar to the

[24] RU/VH is defined as institutions with very high research activity while RU/H are institutions with high levels of research activity. These classifications replaced the older definitions of R1 and R2 institutions. The differing size classifications for Master's and Bachelor's granting institutions were aggregated into single categories based on the level of degree offered.

[25] The University of Texas System data is included in the figures for Texas. It is not treated as an independent state for the purposes calculating nationwide averages or variance.

Table 5.2

Higher Education Sector Standardized Scores

State	Score	State	Score
Wyoming	-0.720	South Carolina	0.010
Rhode Island	-0.680	Tennessee	0.079
Delaware	-0.673	Missouri	0.105
Alaska	-0.639	Louisiana	0.116
Hawaii	-0.603	Maryland	0.145
New Hampshire	-0.530	Illinois	0.152
Iowa	-0.529	Alabama	0.220
Vermont	-0.515	Colorado	0.265
Idaho	-0.488	Indiana	0.276
Nevada	-0.473	Virginia	0.378
South Dakota	-0.447	North Carolina	0.454
Connecticut	-0.442	Georgia	0.513
Arizona	-0.432	Michigan	0.516
Utah	-0.386	Florida	0.634
Nebraska	-0.372	Ohio	0.952
North Dakota	-0.371	California	1.389
Montana	-0.371	Pennsylvania	1.531
New Mexico	-0.360	New York	1.636
Maine	-0.350	Texas	2.305
Washington	-0.327		
Kentucky	-0.312		
Minnesota	-0.281		
Kansas	-0.278		
Oregon	-0.256		
West Virginia	-0.215		
Arkansas	-0.197		
Mississippi	-0.141		
Wisconsin	-0.118		
Oklahoma	-0.089		
Massachusetts	-0.047		
New Jersey	-0.036		
University of Texas System	-0.004		

system in an average state. The one RU/VH institution, four RU/H institutions, and four MA institutions mirror national averages very closely. In fact, it is the closest system to the national average, followed shortly by the systems in South Carolina and New Jersey. For this reason, the University of Texas System seems to provide not only excellent data, but when viewed separately from the state of Texas, looks similar to an average state's higher education system.

The data from the U.T. System includes detailed financial information at the budget item level. In particular, these budget items roughly approximate academic departments and other subunits within an institution. This includes the budget code, description, expense category as reported to IPEDS, and full-time equivalent count for faculty, administrators, and classified staff. In addition, the data includes expenses on salaries, other wages, travel, and miscellaneous expenses. This data focuses specifically on the educational and general fund at these institutions, which makes up the largest fund at every institution except for UT-Dallas. The educational and general fund in FY2013 ranged from a low of 31% of total institutional budgets at UT-Dallas to 65% at UT-Pan American. Other funds, including designated funds, auxiliary funds, restricted funds, and capital funds are excluded since they are smaller and do not follow the same budget structure as the educational and general fund.

One university, the University of Texas at Dallas, strays from the reporting of the other eight institutions. More specifically, UT-Dallas does not report budget information at the departmental level for all schools. Instead, they frequently report multi-unit aggregate information. For example, the School of Arts and Humanities does not include any departmental information but instead only reports aggregate faculty salaries as a single line item.

Another issue with this dataset is that institutions frequently go through reorganizations and changes in budgeting. Therefore, budget codes were used as the unit identifier rather than the department description. For example, UT-Pan American had separate departments for Anthropology and Sociology until 2013, when the department of Sociology and Anthropology was formed. In these instances, the new department was treated as a separate new department because it resulted in a new budget item and there was no information on how the departments were merged, or, in other instances, how they were divided. In a somewhat related detail, when budget information for a department is unavailable, the data is coded as missing rather than 0. This helps in the fixed effects analysis by restricting to an institution that reports data rather than imposing 0 on data that is unavailable.

The U.T. System data provides the greatest level of detail at the departmental level. While the U.T. System may not be perfectly reflective of national sectors of higher education, it does resemble the national average and provides variety both by type of institution and over time. Since the research questions are primarily about internal budgeting, this approach seems appropriate for examining the differences across this system.

Texas Higher Education Coordinating Board

The Texas Higher Education Coordinating Board collects data on a multitude of variables from the public institutions across the state of Texas. In particular, there is a focus on enrollment, majors, and degrees awarded. These are posted to the organization's website and collected for every semester from 2000 to 2011. However, degrees awarded were not available for the most recent academic year, limiting its span to 2010. This information is reported at a very detailed level, down to the CIP code, which is the classification of instructional programs (CIP) used by the National Center for Education Statistics to identify academic programs. In particular, the information by institution and CIP code is included for enrollment by level, degrees awarded by level, declared major by curriculum area, and semester credit hours by level. The semester credit hour (SCH) data is a combination of student enrollments and the credit hours awarded for the course, meaning that it is essentially a measure of student contact hours. This definition means that if 30 students were enrolled in a course worth 3 credit hours, the reported SCH would be 90.

One of the issues in dealing with the THECB data is the reliance on CIP codes. These are codes assigned according to NCES reporting requirements, but do not necessarily align to an institution's organizational structure. This presents three problems. First, these CIP codes must be matched to the related institutional programs. This required combining THECB data with the University of Texas System and the institutional data using individual course catalogues to match the THECB data reported by CIP code to the departmental data provided by the U.T. System. The second issue with the reporting by CIP code is the designation of interdisciplinary studies. This means there is information for multi-disciplinary programs that do not have a designated home at an institution. For example, a biochemistry program could either be in a department of biology or a department of chemistry. Therefore, CIP programs with a designation of interdisciplinary studies are not included at the departmental analysis. Rather, these programs are only included in the school level analyses where a program like biochemistry clearly falls under the jurisdiction of a school of natural sciences. However, interdepartmental programs are also problematic in the school level analysis. There are a handful of programs that operate across schools. In these 7 instances, the schools are merged together by CIP program area. For the University of Texas at Brownsville, the College of Biomedical Sciences and Health Professions is merged with the College of Nursing. Arlington combines the School of Social Work and the School of Urban and Public Affairs. Austin has three collapses: the College of Liberal Arts with the Lyndon B. Johnson School of Public Affairs and the School of Social Work, the College of Natural Sciences and the Jackson School of Geosciences, and the College of Pharmacy and the School of Nursing. Finally, the University of Texas El Paso collapses information for the College of Health Sciences and School of Nursing as well as a collapse for the College of Liberal Arts and University College.

Finally, semester credit hour by CIP code contains 11,545 observations across the 9 member U.T. System since 2009. Due to time and resource constraints that it would require to look up each of these using course catalogues, I use the structure of the CIP code to collapse to the first 2 digits, which includes aggregate program information. Because of the difficulty in assigning these aggregate collapses to departments, this information is only used at the school level, much like the interdisciplinary information is only included at the school level.

Integrated Postsecondary Education Data System (IPEDS)

The Integrated Postsecondary Education Data System (IPEDS) is hosted by the U.S. Department of Education's National Center for Education Statistics and reports data for those institutions receiving federal financial aid as required by the federal government through the Higher Education Act of 1965. This includes enrollment information, admissions and price information, graduation rates, and budget information for both revenues and expenses. Unlike the U.T. System budget information, the IPEDS reported data includes revenues and expenses across all funds. IPEDS includes a long history of data, back to 1986. Prior to IPEDS, the Higher Education General Information Survey (HEGIS) was conducted between 1966 and 1985. This dataset has been used extensively in academic publishing and is the primary source for groups such as the College Board and the Delta Cost Project. According to IPEDS, there are 572 public, 4-year institutions nationwide that will be used in the various analyses, providing a full picture of public higher education, albeit only at the institutional level. The information provided by IPEDS is used in every model. In the institutional models, IPEDS is the primary source of information. In the school and departmental levels, IPEDS provides the institutional information used as control variables.

There are a number of nuances about using IPEDS data. First, one drawback is that the information is restricted to aggregate institutional information, it is rarely broken by level of student, and it does not include any subunit information. The only subunit information is that expenses must be reported by category. These categories include instruction, research, public service, academic support, student services, institutional support, plant maintenance, scholarships, auxiliary expenses, hospital services, independent operations, and other. Therefore, while IPEDS cannot provide information about departments or schools, it offers a different view of how money is used based on area. In some capacity, this information might be viewed as being just as important as departmental or school based budgets. Rather than focusing on which units get funds, it focuses on how the funds are spent. However, the reported expense category can change from year to year and is somewhat subjective based on an institution's interpretation. For example, faculty salaries are budgeted under the category for instruction despite the fact that faculty are required to produce outputs in instruction, research, and public service simultaneously.

Another key issue with IPEDS is the parent-child relationship. Institutions may report information at a system level rather than at the institutional level. This means that the figures listed in IPEDS may be for a multi-campus system rather than a single institution. This type of reporting was especially prevalent prior to 2004. However, since the 2004 academic year, only 9 institutions have a parent-child relationship that might threaten this study. The San Diego State University system reports at the system level for a majority of their variables. The remaining 8 systems include the University of California System, Pennsylvania State System, Rutgers University, Vermont State Colleges, Kent State University, West Virginia University, University of Pittsburgh, and University of Washington. These 8 systems only report their financial information at the system level. In order to preserve as much information as possible at the institutional level, the variables directly affected by the parent-child relationship are replaced as missing rather than aggregating all of the institutions to a single system level as is done by the Delta Cost Project. This keeps enrollment and test score information intact while only omitting the financial information that is not applicable at the institutional level.

Individual variables also are somewhat problematic as the definitions can change over time. For example, the SAT added a writing component in 2006 which changed the previous label of SAT Verbal to SAT Reading. For the purposes of the analyses, these scores are treated interchangeably. However, IPEDS does not report an average test score. Rather, for both SAT and ACT, IPEDS reports the 25^{th} and 75^{th} percentile scores. For simplicity purposes, the midpoint between these scores is used as a single measure of an institution's test scores.

Finally, IPEDS uses its own form of imputation to add information when missing. However, the imputation methodology is poor, frequently carrying forward values from prior years, using values from the nearest neighbor, or imposing a value of 0. In these instances, the information was replaced as missing rather than using the imprecise estimates provided by IPEDS.

Data Merging & Cleaning

In order to create working data to analyze the research questions, the three sources of data had to be combined and cleaned. The IPEDS data is reported at the institutional level and includes its own identification number. The Texas Higher Education Coordinating Board reports data at the program level by CIP code. The U.T. System data includes budget information at the departmental level as reported by budget codes. In order to merge the various sources of data together, I first had to identify the needs at each level of analysis. This includes creating a dataset at the institutional level, a dataset at the school level, and a dataset at the departmental level.

The data at the departmental level is instrumental in the various analyses as it is the data that is reported at the most detailed level of analysis. In order to merge the various sources of data together, I searched through each institution's course catalogue in the U.T. System. I matched the information to that reported to the Texas Higher Education Coordinating Board and included the CIP code for courses and degrees offered for each department. I was then able to merge the THECB data with the U.T. System data using the matching CIP codes acquired through the various course catalogues. I also merged IPEDS data to this by matching based on institutional identifiers. In addition, the data across the three datasets is reported at both fiscal and academic years. An academic year runs from fall to the following summer. For example, academic year 2011 includes fall 2011 through summer 2012. However, a fiscal year runs from September through August. In this instance, the academic year that runs from September 2011 to August 2012 is actually fiscal year 2012. Therefore, I matched information by subtracting 1 from each fiscal year so it aligns with the academic calendar. One issue that arose with this matching is the overlap in years. The U.T. System data includes financial information for academic years 2008 to 2012 but the THECB data only includes data up to 2011 and is even further restricted to 2010 once including graduation information. One final thing to note is that excluded from this lower level of analysis is the inter-departmental information and information on semester credit hours, as mentioned previously, because of the level of complexity in reporting directly as departments.

The data at the school level rolls the departmental level information up to the next highest unit. This was done with a simple collapse to the closest usable unit. In addition, this collapse allowed me to re-introduce the interdisciplinary information and semester credit hours. These two sources of information, which were too complex to include at the departmental level, could be included when looking at schools and colleges.

Finally, for the institutional dataset, the information primarily comes from IPEDS. This includes all 572 public, 4-year institutions and is cleaned to account for the major issues in IPEDS including the parent-child relationships, imputation, and changes in variable definitions.

Summary of Data Sources

The three sources of data all provide a different angle in examining how institutions allocate money and what they are producing. The U.T. System data looks within a system over time at departments, but lacks certain inputs and outputs that are too complex to include at a departmental level. The school level data is able to include all of the various sources of data most comprehensively, but lacks the detail of the departmental level and reduces the sample size. Finally, IPEDS provides information for hundreds of institutions over time, but only at the aggregate level. These sources are summarized in Table 5.3. By conducting the analysis on these three different datasets, all at different levels, it provides a more comprehensive look at evaluating the research questions by taking advantage of the differing components in each.

Table 5.3

Sources of Data

Source of Data	Population	Unit of Analysis
University of Texas System	U.T. System	Departments/Schools
Texas Higher Education Coordinating Board	U.T. System	CIP Code
IPEDS	All Public, Four-Year Institutions	Institution

Assumptions

There are a few assumptions that must be outlined in transitioning from the conceptual framework to the empirical study and the limitations on the data available. First, and most importantly, this study is primarily concerned with expenses, and less so with revenues. Therefore, the focus is on what institutions do with funds after they are received, not on the allocations decisions of states or other funders. This makes the assumption that institutions make their internal funding decisions only once their revenues are identified. This is common practice in non-profit organizations that must maintain balanced budgets and therefore must know *how much* money they have to spend before they decide *how* to spend it (Massy, 1996). Given this assumption, states and other funders become less important to institutional processes. This is why revenues are treated as independent variables.

However, as outlined in the conceptual framework, there are multiple feedback loops that tie institutions back to their funders. This raises questions about simultaneity and the fact that not only do revenues drive expenditures, but expenditures can drive future revenues. Indeed, the literature identified such studies testing the Matthew effect where state revenues actually drive the production of other types of revenues (Cheslock & Gianneschi, 2008). Therefore, institutions could be spending money from state allocations in such a way that it generates revenues from other sources. In addition, the development of performance funding and performance budgeting creates a direct tie between institutional outcomes and future funding. To reiterate, this study is focused on the production side. While outcomes may be aligned to future funding, *motivation* to achieve outcomes is not the area of interest. Rather, this study looks at the *mechanisms* involved in producing the outcomes, not the link between outcomes and future revenues.

Variables & Methodology

The variables in these datasets can be presented in four different ways. The financial data, in particular, can be reported as (1) raw figures, (2) as logged values, (3) as amounts per student or per staff member, or (4) as a percent of total institutional expenses. There are benefits and limitations to each. For example, models using raw figures provide detailed information, but this does not account for size or complexity. Logged values are useful in looking at percent changes over time in log-log regressions and are commonly used in most financial studies. Similarly, per FTE models are quite common, especially in studies on tuition and financial aid. Finally, using figures as a percent of total institutional expenses show the importance of various departments and schools in comparison to the overall institution. Each of these will be used when appropriate given the question and model. For example, raw figures and percentages are used in many of the descriptive statistics, amounts per student or per staff member are the primary focus in the regression to be consistent with previous research (Leslie et al., 2012), and logged values must be used in the stochastic frontier analysis. Values per full time equivalent also have an advantage over the other measures because it helps control for size while curbing collinearity in the regressors. In models with faculty salary as a right-hand side variable, if FTE faculty counts were included, there would be collinearity between the salary amounts and FTE counts. Therefore, creating a measure of salary per FTE helps remove the collinearity and keeps the variance inflation factor under 10.

The variables themselves can be divided into three primary categories: outcomes, financial variables, and control variables. Outcomes are the primary dependent variable in most of the analyses, particularly research questions 2 through 4. These include typical measures used by institutions, states, and the federal government to analyze performance such as degrees awarded, majors by subject area, retention rates, and graduation rates. Indeed, Rabovsky (2013) pointed out that the most commonly used outputs for state performance metrics are retention and graduation rates. Financial variables differ based on the data used. Revenue is only included in the IPEDS data at the institutional level. These are broken down by different sources of revenue according to NCES reporting requirements. Similarly, expenditures are listed in IPEDS by the institutional expense category. In the Texas data, however, expenditures are recorded as true budget items. These budget items are classified by expenditures on personnel, operating expenses, or on capital projects. Furthermore, expenditures are broken down by program use. For example, a budget item in a department of economics would contain information about personnel expenses on faculty and staff and operating expenses such as travel, but all of these would be rolled into the category for instruction in IPEDS. Finally, control variables for enrollment, staffing, and other characteristics are included to deal with differences in size and structure across the different units of analysis.

In addition to the above comparisons across the IPEDS and Texas data, I examined the data at the various levels to ensure consistency across the variables and to provide a check for the validity of the data. The raw U.T. System data is relatively consistent with that reported in IPEDS. For example, the UT-Arlington budget lists instructional expenses of $131 million and institutional support of $32 million in

FY2009, similar to their IPEDS report that year of $136 million in instructional expenses and $32 million in institutional support. In another example, the budget for UTEP in FY2010 showed revenues of $42 million from federal operating revenues and $40 million from federal nonoperating revenues. IPEDS that year listed revenues of $41 million and $35 million, respectively. However, it should be noted that there are some differences between the U.T. budgets and IPEDS, with IPEDS frequently having higher reported numbers than that listed by the U.T. System budgets. These slight discrepancies are likely due to budgets being a proposed plan of spending prior to the beginning of a fiscal year while IPEDS reports actual and adjusted spending for that fiscal year. This also explains the higher values frequently reported by IPEDS. In general, the consistency across institutions and the various sources provides a reassurance that the data is valid. However, the school and departmental analyses are restricted to a single fund, the educational and general fund, and to the academic departments identified, when applicable.

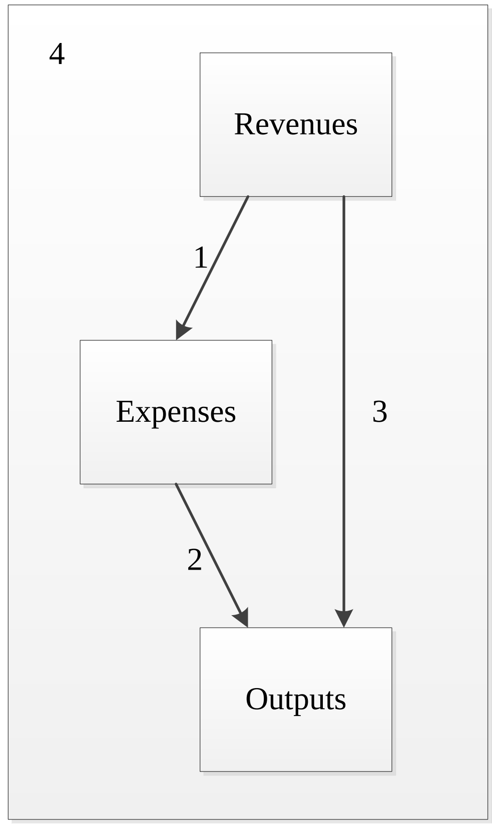
Testing the Simplified Framework

The full conceptual framework found in Chapter 3 is largely theoretical and has many components to test, some of which cannot be quantified. I present a simplified framework below, which visually depicts the testable relationships in the higher education production function.

In this figure, the four main testable relationships are depicted as they related to the various research questions. The first relationship (1) is the link between revenues and expenses. In this model, expenses are determined by the various sources of revenues.

Figure 5.1

Simplified Framework for Regression Models



This model ties directly to the first research question which looks at this very relationship. The second relationship (2) looks at the link between expenses and outputs. This is directly associated with the second research question. In addition, this link can be examined across the different levels of analysis and in a multi-level approach where the departments and subunits affect institutional outputs. The third link (3) looks at the link between revenues and outputs. This is an indirect look at which revenues might be associated with various outputs. Rather than looking at the direct links seen in the first two examples, this relationship looks at the indirect links in the production process. This blends the second and third research questions, looking at the production of outputs, which is associated with the second research question, but also looking across the broad spectrum on the production function, introducing the input-output relationship for the third research question. Finally, the field represents the fourth (4) relationship in the analysis. This last analysis extends the previous components, which focused on individual relationships into a measure of technical efficiency with data envelopment analysis and stochastic frontier analysis.

The controls in the different models address the other components seen in the conceptual framework from Figure 3.1. These include controls for Carnegie classification, selectivity, enrollment, and other factors that might impact the quality or composition of the inputs, processes, or outputs. As mentioned previously, the quality of the inputs is likely to impact the performance on outputs. For example, while all of the institutions in the analysis are public, four-year institutions, the type of student attending a selective research institution is likely to differ from those attending an open access comprehensive institution. These differences in the student inputs are likely to affect the performance on the institutional outputs and are therefore controlled for in the various models. Controlling for these attributes is especially important when using the production function framework and its underlying assumptions of turning raw inputs into finished products. The various relationships introduced above will now be broken down into more detail with the associated models and variables used in each analysis.

The Relationship Between Revenues & Expenses

For the first question regarding the relationship between sources of funding and expenses, I use descriptive statistics to display differences across institutions, types, and time. At the institutional level, this uses IPEDS to compare institutions in regards to their sources of funding and their spending on different categories such as instruction, research, and institutional support. Because revenue information is only available at the institutional level, the U.T. System data is not used to address this research question.

In addition to the descriptive analysis, I developed a fixed effects model to look at the relationship between revenues and expenses. This is a precursor to the models that are tested in the third hypothesis regarding efficiency. The fixed effects model for this analysis uses revenues as independent variables that influence the dependent spending on various expense items. This model is displayed below in formula 5.2.

$$EXPENSES_{it} = \beta_0 + \beta_1 REVENUES_{it} + \beta_2 CONTROLS_{it} + a_i + \delta_t + e_{it} \quad (5.2)$$

In this model, the dependent variable is a chosen expense item according to IPEDS. This structure is very similar to the models run previously by Leslie and colleagues (2012), but with updated data and using all types of four-year institutions rather than just focusing on research institutions. The independent variables include revenues and a series of controls. For example, it would look at how spending on instruction varies based on revenues from state appropriations and tuition, among others. In addition, this model includes year (δ_t) and institutional (a_i) fixed effects to allow for the examination of changes in funding within an institution over time. The coefficients on the regressors in this example would indicate an association between revenues and expenses within an institution and over time.

There are a number of considerations when dealing with fixed effects models. First, the variance inflation factor (VIF) of the model must be under 10. This is to ensure there is no multi-collinearity in the regressors. In each model, the VIF is indeed under 10. Second, fixed effects models are less efficient than random effects models. Therefore, both models must be run and compared. The Hausman test can compare the estimates to ensure the estimates are consistent. If the estimates are similar and the Hausman test fails to reject the null hypothesis that both estimates are consistent, then random effects can provide more efficient estimates. However, if the Hausman test rejects the null hypothesis, then fixed effects should be employed as it should provide the consistent estimates. Indeed, the Hausman tests all reveal the need to use fixed effects models. The third consideration involves strict exogeneity. When dealing with panel models, the estimates could be biased because of correlations between the regressors and the error term. In essence, the error term at any time cannot be correlated with any of the regressors at any time in the panel, including future values. To test for this potential source of bias in the estimates, future values of the independent variables can be included to see if they are associated with current values of the outcome variable (Wooldridge, 2009). If the future values are significant, there may be correlations across time and the use of instrumental variables would be necessary to deal with the potential bias. This is somewhat of a concern in the models using IPEDS data as future values of revenues are indeed significantly related to current levels of expenses, even after controlling for current and lagged values of revenues. It is less problematic in evaluating the relationship between expenses and outputs or for the school and departmental models. This is likely due to the incremental nature of budgeting and future values of revenues and expenses both being based on current funding and expense levels. I continue forward with the fixed effects analysis to replicate the study conducted by Leslie et al. (2012), but caution the possible need to use instruments in future research.

The Relationship Between Expenses & Outputs

In this second research question, the relationship between expenses and outputs is explored. The structure is very similar to descriptive and fixed effects analyses seen in the previous question with a few key exceptions. First, expenses in this analysis are now independent variables while outputs become the dependent variable. Second, the structure of the data allows these regressions to be conducted across the different levels of data. This means that models including outputs at the departmental, school, and institutional level are now possible when it comes to relating expenses to outputs. The general formula closely aligns to 5.2, but the subscripts are now generic as a unit of analysis, u, rather than institution. This is presented below as formula 5.3.

$$OUTPUT_{ut} = \beta_0 + \beta_1 EXPENSES_{ut} + \beta_2 CONTROLS_{ut} + a_u + \delta_t + e_{ut} \quad (5.3)$$

Finally, I include a model which looks at the indirect links between inputs and outputs as shown in Figure 5.1 as relationship (3). Following the work by Feeney and

Welch (2012) and Taylor, Cantwell, and Slaughter (2013), this looks at the links between inputs and outputs. This introduces these various relationships before using data envelopment analysis and stochastic frontier analysis used in the measures of efficiency. These models look at a single output and determine which inputs are associated with their development.

$$OUTPUT_{it} = \beta_0 + \beta_1 REVENUES_{it} + \beta_2 CONTROLS_{it} + a_i + \delta_t + e_{it} \qquad (5.4)$$

Formula 5.4, shows this relationship between outputs and revenues, taking a similar structure to the previous models but using revenues as the indirect link to an output rather than the direct relationships between revenues and expenses or expenses and outputs.

Measures of Efficiency

In the conceptual framework, the combination of various resources and quality produces outcomes through processes conducted by institutions. However, actual outcomes may not be reflective of potential outcomes. DEA and SFA models create values for potential outputs[26] based on inputs and this allows the actual outputs to be compared to this value. This ratio of actual outputs to potential outputs creates a type of efficiency score that is unique to each unit of analysis. In this model, the interest is less about the direct relationship between inputs and outcomes, but rather about how

[26] Outputs are used here rather than outcomes because the models that follow are drawn from economics and the study of gross productivity (also known as productivity ratios) in terms of relating outputs to inputs. The examples used in these studies are from the private sector in terms of measuring the production of goods in relation to the labor and capital involved in the production process. However, many measures considered outcomes in higher education will be used interchangeably in this study with this definition of outputs.

effectively the units are acting in comparison to peer units that develop a frontier of production.

The models that use this type of approach include data envelopment analysis and stochastic frontier analysis. As described in the literature review on these models, both have strengths and weaknesses when it comes to evaluating efficiency. The mechanics of such models draw on Coelli's (1998; Coelli, Rao, O'Donnell, & Battese, 2005) *An Introduction to Efficiency and Productivity Analysis*[27]. While this book comes from a business and manufacturing background, the concepts of efficiency can readily be applied to the non-profit and higher education sector, similar to how other theoretical concepts from business and public administration have transferred to higher education as outlined in the literature review and conceptual framework. The econometric models outlined use technical efficiency to measure optimal performance. Technical efficiency, which is the primary focus of these models, is defined as optimizing outputs given fixed inputs. This is parallel to the discussion of efficiency in the conceptual framework for ensuring money is allocated toward functions with the greatest returns. In addition, scale efficiency measures the extent to which institutions can take advantage of their size and economies of scale by altering their composition to fit the best size. This is an important consideration given Robst's (2001) findings that efficiencies differ by institutional size. The various authors who conduct these types of analyses (Abbott & Doucouliagos, 2003; Avkiran, 2001; Coelli, 1998; Coelli et al., 2005), point out that it is often easier for institutions to improve their technical efficiency through internal budget allocations than it is to adjust their scale efficiency through altering the size of their institution. These

[27] See also: Aigner, Lovell, & Schmidt (1977); Cobb & Douglas (1928); and Meeusen & van den Broek (1977).

concepts combine to create a production frontier of maximum possible performance based on the performance of peers. Actual performance is then compared to this frontier.

Stochastic Frontier Analysis[28]. In stochastic frontier analysis, outputs are a function of inputs, inefficiency, and random noise. Rather than choosing inputs and outputs and letting the performance of peers develop the frontier, as will be seen with data envelopment analysis, this model uses a parametric approach to develop measures of efficiency. This is illustrated in Formula 5.5 below[29].

$$q_i = \exp(\beta_0 + \beta_i \ln x_i) * \exp(v_i) * \exp(-u_i) \tag{5.5}$$

Where

$\exp(\beta_0 + \beta_i \ln x_i)$ is reflective of the frontier based on inputs,

$\exp(v_i)$ is a random error component, and

$\exp(-u_i)$ is the inefficiency.

Observed levels of inputs and outputs can then be plotted against the frontier to determine inefficiency. Units with observed values that are closest to the frontier, after accounting for random noise, are said to have lower levels of inefficiency. Said otherwise, they are more efficient in the use of their resources.

Unlike data envelopment analysis, stochastic frontier analysis looks at the technical efficiency on a single measure of output. The parametric approach allows for traditional measures of model fit, including coefficients, confidence intervals, and significance testing, which cannot be done with the non-parametric approach used in data envelopment analysis. With this approach, I also use variable returns to scale and examine the technical efficiency of the units. The use of variable returns to scale is

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[28] Belotti, Daidone, Ilardi, & Atella, (2013a; 2013b); StataCorp (2014)
[29] Coelli, Rao, O'Donnell, & Battese (2005, pp. 243) Formula 9.5.

preferred to constant returns to scale due to the differences in efficiency that accompany differences in size (Robst, 2001). In addition, stochastic frontier analysis also allows for panel models, allowing for fixed effects to be introduced in order to examine whether a unit is moving towards or away from the frontier over time. In essence, this looks at the annual measures of efficiency in comparison to their performance over time. Positive values would be associated with becoming more efficient while negative values of technical efficiency would indicate that units are become less efficient over time.

Data Envelopment Analysis[30]. Data envelopment analysis is a non-parametric procedure which develops a frontier based on the performance of the individual institutions on their multiple outputs. This technique is helpful because it lets the data create a frontier rather than forcing a relationship through a specified functional form. In addition, this model allows the comparison of multiple inputs to multiple outputs while stochastic frontier analysis was limited to looking at a single output at a time. The problem with such a model, however, is that it is especially susceptible to measurement error (Avkiran, 2001; Van Biesebroeck, 2007). If observations are measured with error, they are likely to affect the development of the frontier and create measures of efficiency that are not accurate. In addition, DEA often assumes there are constant returns to scale (Johnes, 2006). Only by comparing to a DEA model with variable returns to scale can measures of scale efficiency be developed. Therefore, both variable and constant returns to scale are included in the output, with greater emphasis put on those with variable returns to scale in order to account for differences accruing because of size.

[30] Ji & Lee (2014); StataCorp (2014)

There are two ways of conducting data envelopment analysis, through input orientation or output orientation. Input orientation focuses on the amount that inputs can be reduced in order to keep outputs stable. Output orientation focuses on increasing outputs given fixed inputs. While my initial approach was to use an output orientation to maximize outputs given fixed inputs, I ultimately chose to use an input orientation for two reasons. First, the results of the initial research questions suggested that inputs are more variable than outputs. Second, once considering this finding, it made sense that states and policymakers would likely be interested in seeing how far they could cut institutional revenues and save money without harming outputs. Thus, I employed an input orientation to look for potential financial savings that would more closely mirror the current economic climate of reduced state appropriations, rather than looking at output generation.

In addition, there are also a number of technical considerations for DEA. Avkiran (2001) points out that the sample size is especially important in choosing the number of inputs and outputs that can be used, citing that the sample size should be 3 times larger than the sum of inputs and outputs or larger than the product of inputs and outputs. Finally, the choice of which inputs and outputs to include is also important. Johnes (2006) suggests that there are two ways of dealing with inputs in data envelopment analysis. The first technique is to include all inputs, as also recommended by Cubbin and Tzanidakis (1998) and Grosskopf (1996). This technique assumes that all inputs affect the production of outputs and that all institutions in the sample face the same environment. If the environment is especially harsh, institutions will have scores that make them look less efficient because they include aspects of the environment that they cannot control. The other technique is to use a two-stage procedure where only controllable inputs are used. Then non-controllable inputs are used in the second stage. However, Johnes points out that McCarty and Yaisawarng (1993) tested the different techniques in a study of secondary education and found no difference in the results. I ultimately used a one-state model to be more conservative in the estimates. This would produce more inefficient values because it does not include aspects of the environment. Results with many efficient values would indicate that institutions are efficient in spite of their environment.

Using data envelopment analysis and stochastic frontier analysis provides a means for objectively comparing the different subunits and institutions across the various datasets. This allows for an analysis of how departments, schools, and institutions use their resources to create various outputs and outcomes for higher education. Furthermore, it allows for an examination of whether these resources are being used most efficiently.

Differences by Time, Location, & Type

Finally, the previous questions will make use of the variation across the different datasets to compare across the different subunits and over time. Not only is there an interest in finding out the relationships between revenues, expenses, and subsequent outputs, but also if these relationships differ based on institutional type or have changed over time. For example, research institutions may spend less on instruction per student than a liberal arts institution because they are focused more on research. Similarly, the economic constraints in the early 2000s have changed the source of various revenues and this change in composition could have changed how funds are allocated. These sub-analyses all stem from the previous questions, but simply view them from a different angle. The same techniques, both descriptive and empirical, are used as outlined in the previous questions but the focus is on the use of different comparison groups and fixed effects to evaluate the within and between variation at different levels.

In particular, this has important implications for the stochastic frontier analyses. Rather than simply looking cross-sectionally at how units score in comparison with each other, common in the previous studies using these techniques, I use longitudinal data to examine how efficiency has changed over time. This is especially important because it does more than simply rank units at a single point in time. Instead, it reveals the institutions that are becoming more or less efficient over time and helps to identify the characteristics of these units in achieving this change in their performance.

Summary of Data & Methods

This chapter has presented an outline for the empirical study presented in this dissertation. The data is drawn from three primary resources: the University of Texas System, Texas Higher Education Coordinating Board, and IPEDS. This data is then used to evaluate the four research questions using various techniques including descriptive analyses, fixed effects models, and measures of efficiency including data envelopment analysis and stochastic frontier analysis. This is summarized in Table 5.4.

This table summarizes that there are three sources of data, all consisting of data at different levels to exploit the variation in each by unit of analysis, institution, and time. In addition, there are four separate research questions, each with methods outlined to best

Table 5.4

Summary of Data, Variables, and Methods

Data	**Variables**
UT-System	Raw Figures
Departments, School, Time	Logged Values
THECB	Per FTE
CIP Code, Time	% of Institutional Expenses
IPEDS	
Institutions, Finance, Time	

RQ1: What is the relationship between institutional revenues and institutional expenses?

Methods
- Descriptive Analysis
- Multivariate Regression
- Fixed Effects

RQ2: What is the relationship between institutional expenses and student outcomes?

Methods
- Descriptive Analysis
- Multivariate Regression
- Fixed Effects

RQ3: What is the relative efficiency of the various units in the analysis in producing outputs in relation to inputs?

- Data Envelopment Analysis
- Stochastic Frontier Analysis

RQ4: How do these relationships change based on type of institution and over time?

fit both the research question and data. Finally, the various equations can be modified with different measures of variables to examine dollar for dollar relationships, percent changes, changes per student or staff member, and changes in relation to overall institutional budgets. Similarly, the dependent variable for outputs and outcomes can be applied to a number of institutional factors including, but not limited to, graduation rates and retention rates. In addition, the frontier models create a comparison of actual outputs to potential outputs given various input levels.

These different variables, models, and samples provide for a thorough examination of the higher education production process and offer new insight into the relationships between revenues, expenses, and outputs in the higher education production function and whether the units are acting efficiently. This study therefore contributes to the literature in higher education finance, politics, and economics by combining topics and theory into a more comprehensive conceptual framework, collecting updated data more reflective of contemporary finances, and using methods to empirically test institutional budgeting and processes, a topic that has received a lot of attention at the state level, but little attention within institutions. With accountability, efficiency, and performance dominating the public agenda for higher education, this study directly addresses concerns of taxpayers and policymakers in evaluating institutions and the public and private returns on investment in public higher education.

CHAPTER VI

FINDINGS

In this chapter, I present the findings for each research question. I begin with a discussion about the descriptive statistics across the different datasets and follow with an examination of each research question and the models that accompany each question. In addition, each research question is addressed at the different levels of analysis, where applicable.

IPEDS Descriptive Statistics

The data from IPEDS includes information from 555 institutions spanning across academic years 2005 to 2012 once accounting for 17 institutions that have issues with parent-child indicators and imputation. This information, presented in Table 6.1, includes the means and standard deviations for the variables in the various analyses and is separated out by Carnegie classification. The data presented is averaged across the panel and adjusted for inflation where applicable.

Revenues

In the overall sample of 4-year institutions, the standard deviations exceed the means of the financial variables, largely because of the vast differences across Carnegie classification. For example, RU/VH institutions average $303 million in revenues from

Table 6.1

Institutional Descriptive Statistics by Carnegie Classification

	Public 4-Year Institutions		RU/VH		RU/H		Doctoral		MA		BA	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Revenues in Millions												
State Appropriations	85.61	106.06	303.16	148.54	118.83	57.84	80.53	50.56	49.47	33.60	17.53	12.66
Tuition and Fees	77.33	100.63	261.80	159.04	125.93	65.41	69.75	42.01	43.97	34.12	12.77	12.84
Federal Operating Grants & Contracts	40.63	94.93	224.70	173.21	53.10	47.43	16.70	10.92	8.25	10.19	3.79	4.72
Sales & Services of Auxiliary Enterprises	35.70	56.39	139.33	94.69	50.66	35.58	31.40	44.07	17.28	15.94	6.36	5.98
Other Sources of Operating Revenues	39.65	91.87	203.35	182.69	49.24	44.15	17.28	12.25	10.90	9.87	4.59	5.56
Other Nonoperating Revenues	39.41	112.08	166.19	286.02	43.49	35.88	35.71	25.97	18.81	19.73	8.45	10.51
Total Operating & Nonoperating Revenues	339.65	507.19	1444.53	766.39	490.23	231.27	268.46	151.47	157.21	95.42	56.82	39.77
Total Revenues	356.90	599.49	1555.60	1054.01	481.68	225.23	261.82	144.02	155.75	94.38	56.07	38.32
Expenses in Millions												
Instruction	99.40	132.43	362.26	207.16	144.07	66.06	87.81	52.93	54.66	36.93	18.24	14.78
Research	43.99	107.81	264.13	178.78	58.45	46.03	11.90	8.72	3.58	7.76	0.96	2.14
Auxiliary Enterprises	37.38	58.90	145.27	98.97	54.29	36.74	36.25	47.93	17.20	15.44	7.31	6.33
Academic Support	26.09	41.21	101.25	74.76	39.32	25.01	20.32	9.02	12.98	9.55	4.20	3.47
Institutional Support	25.07	28.37	77.32	45.60	35.06	15.39	23.63	11.33	16.60	11.50	6.67	5.33
Public Service	18.20	44.69	95.27	90.42	23.87	23.83	8.25	7.98	4.73	6.51	1.42	1.65
Student Services	15.29	14.62	37.54	21.00	21.87	11.03	14.65	9.42	12.09	9.42	4.57	3.42
Scholarships & Fellowships	13.61	17.79	39.96	30.60	18.30	14.14	15.46	9.64	9.40	10.10	3.54	4.49

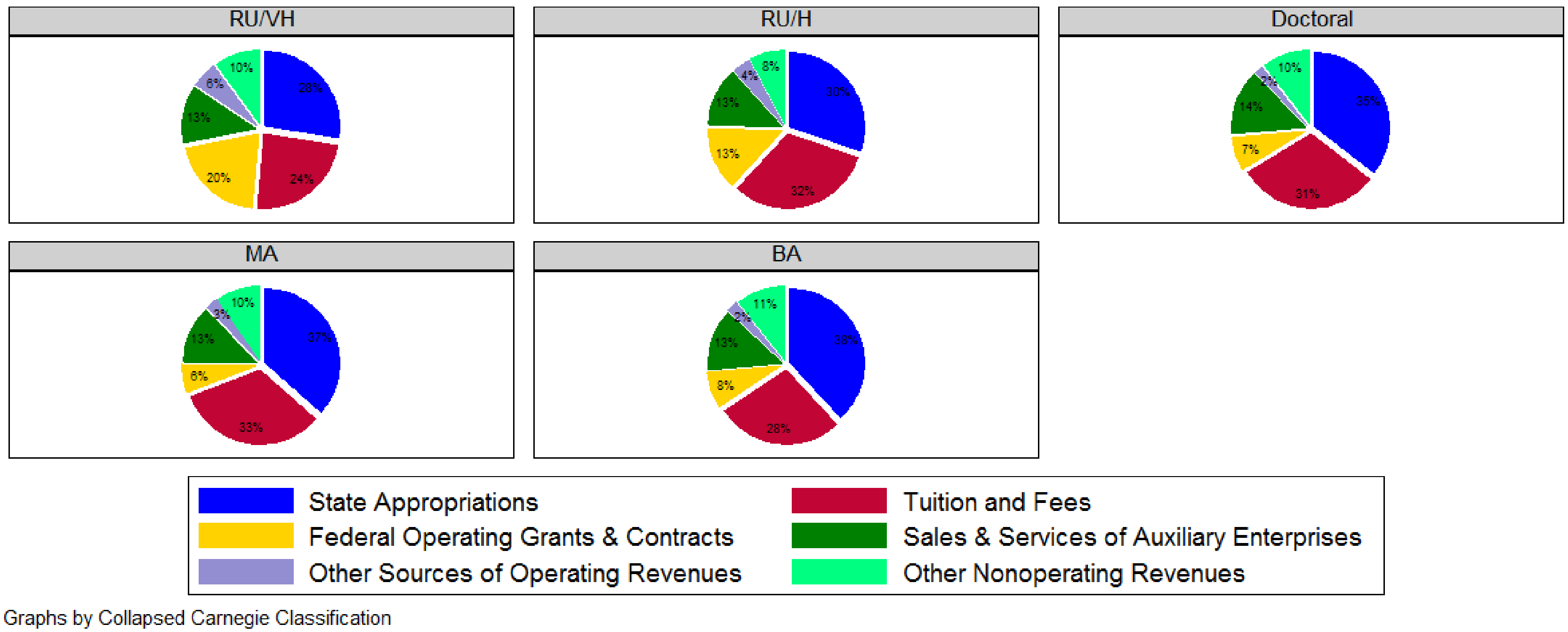
Table 6.1 (Continued)

Institutional Descriptive Statistics by Carnegie Classification

	Public 4-Year Institutions		RU/VH		RU/H		Doctoral		MA		BA	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Expenses in Millions (Continued)												
Other Expenses	41.27	61.98	169.35	105.86	55.12	25.07	28.74	16.01	20.97	12.43	7.43	4.31
Total Operating Expenses	309.79	506.66	1350.75	852.05	422.00	195.93	225.29	128.56	134.99	78.92	48.57	31.81
Total Expenses	332.32	544.47	1443.64	920.13	447.05	207.87	242.01	132.53	146.05	87.24	52.19	35.62
Control Variables												
Published In-State Tuition and Fees (in Thousands)	7.03	2.58	8.35	2.47	7.98	2.89	6.42	1.75	6.43	2.02	7.15	3.20
ACT Score	21.87	2.65	25.17	1.97	23.16	2.25	20.62	2.26	21.07	2.07	20.52	2.15
Admissions Rate	68.45	17.07	64.45	16.23	71.50	15.78	68.55	16.75	67.36	17.22	72.33	17.27
SAT Score	1038.07	110.82	1176.85	72.46	1092.76	84.44	978.81	87.57	1006.08	87.01	971.85	91.99
Student-Faculty Ratio	18.16	3.34	18.51	3.33	18.37	3.25	18.65	2.48	18.51	3.24	16.89	3.49
Student FTE Enrollment (in Thousands)	11.12	9.77	27.90	10.37	15.74	6.43	11.45	5.60	7.79	5.23	2.88	2.76
Outputs												
BA Degrees	1811.97	1846.33	4996.20	2235.85	2650.31	1253.96	1840.40	1077.00	1368.55	1055.14	347.17	382.67
MA Degrees	551.15	657.74	1587.62	775.15	944.71	520.08	672.48	502.89	390.43	394.20	9.73	18.53
Full-Time Retention Rate	73.12	10.91	86.36	6.38	76.28	8.16	70.74	8.32	71.76	9.73	66.62	10.31
4-Year Graduation Rate	23.86	14.95	39.76	16.56	25.81	14.87	19.87	9.29	20.92	12.60	20.03	13.19
6-Year Graduation Rate	46.76	16.26	66.65	13.79	50.96	13.87	42.87	11.74	43.89	13.71	37.85	14.23
Observations	4424		568		576		224		2130		926	
Groups	555		71		72		28		268		116	

Figure 6.1

Operating and Nonoperating Revenues by Carnegie Classification



state appropriations, $262 million from tuition and fees, and $225 million from federal operating grants and contracts. However, BA granting institutions only average $18 million, $13 million, and $4 million respectively from these various sources. I also created values in relation to operating and nonoperating revenues, which can be seen in Figure 6.1. Again, the figures are averaged across the panel after adjusting for inflation.

The blue wedge in these graphs, representative of state appropriations, is larger in the Carnegie classifications focusing on doctoral, MA, or BA granting institutions. In essence, these types of institutions rely more heavily on state appropriations than research institutions. Tuition and fees, on the other hand, does not exhibit such a pattern, with percentages ranging from 24% at institutions with very high research activity to 33% at MA granting institutions with no clear pattern of increasing or decreasing importance. Finally, federal operating grants and contracts, the yellow wedges, which makes up the third largest proportion of revenues at both types of research institutions, is less than the sales and services of auxiliary enterprises and other nonoperating revenues at the other types of institutions. This reflects the importance of research at these types of institutions while other types of institutions are more reliant on the state. Indeed, high research institutions drew 28% of their revenues from state appropriations, on average, while 24% was from tuition and fees. For BA granting institutions, these figures are larger, at 38% and 28%, respectively. This indicates that despite the larger amounts received at research institutions, BA institutions rely more heavily on these two sources of revenues. In essence, research institutions have a more diverse profile of revenues when compared to non-research institutions.

Figure 6.2

Institutional Revenues Over Time

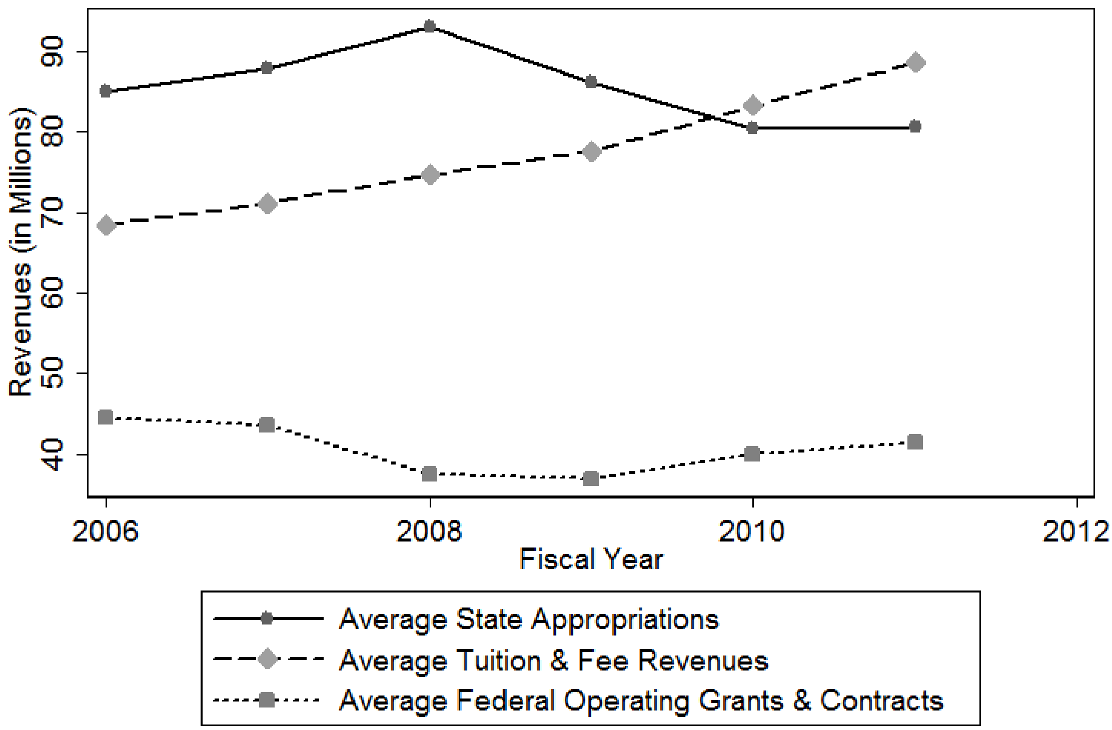
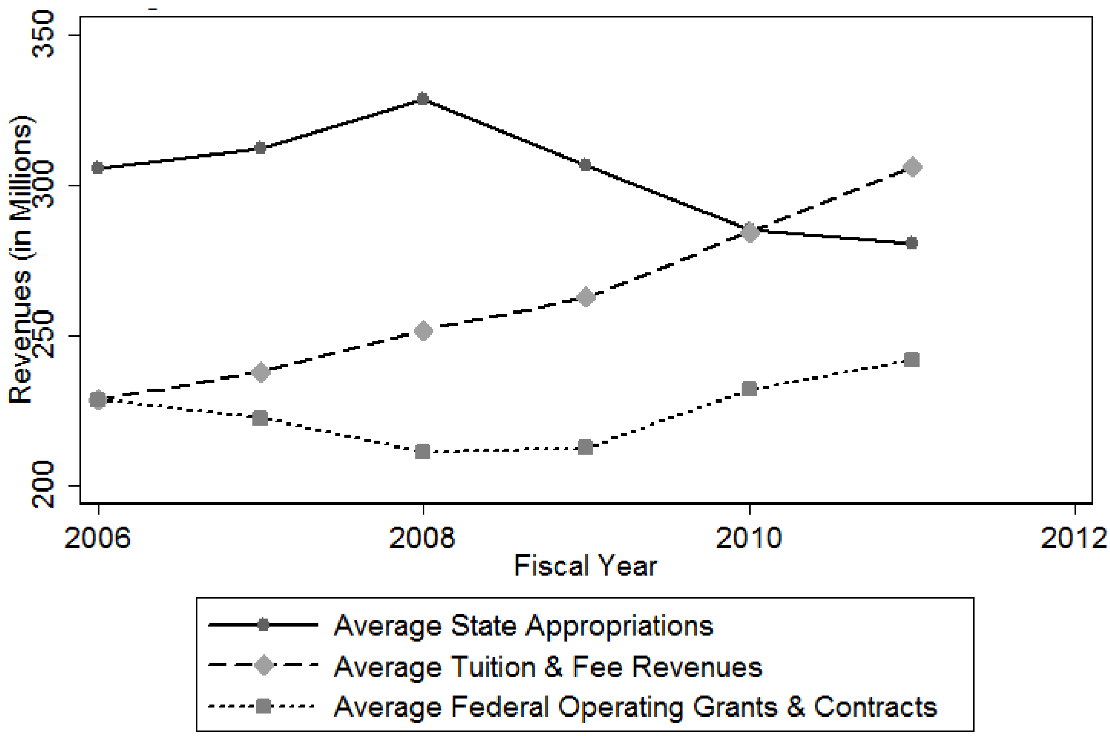


Figure 6.3

Institutional Revenues at RU/VH Institutions Over Time



When looking at these patterns over time, with a particular focus on state appropriations, tuition and fees, and revenues from federal operating grants and contracts, interesting patterns emerge. Since fiscal year 2010, tuition and fee revenues have replaced state appropriations as the largest revenue source, as shown in Figure 6.2. However, when restricting to only institutions with very high research activity, as seen in Figure 6.3, tuition and fee revenues, which were roughly equivalent to federal operating grants and contracts in 2006, have overtaken both federal revenues and state appropriations and become the leading source of revenues in only 5 years. In addition, this graph shows that average state appropriations have been declining since 2008 while federal operating grants and contracts have been increasing, closing the gap between the various revenues sources. While the aggregation of all institutional types in Figure 6.3 showed relatively flat growth to research grants, restricting to research granting institutions showed a rapid growth in the importance of research funds.

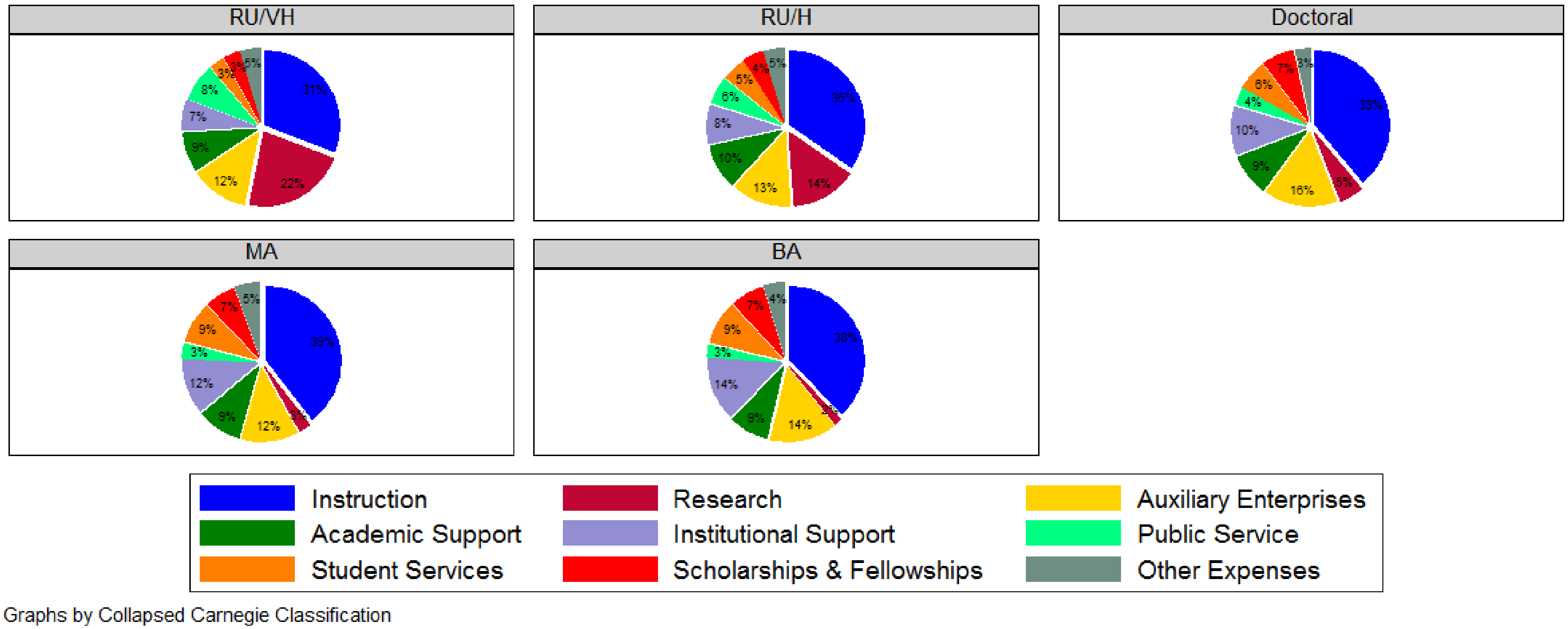
This trend over time is especially interesting for research institutions because it shows a restructuring of institutional revenue sources since the Great Recession. In particular, tuition and fees is not only now the largest revenue source at research institutions, but for many other types of institutions as well. However, the second largest source of revenues at research institutions may also soon change if the negative trend with state appropriations and positive trend for federal operating grants and contracts continues. If federal operating grants and contracts, synonymous with research funding, overtake state appropriations as the second largest source of revenues at these institutions, it may be reflective of a shift for both funders and institutions. Namely, this could show an increasing reliance on research outputs at these types of institutions, not only for prestige, but for funding purposes. As this occurs, the relative importance of state funding as a revenue source could further decline, shifting the focus away from state policymakers to those stakeholders interested in research, thereby putting additional pressure on faculty and administrators to produce research outputs at the potential expense of state and educational goals. In addition, the increasing reliance on tuition and fee revenues, given declining state support, could lead to changes in enrollment profiles. Research institutions could widen the gap in student inputs with other types of institutions as the cost of higher education increasingly falls to tuition support rather than state support. This means that the ability to pay may stratify students into a certain institutional type even more than in the past. These two revenue forces, the increasing reliance on research revenues and the individual support for instruction, could therefore change how expenses are appropriated within institutions.

Expenses

For institutional expenses, Table 6.1 again shows that standard deviations exceed the means for the full sample because of the differences across Carnegie classification. For example, institutions with very high research activity have means of $362 million spent on instruction, $264 million spent on research, and $95 million spent on public service. BA institutions only spend $18 million on instruction, less than $1 million on research, and $1.42 million on public service. However, instruction makes up a larger percent of institutional budgets at BA granting institutions when compared to research institutions. Indeed, Figure 6.4 shows the breakdown of expenses by Carnegie classification and illustrates that BA granting institutions report that roughly 38% of their

Figure 6.4

Operating Expenses by Carnegie Classification



expenses are spent on instruction while only 2% is spent on research and 3% is spent on public service. At research institutions, only 31% of institutional budgets are spent on instruction while nearly 22% is spent on research. These findings are not particularly surprising, but illustrate the clear differences in spending patterns based on the institution's mission.

While there are differences in expenditures based on institutional focus, the shifts over time that were seen with revenues are not present for expenses. Instead, expenditures over time have a relatively slow and stable increase across instruction, research, and public service. None of these items seems to be overtaking the other, despite the shifts in funding source. This could illustrate that while research is increasing both as a revenue source and expense item, the shift toward tuition in lieu of state support is not impacting expenses on instruction or public service. In fact, expenses for all of the various items are increasing or relatively stable. Rather than foregoing one expense for another, expenses as a whole are increasing, illustrating the rising costs of higher education (Ehrenberg, 2002a) despite revenue fluctuations. In particular, despite tuition and research revenues increasing at research institutions while state appropriations decline, expenses on instruction, research, public service, and the like all show increases over time. This could indicate the stability of expenses that result from increased tuition and fees offsetting the loss of state appropriations. These relationships will be further explored in the regressions that follow.

Controls & Outputs

In addition to the differences in finances, institutions differ based on student inputs and outputs. For example, despite the increased expenses on instruction at non-research institutions, incoming students have lower test scores. Average SAT scores are less than 1000 at BA granting institutions while they are nearly 1200 at institutions with very high research activity. Similarly, reported ACT scores are just over 20 at BA granting institutions while they exceed 25 at institutions with very high research activity. The admissions rates also differ across Carnegie classification. While research institutions average an admissions rate of only 64%, BA institutions admit over 72% of applicants. Furthermore, enrollments at research institutions average nearly 28,000 while BA granting enrollments are only 2900. This could explain some of the test score differences, with larger research institutions being able to pick more qualified students from a larger applicant pool. BA granting institutions, needing a certain enrollment threshold in order to hit their financial benchmarks, might be forced to admit more students from their application pool, including those with lower test scores.

Finally, student outputs also vary across institutions. Given the enrollment differences, it is no surprise that research institutions produce over 14 times the amount of BA degrees as BA granting institutions. However, research institutions are also more successful at producing graduates within 4 years and within 6 years. The graduation rates at institutions with very high research activity average roughly 40% of students graduating within 4 years while 67% graduate within 6 years. At BA granting institutions, these figures are significantly lower at 20% and 38%, respectively. Similarly, the full-time retention rates at these institutions differ dramatically, with a retention rate of over 86% at research institutions while BA granting institutions reported a full-time retention rate of just under 67%. Descriptively, not only are research institutions larger and more selective, but the students that do enroll are more likely to stay for multiple years of schooling and graduate more quickly. This could either be because of the institutional delivery of educational services or simply a reflection of the quality of students enrolling at these institutions. These issues will be further explored in the empirical analyses that follow later in this chapter.

School Level Descriptive Statistics

Moving into the data from the University of Texas System and Texas Higher Education Coordinating Board, the descriptive statistics for the school level variables are presented in Table 6.2. These include 64 schools from the 9 institutions included in the UT-System for academic years 2008 to 2011. The data is averaged across this time after adjusting for inflation in the financial variables.

At the school level and for academic programs, faculty salaries dominate expenses, with roughly $9.3 million spent on average. The next closest expense item is on classified staff at $1.1 million. Similarly, faculty counts are significantly larger than administrative and classified staff, with 88 faculty members compared to 6 administrative staff and 26 classified staff.

The student outputs at the school level include degrees granted, majors, and semester credit hours. Not surprisingly, undergraduate outputs are by far the largest in these categories. This is not only because of larger undergraduate enrollments, but also because of institutional mission. For example, UT-Brownsville, UT-Pan Am, UTPB, and

Table 6.2

School Level Descriptive Statistics

	Mean	SD
Expenses in Thousands		
Faculty Salary	9262.42	11,223.46
TA Salary	665.82	1890.14
Administration Salary	677.37	679.14
Classified Staff Salary	1074.70	1418.23
Wages	128.83	179.34
Travel Expenses	26.20	41.98
Miscellaneous Other Expenses	319.94	842.21
Full-Time Equivalents		
Faculty	88.50	92.39
Administration	5.99	5.78
Classified Staff	26.25	28.64
Degrees Granted		
Bachelor’s	468.67	519.49
Master’s	186.72	225.08
Professional	9.06	51.95
Doctoral	22.68	46.83
Majors		
Undergraduate	5084.54	4799.66
Master’s	1184.13	1153.24
Professional	59.79	345.42
Doctoral	383.29	743.48
Semester Credit Hours in Hundreds		
Undergraduate Lower-Level	346.85	561.71
Undergraduate Upper-Level	274.20	249.19
Undergraduate	621.05	767.37
Master’s	85.05	84.00
Professional	8.79	49.05
Doctoral	24.67	51.29
Total	739.57	823.75
Institutional Variables		
Published In-State Tuition and Fees in Thousands	7.44	1.95
4-Year Graduation Rate	21.54	16.86
6-Year Graduation Rate	43.93	19.76
ACT Score	22.72	3.47
Admissions Rate	69.67	18.72
SAT Score	1072.99	121.77
Observations	253	
Groups	64	

UT-Tyler, are all MA granting institutions and would, therefore, not be expected to produce doctoral degrees.

The data in this table are from academic schools and excludes information from non-academic departments such as the operation of plant and maintenance. This is because non-academic departments do not produce academic outputs and are therefore not used in the school level and departmental regressions that follow. These types of non-academic expenses are included as controls in the institutional level regressions since they are overhead that affect total institutional expenses and outputs. These non-academic departments are primarily associated with administrative salaries, wages, and miscellaneous expenses. Administrative salaries are typically classified as institutional support, wages are primarily used for student services and libraries, while miscellaneous expenses include staff benefits and scholarship expenses. Miscellaneous expenses are arguably the most important of these expenses since it is the largest single line-item expense for institutions. For example, UT-Austin, the largest institution in the study, reported between $125 million and $138 million spent annually on staff benefits. While this covers all faculty and staff in the entire institution, it is double their expenses on faculty salaries in their school of liberal arts, their largest individual school. Their next highest miscellaneous expense was on scholarships and fellowships, ranging between $55 million and $69 million per year. Indeed, this pattern holds across the other institutions, with staff benefits and scholarships dominating non-academic institutional expenses.

In addition, the school level descriptive statistics show considerable variation. This not only applies between institutions but also within institutions. For example, UT-Austin spends 28% of its budget on its school of liberal arts and public affairs and 23%

on its school of sciences. However, their nursing program and college of communication only receive 5% of expenses. UT-Tyler has a much smaller budget than UT-Austin, but is more equitable with its schools. Their college of arts and sciences receives 30% of the budget but nursing and health sciences receives 23% and the remaining schools all receive between 14% and 17%.

Departmental Level Descriptive Statistics

The final dataset includes information from the individual departments. As with the school level data, it includes information that pertains directly to academic departments and the production of outputs within that department. In general, faculty salaries per FTE are largest in schools of business and particularly within departments of finance and accounting. These are followed by programs for engineering and computer science, when applicable. For classified salaries and wages, the expenses are largest in the various sciences such as chemistry, physics, and biology. Again, engineering and computer sciences follow. These patterns could reflect higher wages for faculty in business but the need for qualified research assistants in the sciences, which drives up the demand for classified staff and the higher premiums paid to non-faculty staff.

The data reported in this table are for 1192 observations from academic years 2008 to 2011 in 299 departments across the 9 member system. As with the previous tables, the data is averaged across the panel and adjusted for inflation where needed. When looking at the departmental descriptive statistics in Table 6.3, again faculty salaries exceed other departmental expenses. Within a department, roughly $1.8 million is spent on 18.5 faculty members on average. Administrative staff counts are less than 1 on

Table 6.3

Departmental Level Descriptive Statistics

	Mean	SD
Expenditures in Thousands		
Faculty Salary	1780.35	1994.95
TA Salary	45.55	125.14
Administration Salary	35.92	160.98
Classified Staff Salary	134.01	239.17
Wages	10.09	19.48
Travel Expenses	3.05	8.15
Miscellaneous Other Expenses	4.38	20.16
Full-Time Equivalents		
Faculty	18.53	15.73
Administration	0.32	1.30
Classified Staff	3.31	5.06
Degrees Granted		
Bachelor's	85.97	124.06
Master's	37.11	90.34
Professional	1.82	23.50
Doctoral	4.49	9.32
Majors		
Undergraduate	869.74	1176.32
Master's	220.21	487.07
Professional	11.77	154.81
Doctoral	74.00	141.46
Institutional Variables		
Published In-State Tuition and Fees in Thousands	7.39	1.85
4-Year Graduation Rate	21.57	17.71
6-Year Graduation Rate	44.77	20.86
ACT Score	22.46	3.54
Admissions Rate	71.15	19.86
SAT Score	1062.44	122.24
Observations	1192	
Groups	299	

average while each department employs roughly 3.3 classified staff costing $134,000. Similar to the school level data, undergraduate degrees and majors exceed the other types of degrees and majors offered. However, while the mean number of professional degrees granted is only 1.82 and below that of doctoral degrees, the standard deviation is much larger, indicating that many programs do not offer professional degrees and these 0 values are bringing down the mean. For example, business programs have a large number of professional degrees, reflective of the MBA degree. However, many other programs do not offer such professional degrees. Also, while doctoral majors looks quite large, with a departmental level mean of 74, this is inflated by large values reported by the University of Texas Austin in their engineering, biological sciences, and education departments.

Revenues & Expenses

The first research question in this study involves the relationship between revenues and expenses. In particular, given the patterns seen descriptively in the institutional data, this research question should help address what kinds of relationships exist between the various sources of revenues and how institutions spend their money. In particular, revenues from state appropriations and tuition are expected to have a positive relationship with expenses on instruction. Increases in these revenues sources for any given institution are likely to be associated with increases in expenses. Similarly, reductions, as is the case with state appropriations, would be associated with declines in instructional support. Revenues from federal operating grants and contracts are expected to be positively associated with research expenses. Additional funding for research would be hypothesized to be linked to additional research expenses. This would reflect the link between the federal government and funding for research activities. State appropriations are expected to have a positive relationship with public service expenses. Similar to the state having an investment in instruction, the state also has an interest in supporting the public service operations of institutions. This would manifest through a relationship between appropriations and expenditures on public service. Finally, tuition and fees are expected to be positively associated with expenses on scholarships and fellowships. As tuition revenues increase, institutions would have more money to spend for institutional aid, reflecting a high-tuition, high-aid policy. These hypotheses stem from earlier work (Leslie et al., 2012) which found evidence of these relationships at public research institutions from academic years 1984 to 2007. This section extends this work by examining whether these relationships hold for different types of institutions and whether they are still consistent for the years during and following the Great Recession, academic years 2005 to 2010.

Table 6.4 presents results from fixed effects regressions where revenues per FTE are the regressors and the various expenses per FTE are the dependent variables. In this table, which includes institutions of all types, the expected relationships emerge. State appropriations, which have been shown to be declining over time, reveal that a $1 reduction is associated with a decrease in instructional expenses of 26 cents. However, as an institution receives more tuition money over time, every additional $1 in revenues is associated with an increase of 38 cents on instruction. Federal operating grants and contracts are positively associated with research, with a $1 increase in grants being associated with a 7 cent increase in instructional expenses, but state appropriations are

Table 6.4

Results of Institutional Fixed Effects, Expenses and Revenues per FTE (AY2005-2010)

	Instruction	Research	Public Service	Academic Support	Student Service	Institutional Support	Scholarships & Fellowships
State Appropriations	0.26*** (0.04)	0.14 (0.11)	0.02 (0.02)	0.08*** (0.01)	0.03** (0.01)	0.12*** (0.03)	0.02* (0.01)
Tuition and Fee Revenues	0.38*** (0.06)	0.26*** (0.04)	0.06** (0.02)	0.18*** (0.05)	0.07*** (0.02)	0.10*** (0.03)	0.14*** (0.03)
Federal Operating Grants and Contracts	0.07* (0.03)	0.26*** (0.05)	0.09* (0.04)	0.12* (0.06)	0.02 (0.01)	0.08** (0.03)	-0.02 (0.02)
Sales and Services of Auxiliary Enterprises	0.03 (0.06)	-0.10 (0.07)	0.02 (0.03)	0.01 (0.05)	-0.01 (0.02)	0.01 (0.04)	0.02 (0.03)
Other Sources of Operating Revenues	-0.05 (0.03)	-0.02 (0.07)	-0.06 (0.03)	0.29 (0.22)	0.00 (0.00)	0.01 (0.01)	0.01 (0.01)
Other Sources of Nonoperating Revenues	0.12 (0.07)	0.03 (0.05)	0.02 (0.01)	0.15 (0.09)	-0.01 (0.02)	0.03 (0.03)	-0.01 (0.01)
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES
Constant	-0.08* (0.03)	0.06** (0.02)	0.03 (0.01)	0.03 (0.03)	-0.03*** (0.01)	0.01 (0.02)	-0.08*** (0.01)
Within R-Squared	0.50	0.14	0.09	0.33	0.37	0.22	0.36
Between R-Squared	0.73	0.78	0.24	0.50	0.05	0.31	0.02
Total R-Squared	0.70	0.77	0.23	0.46	0.07	0.29	0.00
F-Statistic	89.75	11.20	7.86	23.62	58.73	24.18	48.26
Observations	2769	2769	2769	2769	2769	2769	2769
Groups	504	504	504	504	504	504	504

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

not associated with public service. Finally, tuition and fee revenues are positively associated with expenses on scholarships and fellowships. A $1 increase in tuition and fee revenues for an institution is associated with a 14 cent increase on expenses for scholarships and fellowships. However, a number of other relationships also arose that were not expected. Federal operating grants and contracts is not only significant for research, but also for expenses on instruction and public service. This is consistent with the results by Leslie et al. (2012), but surprising given the focus of the revenue source being research. It would not be expected that research grants would go to support instructional activities. However, this is explored in more detail when separating by Carnegie classification. In addition, while state appropriations were significant in relation to public service in the previous study, it is not significant in this study. Instead, tuition is significant and positive in its association with public service, which was significant and negative in the former study. These differences could reflect the inclusion of non-research institutions, which may not have the type of public service mission as state flagships. The other expense categories, which are much smaller, all showed positive significant relationships with state appropriations and tuition. However, only academic support and institutional support had significant relationships with federal operating grants and contracts.

While the relationships are generally similar to those found previously, the question remains as to whether there are differences because of the updated timeframe or because of the inclusion of other types of institutions. Therefore, I repeated this analysis by Carnegie classification, paying particular attention to expenditures on the tripartite mission of higher education: instruction, research, and public service.

Table 6.5

Results of Institutional Fixed Effects, Expenses and Revenues by Carnegie Classification per FTE (AY2005-2010)

	Instruction					Research				
	RU/VH	RU/H	Doctoral	MA	BA	RU/VH	RU/H	Doctoral	MA	BA
State Appropriations	0.41***	0.37***	0.25**	0.21***	0.15*	0.08	0.18***	-0.02	0.26	0.04
	(0.07)	(0.08)	(0.08)	(0.05)	(0.07)	(0.06)	(0.04)	(0.07)	(0.20)	(0.02)
Tuition and Fee Revenues	0.45**	0.57***	0.38	0.23***	0.46***	0.34**	0.20*	0.07	0.02	-0.03
	(0.15)	(0.16)	(0.28)	(0.06)	(0.11)	(0.11)	(0.08)	(0.09)	(0.04)	(0.03)
Federal Operating Grants and Contracts	0.02	0.08	-0.01	0.04	0.16*	0.65***	0.20**	0.04	0.06	0.02
	(0.08)	(0.05)	(0.12)	(0.04)	(0.07)	(0.08)	(0.07)	(0.06)	(0.05)	(0.04)
Sales and Services of Auxiliary Enterprises	-0.04	-0.13	-0.10	0.16	-0.15	-0.25	-0.14	0.06	-0.13	0.01
	(0.10)	(0.15)	(0.23)	(0.09)	(0.12)	(0.15)	(0.08)	(0.21)	(0.09)	(0.02)
Other Sources of Operating Revenues	-0.05	-0.17**	0.09	0.04	-0.02	0.06**	-0.08	0.03	-0.19	-0.05
	(0.04)	(0.06)	(0.18)	(0.03)	(0.13)	(0.02)	(0.06)	(0.11)	(0.15)	(0.03)
Other Sources of Nonoperating Revenues	0.30*	0.19*	-0.17	0.07	-0.17	0.07	0.11	-0.01	-0.03	0.04
	(0.11)	(0.09)	(0.15)	(0.05)	(0.10)	(0.07)	(0.13)	(0.05)	(0.03)	(0.04)
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	1.77**	0.19	-0.51*	-0.74***	-0.68**	2.90***	1.34***	-0.95***	-1.49***	-1.88***
	(0.64)	(0.33)	(0.22)	(0.11)	(0.23)	(0.49)	(0.20)	(0.23)	(0.23)	(0.07)
Within R-Squared	0.64	0.60	0.48	0.48	0.50	0.61	0.38	0.12	0.08	0.11
Between R-Squared	0.66	0.40	0.52	0.56	0.38	0.72	0.77	0.11	0.20	0.03
Total R-Squared	0.63	0.42	0.48	0.49	0.39	0.71	0.74	0.06	0.24	0.06
F-Statistic	21.60	41.97	15.16	52.99	14.25	50.27	6.53	4.10	2.03	1.88
Observations	366	416	166	1478	343	366	416	166	1478	343
Groups	62	70	28	258	86	62	70	28	258	86

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.5 (Continued)

Results of Institutional Fixed Effects, Expenses and Revenues by Carnegie Classification per FTE (AY2005-2010)

	Public Service				
	RU/VH	RU/H	Doctoral	MA	BA
State Appropriations	0.01	0.05**	0.02	0.04**	0.01
	(0.05)	(0.02)	(0.04)	(0.01)	(0.02)
Tuition and Fee Revenues	0.03	0.09**	-0.04	-0.00	0.06*
	(0.07)	(0.03)	(0.04)	(0.02)	(0.03)
Federal Operating Grants and Contracts	0.20*	0.02	-0.02	0.03	0.15
	(0.09)	(0.03)	(0.02)	(0.04)	(0.12)
Sales and Services of Auxiliary Enterprises	0.14	-0.06	-0.12	0.02	0.01
	(0.13)	(0.05)	(0.08)	(0.04)	(0.05)
Other Sources of Operating Revenues	-0.07*	-0.05	-0.02	0.01	0.01
	(0.03)	(0.02)	(0.07)	(0.02)	(0.05)
Other Sources of Nonoperating Revenues	0.04	0.02	0.02	-0.01	0.00
	(0.04)	(0.03)	(0.02)	(0.01)	(0.02)
Year Fixed Effects	YES	YES	YES	YES	YES
Constant	0.92*	0.25***	-0.60***	-0.42***	-0.22
	(0.46)	(0.06)	(0.07)	(0.06)	(0.17)
Within R-Squared	0.20	0.16	0.12	0.03	0.23
Between R-Squared	0.02	0.11	0.00	0.02	0.26
Total R-Squared	0.02	0.11	0.00	0.03	0.26
F-Statistic	3.48	3.98	1.75	5.08	2.08
Observations	366	416	166	1478	343
Groups	62	70	28	258	86

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

When separating out by Carnegie classification, the results for instruction at very high research institutions are quite similar to those found by Leslie and colleagues (2012) for state appropriations and tuition. In my results, a reduction of $1 in state appropriations for an institution were associated with a 41 cent reduction on instruction at very high research institutions while this was 32 cents in the former study (Leslie et al., 2012). Similarly, I found a relationship for tuition and instruction of a 45 cent increase in instruction per $1 increase in tuition and fee revenues. Leslie et al. (2012) found this relationship to be 46 cents.

In looking at all types of institutions, I found that federal operating grants and contracts are not significant in their relationship with instruction for any Carnegie classification except for bachelor's granting institutions. The coefficients for tuition are all larger than those for state appropriations across all classifications, possibly indicating the increased status of tuition as a revenue source and its impact on the largest expense item, instruction. The coefficients on state appropriations are larger at research institutions and progressively decline for each subsequent Carnegie classification. This indicates a larger decline to instruction for these types of institutions when state appropriations are cut, which may reflect the focus on instruction at BA granting institutions and their attempts to protect instruction from cuts while research institutions have a more diverse mission orientation and are more apt to cut instruction in lieu of other activities when support wanes. However, the same is not true of tuition and fee revenues and their relationship to instruction. High research institutions have the largest coefficient in their relationship with instructional expenses followed by BA granting institutions and institutions with very high research activity.

In turning to research expenses, no revenue sources are significant for non-research institutions. However, for very high and high research institutions, federal operating grants and contracts are statistically significant, as are tuition and fee revenues. As federal operating grants and contracts increase by $1 for an institution, research expenses are associated with an increase of 65 cents. For tuition and fee revenues, this relationship is smaller, at 34 cents. Finally, state appropriations are significant for institutions with high research activity while other sources of operating revenues are significant for institutions with very high research activity. These relationships show that research institutions rely on different sources of funds to support their research activities while non-research institutions simply do not partake in much research.

Finally, the expenses on public service expenses do not have a clear pattern. Institutions with very high research activity show a positive relationship with federal operating grants and contracts while those with high research activity and master's granting institutions are associated with state appropriations. In addition, high research activity institutions and bachelor's granting institutions are positively associated with tuition. Therefore, there does not appear to be a clear relationship between funding and expenses that is consistent across institutional type for public service, unlike the more clear patterns seen for instruction and research. The results for public service also have much smaller coefficients than those for instruction or research. For example, a $1 increase in federal operating grants and contracts per FTE at a very high research institution is associated with a 65 cent increase in research expenses. However, the same $1 increase is only associated with a 20 cent increase in public service expenses at these types of institution.

These results, in particular, indicate that while instruction is a consistent goal across all types of Carnegie classifications, and therefore shows similar patterns in the positive relationships with state appropriations and tuition, the same does not hold for research and public service. In particular, the relationships between revenues and expenses on research and public service are not significant for institutions whose Carnegie classification does not focus on these types of activities. Non-research institutions do not show any significant results for research expenditures. For public service, there is no clear pattern across the different institutional types.

By comparing to the results from Leslie et al. (2012), the results are fairly consistent, though there does appear to be some shifts because of the Great Recession. In particular, the relationships for instruction are relatively the same with the exception of federal operating grants and contracts. While Leslie et al. (2012) found a significant positive relationship between federal grants and expenses on instruction, there is no relationship in this data from 2005 to 2010. For research, tuition in my model is statistically significant and has a much larger coefficient than that reported previously. However, grants are still the largest coefficient for research in both models. Finally, every regressor in the previous analysis for public service was found to be statistically significant. In my model, grants were positive and statistically significant while other sources of operating revenues was negative. These differences could potentially be due to the much larger sample used by Leslie et al. in their analysis over 24 years and the long pattern before the Great Recession. By restricting to 2005 to 2010, I am isolating the effects to a smaller timeframe, which changes the ability to fit the model over a long period of time. In addition, it looks at the time surrounding the Great Recession and the potential changes because of the economic downturn.

In addition to these differences that can be seen in my sample from that conducted by Leslie et al. (2012) prior to the Great Recession, my inclusion of other types of institutions helps reveal how these relationships between expenses and revenues vary based on institutional type. In addition, they provide a good context leading into the second question between expenses and outputs, especially in identifying the importance of tuition and state appropriations in instructional expenses.

It should be noted that models with alternate function forms, including additional controls and squared regressors, can be found in the appendix. The models presented above are consistent with those published previously (Leslie et al., 2012). In one of these supplemental models, I include admissions rate as a control proxy for student quality (Archibald & Felaman, 2008b; Breu & Raab, 1994; Zhang, 2005). Admissions rate was chosen as the control for student quality because it is commonly used in other research as a measure of quality and is highly correlated with both ACT scores and SAT scores. However, it is an improvement over standardized test scores because it is consistently reported while institutions and states vary greatly in their preference for different test scores. This inclusion had no significant impact on the model results. In another model, I also include student-faculty ratios, a classic proxy for student quality (Enarson, 1960; Glenny & Schmidtlein, 1983; Levin, 1991). However, this data was only available for academic years 2008 to 2010, thereby limiting the number of observations and hurting the model fit. In these models, many of the coefficients are suppressed or no longer significant. Finally, I also used models with different functional forms including squared terms for various revenue sources. These slightly increase the within r-squared but cause the between r-squared and total r-squared values to fall.

Expenses & Outputs

In the second research question, I seek to determine the relationships between expenses and outputs. While the previous question could only be addressed with IPEDS data due to the limitations on revenue data, this question can be addressed at all three levels of analysis. In IPEDS, I look at the relationships between expenses and outputs that include degree completions, retention rates, and graduation rates. As stated previously, Rabovsky (2013) describes these as the most commonly used performance metrics by states. In the school level data, I look at outputs that include degree completions, majors, and semester credit hours. Semester credit hours are unique from degrees or majors in that they measure students that are not directly linked to the school. For example, an English department may have small counts for degrees attained and majors, but the semester credit hours would be much larger because of the general education requirements of non-English majors to take writing courses. Finally, the departmental level data look at degree completions and majors due to the complexity in tying semester credit hours to a single department.

These models use the same techniques as in the first analysis between revenues and expenses. This primarily focuses on the use of multivariate regressions and fixed effects regressions. Fixed effects regressions are somewhat limited in these models because of the short time frame, making changes over time more difficult to detect. As with the other models, expenses per FTE are used to ensure that the variance inflation factor on these models is less than 10. This is to ensure that the models are parallel to the models used in the analysis on revenues and expenses. I also used Hausman tests which confirmed that fixed effects models are preferred to random effects models and looked at future values to examine strict exogeneity. Unlike the previous analysis, future values are less predictive of current outputs in the school and departmental samples and strict exogeneity is likely less of a problem, however results from the IPEDS level data again should be interpreted with caution.

Institutional Level Expenses & Outputs

The dependent variables in these analyses include degree completions, retention rates, and graduation rates. For degree completions and retention rates, the years span from academic year 2005 to 2010. For graduation rates, the years span from 2006 to 2010. The independent variables include the expenses per full-time equivalent student. I first conducted bivariate regressions between each outcome and the individual expense items. For BA degrees, only student services were significant, with a negative relationship in the production of BA degrees. An increase of $1000 per FTE to student services at an institution was associated with a decrease of 38.95 BA degrees in the bivariate fixed effects regression, though only significant at the 10% level. Once including controls for tuition and admissions rates, the coefficient became more negative, decreasing BA degrees by 62.58 per $1000 of additional expenses per FTE. In looking at full-time retention rates, expenses on instruction and student services were negatively associated with retention rates in their individual regressions, but these relationships were no longer significant once including other types of expenses. Finally, the bivariate regressions for graduation rates showed no relationships with any of the major expense categories.

I then conducted full institutional models which are presented in Table 6.6. The first column in each regression includes only expense items while the second column includes additional controls for tuition and admissions rate. These help to control for differences in the potential inputs for these institutions. In these models, which include the full sample of institutions, few expenses are significant in the production of student outputs. This is not surprising given the lack of relationships in the bivariate regressions. Instructional expenses, which would be hypothesized to be associated with degree, retention, and graduation outputs, are not significant in any model. Similarly, academic support, another expense item that may impact these outputs, is not significant. The only significant relationships for degree completions is with student service expenses, which operate in the opposite direction as would be hypothesized. Rather than additional expenses on student services improving degree completion, they actually hurt both BA and MA degrees. This negative relationship may be because of the student inputs, with lower achieving students utilizing more student services and negatively impacting graduation. While the expenses on academics are not significant, these students may be spending more time on social activities and student services, which distract from academic endeavors and therefore hurt degree completion. However, the same cannot be said about graduation rates. In fact, the only significant relationship with graduation rates is with scholarships and fellowships, which have a negative relationship with four-year graduation rates but no significant relationship with six-year graduation rates. This

Table 6.6

Results of Institutional Fixed Effects, Various Outputs and Expenses per FTE (in Thousands)

	BA Degrees		MA Degrees	
Instructional Expenses	7.40	9.75	3.56	4.39
	(8.99)	(9.90)	(5.80)	(5.50)
Research Expenses	10.17	9.24	8.05	8.03
	(9.38)	(8.62)	(6.44)	(6.20)
Auxiliary Expenses	2.89	-1.57	-1.30	-1.86
	(13.60)	(15.81)	(7.10)	(7.27)
Academic Support	5.44	6.76	9.39	8.57
	(5.67)	(5.62)	(6.20)	(5.09)
Institutional Support	4.87	9.14	-4.24	-6.66
	(12.15)	(13.57)	(7.05)	(7.26)
Public Service	-9.41	-17.35	0.86	0.06
	(12.60)	(13.42)	(13.24)	(14.36)
Student Services	-60.16*	-90.45*	-47.03**	-44.33**
	(29.48)	(36.11)	(15.04)	(16.12)
Scholarship and Fellowships	1.90	5.71	9.15	11.03
	(14.62)	(16.44)	(12.73)	(14.76)
Other Expenses	1.59	3.31	1.63	2.47
	(3.62)	(3.88)	(3.56)	(3.83)
Published In-State Tuition and Fees		43.98**		12.56
		(16.65)		(7.61)
Admissions Rate		-0.35		0.14
		(0.45)		(0.24)
Year Fixed Effects	YES	YES	YES	YES
Constant	1938.21***	1784.04***	603.50***	538.46***
	(4.38)	(109.65)	(2.57)	(52.02)
Within R-Squared	0.21	0.23	0.13	0.13
Between R-Squared	0.18	0.16	0.28	0.33
Total R-Squared	0.11	0.13	0.23	0.28
F-Statistic	16.73	14.43	11.07	9.90
Years	2005-2010	2005-2010	2005-2010	2005-2010
Observations	2769	2522	2769	2522
Groups	504	464	504	464

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.6 (Continued)

Results of Institutional Fixed Effects, Various Outputs and Expenses per FTE (in Thousands)

	FT Retention Rate	
Instructional Expenses	-0.25	-0.35
	(0.23)	(0.25)
Research Expenses	0.08	0.08
	(0.08)	(0.07)
Auxiliary Expenses	-0.27*	-0.29*
	(0.12)	(0.12)
Academic Support	0.09	0.14
	(0.07)	(0.08)
Institutional Support	-0.88**	-0.71**
	(0.31)	(0.22)
Public Service	0.04	0.10
	(0.12)	(0.12)
Student Services	-0.66	-0.60
	(0.46)	(0.49)
Scholarship and Fellowships	-0.41	-0.32
	(0.37)	(0.37)
Other Expenses	-0.03	0.02
	(0.09)	(0.07)
Published In-State Tuition and Fees		-0.13
		(0.15)
Admissions Rate		-0.04*
		(0.01)
Year Fixed Effects	YES	YES
Constant	73.03***	77.67***
	(0.15)	(1.42)
Within R-Squared	0.07	0.08
Between R-Squared	0.10	0.13
Total R-Squared	0.05	0.08
F-Statistic	8.64	10.97
Years	2005-2010	2005-2010
Observations	2736	2519
Groups	497	461

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.6 (Continued)

Results of Institutional Fixed Effects, Various Outputs and Expenses per FTE (in Thousands)

	4-Year Graduation Rate		6-Year Graduation Rate	
Instructional Expenses	0.13	0.12	-0.02	-0.02
	(0.11)	(0.11)	(0.12)	(0.11)
Research Expenses	0.18	0.16	0.16	0.14
	(0.16)	(0.16)	(0.13)	(0.13)
Auxiliary Expenses	0.10	0.11	0.06	0.08
	(0.18)	(0.18)	(0.16)	(0.16)
Academic Support	0.02	0.04	0.02	0.04
	(0.07)	(0.07)	(0.07)	(0.07)
Institutional Support	0.27	0.27	-0.05	-0.06
	(0.18)	(0.18)	(0.19)	(0.20)
Public Service	0.16	0.16	0.13	0.14
	(0.14)	(0.14)	(0.20)	(0.20)
Student Services	-0.29	-0.34	0.27	0.15
	(0.41)	(0.42)	(0.43)	(0.43)
Scholarship and Fellowships	-0.90*	-0.90*	-0.48	-0.46
	(0.37)	(0.36)	(0.39)	(0.38)
Other Expenses	0.01	0.01	-0.06	-0.06
	(0.06)	(0.06)	(0.08)	(0.08)
Published In-State Tuition and Fees		0.25		0.40*
		(0.16)		(0.19)
Admissions Rate		0.01		0.03**
		(0.01)		(0.01)
Year Fixed Effects	YES	YES	YES	YES
Constant	24.02***	21.86***	47.77***	43.41***
	(0.10)	(1.30)	(0.10)	(1.39)
Within R-Squared	0.09	0.09	0.07	0.08
Between R-Squared	0.22	0.31	0.19	0.29
Total R-Squared	0.20	0.28	0.16	0.25
F-Statistic	8.00	7.06	6.08	6.23
Years	2006-2010	2006-2010	2006-2010	2006-2010
Observations	2073	2073	2073	2073
Groups	452	452	452	452

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

suggests that additional expenses on scholarships and fellowships may be associated with students staying on campus longer because of the reduced cost of attendance.

However, these results include all types of institutions and could exhibit differential patterns by Carnegie classification. In the following tables, I present the results by Carnegie classification while focusing on BA degree completion, full-time retention rates, and 6-year graduation rates. Table 6.7 presents the results focusing on bachelor's degree completion. While the full sample in Table 6.6 showed only a negative relationship with expenses on student services, separating out by Carnegie classification shows no relationship for this variable. Instructional expenses show mixed relationships. While there is a positive relationship at institutions with high research activity, there is a negative relationship at the lower tiered institutions. In essence, high research institutions, with large enrollments and instructional expenses show a positive relationship while the other institutions may be operating at a less than optimal scale, with more expenditures on instruction than needed in order to produce degrees. This relationship will be further explored in the measures of technical efficiency that follow in the stochastic frontier and data envelopment models.

For academic support, there is a positive relationship between spending and degree completions at BA granting institutions. For every $1000 in additional expenses on academic support per FTE at an institution, BA degrees completed are expected to increase by 30 to 35 at BA granting institutions. This could be indicative of academic support programs that help students with their studies and help them to finish their degree. However, this is only seen for BA granting institutions. The finding is not robust across the different types of institutions. Finally, expenses on public service has a

Table 6.7

Results of Institutional Fixed Effects, BA Degrees by Carnegie Classification and Expenses per FTE for AY2005-2010 (in Thousands)

	RU/VH		RU/H	
Instructional Expenses	7.28	16.42	60.60*	62.70*
	(21.19)	(27.39)	(26.33)	(25.83)
Research Expenses	-5.62	-9.66	-32.67	-31.27
	(16.71)	(19.35)	(23.25)	(22.48)
Auxiliary Expenses	-30.86	-28.91	-71.26*	-62.07
	(45.67)	(45.73)	(33.28)	(31.49)
Academic Support	-2.61	1.96	-35.42	-69.82
	(3.55)	(7.65)	(78.31)	(74.95)
Institutional Support	-23.98	-22.27	1.40	9.13
	(41.96)	(44.07)	(45.41)	(49.69)
Public Service	-47.74*	-47.98*	-168.05**	-160.08*
	(21.97)	(21.76)	(63.07)	(62.00)
Student Services	34.79	-79.03	-70.57	-111.52
	(88.53)	(198.46)	(69.58)	(60.82)
Scholarships & Fellowships	104.02	95.51	86.07	93.77
	(94.11)	(91.60)	(62.79)	(62.49)
Other Expenses	2.97	6.37	-10.82	7.89
	(12.19)	(15.13)	(30.62)	(32.58)
Published In-State Tuition & Fees		40.40		36.64*
		(82.67)		(16.95)
Admissions Rate		0.46		-0.54
		(2.84)		(1.24)
Year Fixed Effects	YES	YES	YES	YES
Constant	5003.70***	4684.34***	2684.56***	2507.70***
	(194.83)	(700.44)	(48.66)	(162.37)
Within R-Squared	0.33	0.34	0.33	0.38
Between R-Squared	0.02	0.11	0.00	0.01
Total R-Squared	0.03	0.09	0.01	0.01
F-Statistic	9.82	8.80	3.77	3.69
Observations	366	361	416	388
Groups	62	61	70	66

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.7 (Continued)

Results of Institutional Fixed Effects, BA Degrees by Carnegie Classification and Expenses per FTE for AY2005-2010 (in Thousands)

	Doctoral	
Instructional Expenses	-36.84*	-36.64
	(17.08)	(24.13)
Research Expenses	11.37	17.77
	(44.22)	(53.14)
Auxiliary Expenses	49.75	46.73
	(36.71)	(39.91)
Academic Support	-27.61	-48.35
	(42.71)	(52.41)
Institutional Support	30.65	50.52
	(38.28)	(57.43)
Public Service	5.77	-2.49
	(70.41)	(84.86)
Student Services	65.45	72.85
	(57.62)	(80.78)
Scholarships & Fellowships	-59.10	-66.08
	(49.76)	(62.43)
Other Expenses	-16.68	-18.39
	(15.83)	(18.16)
Published In-State Tuition & Fees		-22.25
		(34.52)
Admissions Rate		-0.45
		(0.91)
Year Fixed Effects	YES	YES
Constant	1877.87***	2109.08***
	(51.68)	(209.89)
Within R-Squared	0.38	0.39
Between R-Squared	0.14	0.04
Total R-Squared	0.13	0.04
F-Statistic	3.07	2.97
Observations	166	151
Groups	28	28

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.7 (Continued)

Results of Institutional Fixed Effects, BA Degrees by Carnegie Classification and Expenses per FTE for AY2005-2010 (in Thousands)

	Master's		Bachelor's	
Instructional Expenses	-16.66*	-17.19*	-8.88	-8.91*
	(7.29)	(8.61)	(5.01)	(4.18)
Research Expenses	-1.82	-0.35	8.75	16.02
	(3.21)	(3.74)	(15.04)	(16.50)
Auxiliary Expenses	2.91	1.70	-10.85*	-10.08
	(8.82)	(10.10)	(4.64)	(5.66)
Academic Support	10.74	13.44	35.53*	30.28*
	(16.70)	(18.98)	(13.62)	(11.52)
Institutional Support	15.12	20.49	-12.60*	-10.32
	(12.43)	(13.97)	(6.11)	(6.53)
Public Service	-13.51	-21.01	5.42	-14.10
	(15.25)	(19.19)	(9.75)	(22.36)
Student Services	20.82	12.32	-11.91	12.10
	(23.32)	(25.48)	(19.77)	(17.56)
Scholarships & Fellowships	9.22	12.98	39.31	11.24
	(13.06)	(15.27)	(22.86)	(14.29)
Other Expenses	-0.55	1.66	1.05	-4.98
	(3.73)	(4.40)	(6.31)	(4.21)
Published In-State Tuition & Fees		25.40		-11.47
		(15.55)		(9.55)
Admissions Rate		-0.37		-0.01
		(0.52)		(0.34)
Year Fixed Effects	YES	YES	YES	YES
Constant	1386.67***	1319.34***	452.27***	512.89***
	(14.39)	(99.18)	(35.57)	(84.88)
Within R-Squared	0.26	0.27	0.28	0.26
Between R-Squared	0.01	0.01	0.04	0.01
Total R-Squared	0.00	0.00	0.03	0.00
F-Statistic	11.22	9.73	3.71	3.42
Observations	1478	1355	343	267
Groups	258	240	86	69

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

negative relationship with degree completion at research institutions. This could largely be due to the nature of the relationship of these institutions with the state as flagship and public serving institutions. Expenses on public service could therefore distract these institutions from producing degrees since the focus may have shifted to a public service mission of the institution rather than the educational goals.

In looking at full-time retention rates, Table 6.6 showed negative relationships between auxiliary expenses and institutional support on retention rates. Once broken down by Carnegie classification, as is shown in Table 6.8, the negative relationship with auxiliary expenses only holds for institutions with very high research activity. For institutional support, it manifests with institutions with high research activity and BA granting institutions. Academic support and scholarships are also found to be significant in these subgroup analyses. For academic support, positive relationships with retention rates emerge for institutions with very high research activity and doctoral granting institutions, but only in the simple models before controls for tuition and admissions rates were included. Once controlling for these proxies for student inputs, the relationships are no longer statistically significant. This suggests that academic support may not actually improve retention rates once controlling for the quality of the student body. Scholarships and fellowships, on the other hand, are significant in both models at BA granting degrees but negative. An additional $1000 per FTE spent on scholarships and fellowships actually reduces the full-time retention rate by 1.2 to 1.7 percentage points at a given institution. This counterintuitive finding only holds for these types of institutions and again may be reflective of the student body. In particular, BA granting institutions may

Table 6.8

Results of Institutional Fixed Effects, FT Retention Rate by Carnegie Classification and Expenses per FTE for AY2005-2010 (in Thousands)

	RU/VH		RU/H		Doctoral	
Instructional Expenses	-0.15 (0.10)	-0.16 (0.10)	-1.17 (0.87)	-1.36 (0.89)	-0.30 (1.40)	-0.85 (1.34)
Research Expenses	-0.06 (0.09)	-0.04 (0.08)	0.18 (0.42)	0.14 (0.42)	2.82 (1.77)	3.10 (2.15)
Auxiliary Expenses	-0.31** (0.10)	-0.31** (0.09)	-0.31 (0.37)	-0.32 (0.40)	-0.46 (0.66)	-1.04 (0.64)
Academic Support	0.06* (0.03)	0.05 (0.03)	0.40 (0.69)	0.75 (0.63)	2.29* (0.99)	1.95 (0.96)
Institutional Support	-0.18 (0.15)	-0.17 (0.15)	-1.69* (0.83)	-1.51 (0.84)	-0.84 (0.79)	-1.17 (1.51)
Public Service	0.09 (0.08)	0.09 (0.08)	0.62 (0.61)	0.73 (0.67)	2.00 (1.61)	1.68 (1.67)
Student Services	0.51 (0.39)	0.54 (0.40)	-2.83 (1.65)	-3.09 (1.71)	1.97 (3.55)	1.46 (3.74)
Scholarships & Fellowships	0.32 (0.27)	0.33 (0.28)	-0.64 (1.42)	-0.73 (1.38)	0.55 (0.54)	0.99 (0.96)
Other Expenses	-0.06 (0.06)	-0.07 (0.06)	-0.43 (0.63)	-0.04 (0.34)	-0.71 (0.54)	-0.81 (0.69)
Published In-State Tuition & Fees		-0.13 (0.20)		0.14 (0.17)		-0.60 (1.18)
Admissions Rate		0.00 (0.03)		-0.01 (0.02)		-0.01 (0.03)
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Constant	87.21*** (0.70)	88.11*** (2.30)	76.70*** (0.84)	77.29*** (2.10)	74.83*** (2.94)	79.75*** (10.74)
Within R-Squared	0.30	0.30	0.24	0.30	0.13	0.13
Between R-Squared	0.26	0.29	0.06	0.04	0.05	0.09
Total R-Squared	0.13	0.16	0.01	0.01	0.01	0.01
F-Statistic	12.18	11.61	3.35	3.08	13.22	5.75
Observations	361	361	416	388	166	151
Groups	61	61	70	66	28	28

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.8 (Continued)

Results of Institutional Fixed Effects, FT Retention Rate by Carnegie Classification and Expenses per FTE for AY2005-2010 (in Thousands)

	Master's		Bachelor's	
Instructional Expenses	-0.03	-0.11	-0.82	-0.96
	(0.19)	(0.18)	(0.61)	(0.65)
Research Expenses	0.07	0.15	0.97	-0.36
	(0.10)	(0.08)	(1.45)	(2.28)
Auxiliary Expenses	-0.33	-0.36	-0.09	0.12
	(0.22)	(0.23)	(0.44)	(0.53)
Academic Support	0.18	0.67	-0.86	-0.41
	(0.57)	(0.47)	(0.91)	(0.90)
Institutional Support	-0.90	-0.62	-1.57**	-1.66**
	(0.61)	(0.32)	(0.57)	(0.54)
Public Service	-0.17	-0.14	-0.31	0.24
	(0.42)	(0.44)	(0.61)	(1.66)
Student Services	-0.59	-0.56	2.40	3.26
	(0.69)	(0.71)	(1.48)	(1.69)
Scholarships & Fellowships	-0.25	0.22	-1.20*	-1.68**
	(0.46)	(0.35)	(0.52)	(0.57)
Other Expenses	0.02	0.14	-0.45	-0.69
	(0.14)	(0.11)	(0.31)	(0.35)
Published In-State Tuition & Fees		-0.26		-1.12
		(0.27)		(1.05)
Admissions Rate		-0.05*		-0.05
		(0.02)		(0.03)
Year Fixed Effects	YES	YES	YES	YES
Constant	70.84***	77.29***	65.46***	75.35***
	(0.42)	(2.12)	(2.90)	(7.22)
Within R-Squared	0.06	0.08	0.11	0.15
Between R-Squared	0.00	0.01	0.19	0.22
Total R-Squared	0.00	0.00	0.09	0.10
F-Statistic	5.27	7.85	4.22	4.87
Observations	1450	1352	343	267
Groups	252	237	86	69

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

be forced to spend more on scholarships and fellowships to attract students, but these students may not actually want to stay at this institution and end up leaving, despite the initial financial incentive.

In the final subgroup analysis, Table 6.9 focuses on 6-year graduation rates. In the full sample, expenses were not significant at all, only the controls were significant. Indeed, only institutions with very high research activity and doctoral granting institutions showed statistically significant relationships between expenses and graduation rates. At very high research institutions, a $1000 increase in academic support per FTE was associated with a 0.11 percentage point increase in 6-year graduation rates. In practical terms, this is an incredibly small finding. These types of institutions average 6-year graduation rates of nearly 67% with a standard deviation of nearly 14%. This marginal improvement is likely not worth the added expense. Indeed, the relative lack of variation in graduation rates, coupled with the small coefficients, indicate that, in general, these relationships are very weak. For doctoral granting institutions, relationships emerge for research expenses per FTE and public service per FTE once controlling for tuition and admissions rates. An additional $1000 in research expenses per FTE are associated with a decrease to graduation rates of roughly 2.3 percentage points. This result could indicate that many doctoral granting institutions are trying to shift into a higher Carnegie classification that involves research. This would be consistent with the proposition by Morphew and Baker (2004) that institutions are trying to move into higher classifications and exhibit spending patterns that reflect those of the classification they are trying to move into. Therefore, as doctoral institutions, the number

Table 6.9

Results of Institutional Fixed Effects, 6-Year Graduation Rate by Carnegie Classification and Expenses per FTE for AY2006-2010 (in Thousands)

	RU/VH		RU/H		Doctoral	
Instructional Expenses	0.04	0.04	-0.13	-0.14	-0.48	-0.31
	(0.17)	(0.17)	(0.27)	(0.27)	(0.40)	(0.47)
Research Expenses	-0.06	-0.05	0.03	0.06	-2.32**	-2.31**
	(0.14)	(0.14)	(0.34)	(0.34)	(0.77)	(0.78)
Auxiliary Expenses	0.22	0.21	0.48	0.53	0.87	1.05
	(0.15)	(0.15)	(0.39)	(0.40)	(0.68)	(0.68)
Academic Support	0.11*	0.11*	-0.76	-0.73	-1.56	-1.51
	(0.05)	(0.05)	(0.65)	(0.66)	(1.39)	(1.48)
Institutional Support	0.37	0.35	-0.41	-0.54	0.27	0.27
	(0.24)	(0.25)	(0.46)	(0.46)	(0.95)	(1.08)
Public Service	-0.06	-0.06	0.80	0.90	5.47	6.95*
	(0.17)	(0.17)	(0.85)	(0.81)	(3.35)	(3.27)
Student Services	-1.01	-0.99	0.19	-0.00	0.89	0.46
	(1.03)	(1.02)	(0.65)	(0.70)	(3.01)	(2.85)
Scholarships & Fellowships	-0.14	-0.16	0.28	0.31	-0.14	-0.31
	(0.59)	(0.60)	(0.71)	(0.71)	(1.29)	(1.38)
Other Expenses	0.06	0.06	-0.07	-0.05	-0.19	-0.13
	(0.09)	(0.09)	(0.26)	(0.23)	(0.44)	(0.43)
Published In-State Tuition & Fees		-0.05		0.19*		0.45
		(0.32)		(0.09)		(0.84)
Admissions Rate		0.03		0.03		0.06*
		(0.03)		(0.02)		(0.03)
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Constant	63.40***	62.10***	50.93***	47.27***	44.69***	38.46***
	(0.98)	(3.02)	(0.73)	(1.56)	(1.86)	(6.28)
Within R-Squared	0.44	0.44	0.15	0.16	0.31	0.36
Between R-Squared	0.08	0.01	0.07	0.12	0.00	0.00
Total R-Squared	0.07	0.02	0.07	0.12	0.00	0.01
F-Statistic	16.44	14.08	2.61	2.93	13.65	27.99
Observations	300	300	325	325	122	122
Groups	61	61	66	66	28	28

Standard errors in parentheses
* $p<0.05$ ** $p<0.01$ *** $p<0.001$

Table 6.9 (Continued)

Results of Institutional Fixed Effects, 6-Year Graduation Rate by Carnegie Classification and Expenses per FTE for AY2006-2010 (in Thousands)

	Master's		Bachelor's	
Instructional Expenses	0.22 (0.20)	0.19 (0.20)	-0.80 (0.63)	-0.61 (0.72)
Research Expenses	0.03 (0.37)	0.10 (0.40)	-0.80 (1.28)	-0.63 (1.49)
Auxiliary Expenses	-0.23 (0.33)	-0.21 (0.33)	-0.74 (0.62)	-0.70 (0.60)
Academic Support	0.16 (0.60)	0.22 (0.59)	1.28 (0.74)	1.16 (0.72)
Institutional Support	-0.38 (0.36)	-0.27 (0.37)	0.05 (0.54)	0.06 (0.54)
Public Service	-0.47 (0.52)	-0.42 (0.54)	1.19 (1.93)	1.56 (1.89)
Student Services	0.59 (0.61)	0.38 (0.62)	1.42 (1.97)	0.89 (2.02)
Scholarship and Fellowships	-0.67 (0.65)	-0.78 (0.61)	-0.07 (0.72)	-0.06 (0.70)
Other Expenses	-0.06 (0.11)	-0.08 (0.10)	0.00 (0.41)	-0.01 (0.45)
Published In-State Tuition and Fees		1.18** (0.44)		-0.26 (1.12)
Admissions Rate		0.01 (0.01)		0.04 (0.04)
Year Fixed Effects	YES	YES	YES	YES
Constant	44.69*** (0.75)	36.78*** (2.79)	36.28*** (2.60)	36.11*** (7.03)
Within R-Squared	0.06	0.08	0.10	0.11
Between R-Squared	0.03	0.20	0.24	0.42
Total R-Squared	0.03	0.19	0.20	0.35
F-Statistic	3.08	3.54	1.60	1.47
Observations	1112	1112	214	214
Groups	235	235	62	62

Standard errors in parentheses
* $p<0.05$ ** $p<0.01$ *** $p<0.001$

of which is quite small, spend more on research, they may be shifting their focus away from the instruction of students to more research based activities. While research has a negative relationship with graduation, public service has a positive relationship. An increase of $1000 per FTE on public service is associated with increases in graduation rates of 6.95 percentage points, holding all else constant including tuition and admissions.

The results from these analyses are somewhat discouraging given the general lack of a relationship between expenses and outputs within institutions over time. When looking cross-sectionally, there are strong relationships between expenses and outputs, however, the problem with a cross-sectional approach is that it compares between institutions rather than within institution. In essence, a positive relationship between expenses and outcomes simply means that institutions that spend more on instruction are associated with more outputs. However, even many of the cross-sectional relationships disappear once disaggregating by Carnegie classification. Furthermore, the introduction of institutional and year fixed effects reveals that increasing or decreasing expenses within an institution typically does not affect outputs. This is likely because of two reasons. First, expenses do not tend to vary greatly from year to year. While there is a lot of cross-institutional variation in expenses, variation within an institution from year to year is relatively small, especially once adjusting for inflation. For example, in the year prior to academic year 2010, instruction at very high research institutions fell by 0.4%, research expenses rose by 2.2%, and public service rose by 2.0%. During the full span between 2005 and 2010, there was a 17.7% increase on instruction within very high research institutions, a 21.9% increase in expense on research, and 25% increase in public service. This illustrates the incremental nature of budgeting in that expenses only change by small amounts each year. The second reason for the potential lack of relationships is similar in that there is little annual variation in outputs within institutions, particularly retention and graduation rates. For example, there was roughly a 4% increase in the number of BA degrees awarded at research institutions between AY2009 and AY2010 but the increase in graduation rates was only 0.7%. Again, these are quite small figures given that they produce nearly 5000 BA degrees per year on average and report 6-year graduation rates of 67%.

These incremental changes suggest that institutions may be operating at a threshold. In essence, there may be an optimal mix between expenses and outputs. This would echo the findings of Powell, Gilleland, and Pearson (2012) that there is an optimal spending level and straying from this optimal point could harm efficiency despite marginal gains to output measures. Rather than thinking of a direct linear relationship between expenses and output, increases in annual expenses may simply because of the increasing costs of operation (Ehrenberg, 2002a). In particular, expenses on instruction and expenses on research increase because of previously identified forces such as cost disease, growth force, the academic ratchet, or the academic lattice (Massy, 1996; Massy & Wilger, 1992; Zemsky & Massy, 1990). Rather than expenses producing additional outputs, they simply are a reflection of the cost of doing business. As stated, spending more per year may not actually greatly impact outputs but could, instead, make an institution less efficient. This hypothesis will be tested using the frontier models that follow in the later sections of this chapter. However, the above models suggest that spending more on most institutional expenses is not likely to lead to improved student outputs.

School Level Expenses & Outputs

While no clear, consistent patterns emerged for institutions, the question remains as to whether schools or departments have a direct relationship between how they spend their money and the student outputs they are producing. For example, focusing strictly on academic departments cuts out the overhead and other expenditures that might be negatively impacting institutional outputs. At the school level, the faculty and staff directly involved in the instruction of their program might produce different results.

Cross-sectionally, schools with larger expenses on administrative salaries, wages, TA salaries, and miscellaneous expenses are associated with greater outputs on semester credit hours, majors, and degrees awarded. Faculty salaries per FTE are not significant in any of the models with the exception of BA majors, where an increase in faculty salaries of $1000 per FTE was associated with a decrease of roughly 34 undergraduate majors. However, this association diminished once controlling for TA salaries, tuition, and admissions rates.

These cross-sectional results for academic year 2010 reveal that administrative salaries are positively associated with semester credit hours, majors, and degrees, but this association fades once including controls for TA salaries, tuition, and admissions rates. For wages, the relationships are slightly more robust, with significant results across both models for BA degrees, BA semester credit hours, and total semester credit hours. In the other models for total degrees and majors, the significance again fades once including TA salary and controls for tuition and admissions rates. In essence, a $1000 increase in wages is associated with an additional 140 total semester credit hours once controlling for other expenses and controls, most of which is due to the 135 increase in semester credit

Table 6.10

School Level Outputs and Expenses (in Thousands)

	BA Degrees				Total Degrees			
Average Faculty Salary per FTE	-3.36	-1.32	-0.45	-0.34	-1.97	-0.71	-0.33	-0.31
	(1.81)	(2.20)	(0.47)	(0.50)	(2.17)	(2.68)	(0.69)	(0.71)
Average Classified Salary per FTE	2.56	-3.03	-2.15	-0.82	-4.50	-9.87	-2.19	-0.26
	(7.33)	(8.59)	(1.80)	(1.50)	(8.77)	(10.49)	(2.01)	(1.85)
Travel Expenses	1.35	1.76	-1.14	-0.54	0.11	0.83	-1.12	-0.74
	(1.26)	(1.69)	(0.75)	(0.99)	(1.50)	(2.06)	(0.88)	(1.00)
Miscellaneous Other Expenses	0.11	0.07	-0.09	-0.09	0.20*	0.18*	0.01	0.00
	(0.07)	(0.07)	(0.12)	(0.13)	(0.08)	(0.09)	(0.15)	(0.15)
Administration Salary	0.33**	-0.02	-0.11	-0.08	0.55***	0.25	-0.11	-0.07
	(0.11)	(0.23)	(0.09)	(0.08)	(0.13)	(0.28)	(0.10)	(0.10)
Wages	0.99**	0.83*	-0.04	-0.01	0.80*	0.78	-0.07	-0.03
	(0.33)	(0.36)	(0.04)	(0.05)	(0.39)	(0.44)	(0.06)	(0.09)
TA Salary		0.13		0.07*		0.09		0.08*
		(0.07)		(0.03)		(0.08)		(0.03)
Published In-State Tuition and Fees		54.88		24.34		73.54		53.45
		(56.49)		(29.47)		(69.02)		(36.53)
Admissions Rate		3.53		2.69		2.36		4.56
		(3.68)		(2.20)		(4.50)		(2.87)
Year Fixed Effects	NO	NO	YES	YES	NO	NO	YES	YES
Constant	298.41	-183.13	728.13***	230.94	531.74	24.08	886.65***	42.49
	(260.18)	(603.45)	(169.55)	(233.02)	(311.16)	(737.33)	(197.62)	(381.34)
Within R-Squared			0.13	0.20			0.14	0.21
Between R-Squared			0.35	0.15			0.40	0.38
Total R-Squared	0.53	0.57	0.32	0.15	0.59	0.60	0.30	0.36
F-Statistic	9.75	6.53	1.23	141.46	12.39	7.59	2.15	29.96
Academic Years	2010	2010	2008-2010	2008-2010	2010	2010	2008-2010	2008-2010
Observations	58	55	170	161	58	55	170	161
Groups	58	55	59	56	58	55	59	56

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.10 (Continued)

School Level Outputs and Expenses (in Thousands)

	BA Majors				Total Majors			
Average Faculty Salary per FTE	-33.71*	-10.84	-1.10	-1.19	-29.46	-6.58	-2.39	-2.69
	(16.42)	(19.16)	(6.26)	(6.15)	(18.17)	(21.79)	(7.27)	(7.00)
Average Classified Salary per FTE	-32.90	-64.77	-24.17	-9.07	-62.95	-103.34	-28.01	-7.25
	(66.43)	(74.95)	(16.05)	(10.38)	(73.49)	(85.22)	(19.05)	(12.38)
Travel Expenses	12.28	15.63	-11.03	-3.21	6.44	10.99	-14.55	-3.90
	(11.38)	(14.74)	(7.81)	(5.93)	(12.59)	(16.76)	(10.07)	(6.73)
Miscellaneous Other Expenses	0.56	0.26	0.06	0.18	0.65	0.33	0.08	0.25
	(0.59)	(0.62)	(0.17)	(0.19)	(0.66)	(0.70)	(0.17)	(0.20)
Administration Salary	3.68***	0.60	-0.61	-0.42	5.41***	2.09	-0.10	0.20
	(0.95)	(1.99)	(0.73)	(0.66)	(1.05)	(2.27)	(0.83)	(0.74)
Wages	8.16**	5.30	0.39	0.72	7.59*	5.10	0.08	0.56
	(2.98)	(3.16)	(0.95)	(0.97)	(3.29)	(3.60)	(1.06)	(1.08)
TA Salary		1.41*		0.78***		1.42*		1.11***
		(0.60)		(0.19)		(0.69)		(0.21)
Published In-State Tuition and Fees		241.28		-122.85		367.94		27.54
		(493.12)		(203.31)		(560.72)		(223.04)
Admissions Rate		53.64		19.15		49.79		25.54
		(32.12)		(13.52)		(36.52)		(15.51)
Year Fixed Effects	NO	NO	YES	YES	NO	NO	YES	YES
Constant	5752.09*	766.08	6493.70***	4632.93*	7117.77**	1819.30	8043.79***	4076.66
	(2358.01)	(5268.16)	(1188.25)	(1882.65)	(2608.48)	(5990.32)	(1415.77)	(2260.87)
Within R-Squared			0.17	0.21			0.20	0.26
Between R-Squared			0.28	0.51			0.14	0.59
Total R-Squared	0.54	0.61	0.20	0.50	0.60	0.64	0.07	0.58
F-Statistic	10.12	7.77	2.84	11.10	12.92	8.85	4.00	13.78
Academic Years	2010	2010	2008-2011	2008-2011	2010	2010	2008-2011	2008-2011
Observations	58	55	228	215	58	55	228	215
Groups	58	55	61	56	58	55	61	56

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.10 (Continued)

School Level Outputs and Expenses (in Thousands)

	BA SCH				Total SCH			
Average Faculty Salary per FTE	-0.83	-0.68	0.00	0.12	-0.87	-0.78	0.03	0.18
	(0.83)	(0.83)	(0.10)	(0.11)	(0.81)	(0.83)	(0.11)	(0.10)
Average Classified Salary per FTE	-15.31	-20.11	-1.78	-0.63	-16.57	-21.83*	-1.99	-0.54
	(10.38)	(10.82)	(1.02)	(0.64)	(10.16)	(10.72)	(1.13)	(0.71)
Travel Expenses	1.85	2.03	0.23	0.56	1.53	1.77	0.09	0.49
	(1.92)	(2.47)	(0.38)	(0.33)	(1.87)	(2.45)	(0.50)	(0.39)
Miscellaneous Other Expenses	-0.01	-0.04	-0.00	0.01	0.02	-0.01	0.00	0.01
	(0.09)	(0.09)	(0.02)	(0.02)	(0.09)	(0.09)	(0.02)	(0.02)
Administration Salary	0.50**	-0.15	0.03	0.04	0.64***	0.02	0.05	0.07
	(0.16)	(0.29)	(0.06)	(0.06)	(0.15)	(0.29)	(0.06)	(0.05)
Wages	1.80***	1.35*	-0.07	-0.04	1.79***	1.40**	-0.08	-0.04
	(0.50)	(0.52)	(0.06)	(0.05)	(0.49)	(0.52)	(0.07)	(0.05)
TA Salary		0.29**		0.05*		0.27**		0.07**
		(0.08)		(0.03)		(0.08)		(0.02)
Published In-State Tuition and Fees		64.57		-22.76		64.74		-13.87
		(80.79)		(18.27)		(80.04)		(19.22)
Admissions Rate		6.28		2.35		5.23		2.81*
		(5.31)		(1.24)		(5.26)		(1.28)
Year Fixed Effects	NO	NO	YES	YES	NO	NO	YES	YES
Constant	712.57	318.38	658.11***	592.31**	792.91*	474.55	755.21***	565.32**
	(382.16)	(885.52)	(58.10)	(208.54)	(373.79)	(877.35)	(66.08)	(200.87)
Within R-Squared			0.21	0.30			0.28	0.37
Between R-Squared			0.02	0.44			0.19	0.53
Total R-Squared	0.54	0.63	0.01	0.43	0.61	0.68	0.10	0.53
F-Statistic	10.00	8.03	1.86	2.49	13.63	9.93	3.12	3.50
Academic Years	2010	2010	2008-2011	2008-2011	2010	2010	2008-2011	2008-2011
Observations	59	53	231	209	59	53	231	209
Groups	59	53	62	55	59	53	62	55

Standard errors in parentheses

* p<0.05 ** p<0.01 *** p<0.001

Note: Semester Credit Hours measured in 100s.

hours. For BA degrees, the increase of $1000 in wages is associated with a 0.8 increase in degrees offered. The magnitudes of these could be even larger given a range of expenditures on wages up to $3,621,658. Again, these are only cross-sectional results and therefore only compare expenses and outputs between schools for a given year. This means that a school that spends $1,000,000 more on wages would be associated with 135,000 more undergraduate semester credit hours and 830 degrees, both of which are realistic given maximum values of these variables of 379,600 and 3,036 respectively.

However, the cross-sectional model only compares across schools rather than looking at changes within schools. Therefore, fixed effects are again the preferred model, though limited by the narrow time frames. These data, from the UT-System and Texas Higher Education Coordinating Board, span 2008 to 2010 for degrees offered and also include 2011 data for majors and semester credit hours. Again, the lack of variation between years and the shorter timespan threaten the identification of significant results. Indeed, the only significant results for the fixed effects regressions in Table 6.10 were those with TA salary, which were positive and significant in every model on the various outputs. In addition, the admissions rate was significant in the full model on total semester credit hours offered. Here, increasing the total amount paid to teaching assistants by $1000 is associated with roughly 0.08 more total degrees and 0.07 BA degrees. Similarly, it is associated with 0.78 more undergraduate majors and an increase of 1.11 total majors. Semester credit hours are also expected to increase by roughly 5 BA credit hours and 7 total semester credit hours. Again, practical terms can be employed where TA salaries were seen to increase from year to year by over $1000 in 71 instances, over $10,000 in 47 instances, and over $100,000 in 25 instances. Therefore, schools which are able to increase their TA salaries by over $10,000, which are primarily schools of sciences and schools of engineering, are likely to see their outputs improve by roughly 1 undergraduate degree, 8 undergraduate majors, and 50 undergraduate credit hours.

Yet, here again, the issue of simultaneity arises. In institutional models, revenues are known before expenses can be allocated. While revenues have historically been allocated based on enrollments and are increasingly becoming based on performance, institutions are able to internally budget their general funds as they desire. At the school level, and later the departmental level, the regressors may not be the best mechanisms of production. For example, while TA salaries were significantly related to degrees, majors, and semester credit hours, it could be argued that increasing TA salaries does not create these outputs. Rather, an increase in student demand could explain why more money is needed for teaching assistants. In essence, teaching assistants are able to teach classes, thereby increasing semester credit hours and helping students major and graduate in their field, but the students themselves could be driving this relationship, not the administrators of the department. To examine this, I progressively move majors and semester credit hours to the right hand side of the equations. First, an increased number of semester credit hours would be associated with more majors and, ultimately, more degrees offered. Once including these as regressors, the relationships for the expense variables change. This can be seen in Table 6.11.

In these models, semester credit hours were not significant in any model once controlling for the number of majors. Therefore, it was excluded from the model. The number of majors is the primary variable of interest, with a coefficient equating to roughly 1.0 to 1.4 additional degrees for every 10 additional majors across every

Table 6.11

School Level Outputs and Expenses (in Thousands) after Controlling for Majors

	BA Degrees				Total Degrees			
Average Faculty Salary per FTE	-0.04	-0.18	-0.28	-0.15	1.07	0.02	-0.22	-0.15
	(0.86)	(0.89)	(0.37)	(0.38)	(1.13)	(1.17)	(0.47)	(0.50)
Average Classified Salary per FTE	5.80	3.77	-0.18	-0.14	2.00	1.61	0.25	0.11
	(3.36)	(3.51)	(0.65)	(0.61)	(4.47)	(4.66)	(1.03)	(0.94)
Travel Expenses	0.15	0.12	0.58*	0.90*	-0.56	-0.39	1.20*	0.86
	(0.58)	(0.69)	(0.25)	(0.35)	(0.76)	(0.91)	(0.52)	(0.53)
Miscellaneous Other Expenses	0.05	0.04	-0.02	-0.02	0.14**	0.14***	0.06	0.05
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
Administration Salary	-0.03	-0.08	-0.06*	-0.06*	-0.01	0.02	-0.06	-0.07
	(0.05)	(0.09)	(0.03)	(0.03)	(0.08)	(0.12)	(0.04)	(0.04)
Wages	0.19	0.28	-0.03	-0.03	0.02	0.22	-0.02	-0.03
	(0.16)	(0.15)	(0.04)	(0.03)	(0.21)	(0.20)	(0.04)	(0.04)
Number of Majors	0.10***	0.10***	0.11***	0.11***	0.10***	0.11***	0.13***	0.14***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
TA Salary		-0.02		0.02		-0.07		-0.02
		(0.03)		(0.01)		(0.04)		(0.02)
Published In-State Tuition and Fees		29.56		17.38		32.70		34.04
		(22.99)		(18.25)		(30.31)		(24.63)
Admissions Rate		-2.09		-0.09		-3.16		0.57
		(1.54)		(0.39)		(2.00)		(0.68)
Year Fixed Effects	NO	NO	YES	YES	NO	NO	YES	YES
Constant	-267.33*	-263.50	-9.88	-173.12	-202.86	-177.86	-191.09	-448.13
	(125.85)	(245.06)	(75.30)	(157.35)	(168.70)	(322.61)	(177.89)	(273.46)
Within R-Squared			0.85	0.86			0.78	0.79
Between R-Squared			0.85	0.89			0.86	0.89
Total R-Squared	0.90	0.93	0.86	0.89	0.90	0.93	0.86	0.89
F-Statistic	67.52	58.53	27.24	95.15	62.68	54.89	25.63	114.43
Academic Years	2010	2010	2008-2010	2008-2010	2010	2010	2008-2010	2008-2010
Observations	58	55	170	161	58	55	170	161
Groups	58	55	59	56	58	55	59	56

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

specification, both for undergraduate and total degrees completed and in the cross-sectional and fixed effects results. In addition, the cross-sectional results for the total number of degrees completed showed a positive relationship where $1000 more in miscellaneous expenses was associated with 0.14 more degrees. In the fixed effects regressions, travel expenses were positively associated with undergraduate and total degrees while administrative salaries had a negative relationship with undergraduate degrees. In general, however, the models at the school level suggest that expenses are only loosely associated with various school level outputs and that the number of majors at the various levels are the most robust predictor of eventual degree attainment. This is consistent to the general findings at the institutional level despite using different data and a different level of analysis.

Departmental Level Expenses & Outputs

The final analysis between expenditures and outputs occurs at the departmental level. Again, this is looking for subunit relationships between the faculty and staff directly involved in the production of student degrees within their departments. One advantage over the school level data is that there is greater power. At the school level, only 53 to 62 schools are available in the analyses, depending on the model specification. However, there are 232 to 262 departments, which allows not only for greater power in the full departmental analysis but also for analyses to be conducted separately by different types of departments. For example, I am able to compare a multitude of different science and mathematics departments against each other by running a separate regression from other departments like humanities. These separate regressions assume that there are differences across departments in the production of degrees. Science and mathematics departments have descriptively been shown to have higher expenses on classified staff, which may be due to the need for lab assistants. Humanities, however, do not have the same costs in their departments and degree production. Therefore, analyses would only want to compare departments of a single type.

To begin, the full sample is again presented. Given the knowledge of the relationships at the school level, the number of majors is included in each model of degree attainment. In these regressions, expenses are only statistically significant in the cross sectional analysis for AY2010. For the total number of degrees awarded, in particular, there is a positive and statistically significant relationship between the average faculty salary per FTE and the total number of degrees awarded. This relationship, one of the few relationships significant for faculty and instruction, indicates that schools that spent more on faculty salaries produced more degrees. This is likely due to the wage premium at research institutions like UT-Austin, the additional degrees produced in these schools for MA and doctoral students, and the nature of the department itself. In these departments, average faculty salary is higher to attract more prestigious faculty and they also have the highest enrollment and degree production. Even after controlling for majors, the coefficient indicates that $1000 more in faculty salary per FTE is associated with 0.58 more degrees awarded. However, the fixed effects models only show patterns with the number of majors. The same pattern holds as with the other analyses, with 10 addition majors being associated with 1 to 1.2 additional degrees awarded. When looking at the total number of degrees, published in-state tuition and fees is also statistically significant. Raising tuition by $1000 is associated with an increase in total

Table 6.12

Departmental Level Outputs and Expenses

	BA Degrees					
Average Faculty Salary per FTE	0.17	-0.08	0.15	-0.08	0.22	-0.08
	(0.13)	(0.09)	(0.13)	(0.09)	(0.13)	(0.11)
Average Classified Salary per FTE	0.47	0.01	0.72	0.00	-0.66	0.01
	(0.48)	(0.03)	(0.50)	(0.03)	(0.58)	(0.03)
Travel Expenses	-0.24	0.33	-0.20	0.33	0.01	0.49
	(0.45)	(0.63)	(0.45)	(0.63)	(0.69)	(0.71)
Miscellaneous Other Expenses	-0.37	0.12	-0.38*	0.12	-0.32	0.10
	(0.19)	(0.15)	(0.19)	(0.15)	(0.19)	(0.15)
Administration Salary	-0.02	-0.03	-0.02	-0.03	-0.03	-0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Wages	-0.02	-0.10	-0.02	-0.11	-0.12	-0.13
	(0.19)	(0.10)	(0.19)	(0.11)	(0.21)	(0.13)
TA Salary			-0.05	0.02	-0.09**	0.03
			(0.03)	(0.05)	(0.03)	(0.05)
Published In-State Tuition & Fees					11.55**	7.55
					(3.52)	(4.58)
Admissions Rate					-0.47	-0.03
					(0.29)	(0.17)
Student-Faculty Ratio					0.45	0.94
					(1.66)	(1.40)
Undergraduate Majors	0.10***	0.11***	0.10***	0.11***	0.10***	0.11***
	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)
Year Fixed Effects	NO	YES	NO	YES	NO	YES
Constant	-31.17*	0.83	-35.23*	0.12	-59.76	-71.69
	(15.75)	(14.68)	(15.86)	(15.08)	(41.74)	(44.15)
Within R-Squared		0.80		0.80		0.81
Between R-Squared		0.79		0.79		0.80
Total R-Squared	0.84	0.79	0.84	0.79	0.86	0.80
F-Statistic	181.99	17.83	160.92	16.78	122.36	14.21
Academic Years	2010	2008-2010	2010	2008-2010	2010	2008-2010
Observations	248	734	248	734	230	683
Groups	248	251	248	251	230	232

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.12 (Continued)

Departmental Level Outputs and Expenses

	Total Degrees					
Average Faculty Salary per FTE	0.51**	0.03	0.48**	0.02	0.58**	0.02
	(0.17)	(0.10)	(0.17)	(0.10)	(0.17)	(0.11)
Average Classified Salary per FTE	-0.22	-0.00	0.06	-0.00	-2.13**	0.01
	(0.64)	(0.04)	(0.67)	(0.04)	(0.77)	(0.05)
Travel Expenses	-0.68	0.35	-0.64	0.36	-0.30	0.29
	(0.60)	(0.57)	(0.60)	(0.57)	(0.91)	(0.63)
Miscellaneous Other Expenses	-0.47	0.24	-0.49	0.24	-0.42	0.25
	(0.25)	(0.19)	(0.25)	(0.19)	(0.25)	(0.21)
Administration Salary	0.01	-0.03	0.02	-0.03	-0.01	-0.03
	(0.04)	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)
Wages	0.20	-0.11	0.20	-0.12	0.15	-0.09
	(0.25)	(0.12)	(0.25)	(0.13)	(0.28)	(0.16)
TA Salary			-0.06	0.03	-0.12**	0.04
			(0.04)	(0.04)	(0.04)	(0.04)
Published In-State Tuition & Fees					18.09***	12.39*
					(4.65)	(5.98)
Admissions Rate					-0.80*	0.11
					(0.38)	(0.20)
Student-Faculty Ratio					2.35	2.11
					(2.20)	(1.95)
Total Number of Majors	0.10***	0.12***	0.10***	0.12***	0.10***	0.12***
	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)
Year Fixed Effects	NO	YES	NO	YES	NO	YES
Constant	-30.43	-17.95	-35.10	-18.87	-98.24	-158.32**
	(20.95)	(16.06)	(21.14)	(15.39)	(55.07)	(56.10)
Within R-Squared		0.75		0.75		0.76
Between R-Squared		0.77		0.77		0.79
Total R-Squared	0.82	0.77	0.82	0.77	0.85	0.78
F-Statistic	157.86	30.11	139.05	42.06	108.25	50.96
Academic Years	2010	2008-2010	2010	2008-2010	2010	2008-2010
Observations	248	734	248	734	230	683
Groups	248	251	248	251	230	232

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

degrees by 12.39. This may be an indicator that students respond to rising tuition prices by graduating rather than paying the higher price for an addition semester or year.

The final analysis in the relationships between outputs and expenses, Table 6.13, takes advantage of the greater number of observations at the departmental level to look at differences between different types of departments, as described previously. Much like the separation by Carnegie classification in the institutional analyses, this runs separate regressions for departmental type. Again, faculty salaries are not significantly related to degree production for any departmental type. Classified salaries are significant in schools of health and nursing, with a $1000 increase in salaries per FTE being associated with approximately 5 more degrees awarded. Travel, administrative salaries, and wages, where significant, all had negative relationships with the number of degrees awarded. The expense item that was significant across the various models was on miscellaneous expenses. In schools of health and nursing and schools of behavioral and social sciences, the relationships were negative. However, there was a positive relationship with degree completions for arts and engineering degrees. Business degrees, which were not significant once controlling for tuition and admissions rate, saw the highest coefficients in the simplified models with an additional $1000 in miscellaneous expenses being associated with approximately 78 more degrees awarded. In general, the most robust relationship across the institutional types is again the number of majors in a department and their association with the number of degrees awarded. As with the institutional and school level analyses, there was a general lack of a robust relationship between expenses and outputs at the departmental level.

Table 6.13

Results of Departmental Fixed Effects, Outputs and Expenses by Departmental Type (AY2008-2010)

	Science & Math		Humanities		Engineering	
Average Faculty Salary per FTE	-0.20	-0.21	-0.04	-0.01	-0.02	-0.12
	(0.19)	(0.21)	(0.08)	(0.09)	(0.25)	(0.29)
Average Classified Salary per FTE	-0.01	0.00	-0.17	-0.08	0.05	0.68
	(0.01)	(0.01)	(0.19)	(0.20)	(0.03)	(0.73)
Travel Expenses	0.41	-0.02	-0.19	0.18	-2.26*	-1.62
	(0.21)	(0.30)	(0.55)	(1.03)	(1.02)	(1.23)
Miscellaneous Other Expenses	-0.03	0.12	-0.09	-0.10	0.81***	0.78***
	(0.08)	(0.13)	(0.12)	(0.12)	(0.16)	(0.18)
Administration Salary	0.16	0.16	0.04	-0.01	-0.06	-0.07
	(0.20)	(0.18)	(0.28)	(0.26)	(0.05)	(0.05)
Wages	-0.05	0.07	0.28	0.31	-0.31*	-0.33*
	(0.05)	(0.11)	(0.27)	(0.26)	(0.14)	(0.14)
Total Number of Majors	-0.00	-0.01*	0.11***	0.11***	0.08***	0.09***
	(0.00)	(0.00)	(0.02)	(0.03)	(0.02)	(0.02)
TA Salary	0.04	-0.00	-0.63	-0.38	0.02	0.01
	(0.02)	(0.03)	(2.89)	(2.65)	(0.04)	(0.04)
Published In-State Tuition and Fees		1.48		5.05		-2.48
		(6.41)		(8.49)		(6.92)
Admissions Rate		0.48**		0.23		-0.13
		(0.16)		(0.21)		(0.18)
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Constant	115.75***	84.24	32.09	-30.25	13.50	20.48
	(17.27)	(65.14)	(69.74)	(88.40)	(37.46)	(66.11)
Within R-Squared	0.21	0.32	0.32	0.33	0.41	0.42
Between R-Squared	0.25	0.43	0.56	0.77	0.82	0.82
Total R-Squared	0.22	0.39	0.55	0.76	0.81	0.81
F-Statistic	4.94	35.99	10.11	10.74	19.46	19.64
Observations	95	83	114	105	107	103
Groups	32	28	38	35	37	35

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.13 (Continued)

Results of Departmental Fixed Effects, Outputs and Expenses by Departmental Type (AY2008-2010)

	Behavioral & Social Sciences		Business	
Average Faculty Salary per FTE	0.03	0.15	0.01	0.04
	(0.40)	(0.46)	(0.06)	(0.05)
Average Classified Salary per FTE	0.09	0.35	0.82	0.92
	(1.24)	(1.26)	(1.16)	(1.12)
Travel Expenses	1.24	1.14	-0.54	-1.26
	(1.53)	(1.47)	(1.47)	(1.75)
Miscellaneous Other Expenses	-1.70**	-1.77**	78.19*	48.30
	(0.58)	(0.61)	(32.21)	(49.51)
Administration Salary	-0.25*	-0.25*	0.39	-0.10
	(0.10)	(0.10)	(1.24)	(1.00)
Wages	0.35	0.37	1.25	1.49
	(0.30)	(0.31)	(0.79)	(0.76)
Total Number of Majors	0.12***	0.12***	0.22***	0.22***
	(0.02)	(0.03)	(0.04)	(0.04)
TA Salary	-0.41	-0.11	-0.33	-0.42*
	(1.13)	(1.04)	(0.22)	(0.17)
Published In-State Tuition and Fees		5.20		29.87
		(5.65)		(24.78)
Admissions Rate		0.22		0.59
		(0.22)		(0.62)
Year Fixed Effects	YES	YES	YES	YES
Constant	13.11	-61.47	-228.36**	-451.73*
	(44.53)	(78.26)	(80.52)	(188.62)
Within R-Squared	0.45	0.46	0.61	0.64
Between R-Squared	0.73	0.80	0.13	0.34
Total R-Squared	0.73	0.79	0.12	0.32
F-Statistic	5.21	4.52	38.99	31.90
Observations	126	117	68	68
Groups	42	39	24	24

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.13 (Continued)

Results of Departmental Fixed Effects, Outputs and Expenses by Departmental Type (AY2008-2010)

	Arts		Health & Nursing	
Average Faculty Salary per FTE	-0.49 (0.49)	-0.77 (0.46)	0.01 (0.15)	-0.04 (0.17)
Average Classified Salary per FTE	1.32 (1.98)	1.72 (2.73)	5.37* (2.02)	5.27* (2.00)
Travel Expenses	-0.43 (0.79)	-0.08 (0.82)	-2.39 (5.43)	-1.63 (5.14)
Miscellaneous Other Expenses	0.35** (0.10)	-4.37 (14.91)	-0.42* (0.17)	-0.41* (0.18)
Administration Salary	0.26 (0.45)	0.43 (0.60)	-0.60 (0.38)	-0.62 (0.36)
Wages	0.55 (0.38)	0.60 (0.42)	0.47 (1.13)	0.56 (1.12)
Total Number of Majors	0.08 (0.05)	0.11 (0.07)	0.12*** (0.02)	0.12*** (0.02)
TA Salary	-3.48 (2.23)	-4.32 (2.89)	0.44 (0.95)	0.36 (0.94)
Published In-State Tuition and Fees		-0.60 (9.47)		25.05 (17.79)
Admissions Rate		-0.25 (0.29)		0.73 (0.61)
Year Fixed Effects	YES	YES	YES	YES
Constant	322.87* (135.50)	427.37 (225.53)	-159.20 (92.98)	-360.27 (186.58)
Within R-Squared	0.44	0.41	0.98	0.98
Between R-Squared	0.53	0.52	0.84	0.84
Total R-Squared	0.53	0.52	0.86	0.86
F-Statistic	10202.52	6113634.68	12649.64	17280.48
Observations	46	43	63	60
Groups	16	15	21	20

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Institutional Level Revenues & Outputs

In the first stage of the production function, significant relationships were seen between revenues and expenses at the institutional level. In the second stage, the relationship between expenses and outputs were largely not significant, even across the various datasets, units of analysis, and subunit analyses. The third relationship identified in the simplified production function (Figure 5.1) is the indirect relationship between revenues and outputs. Given the previous results, if these analyses are significant, it could be posited that either institutions are inefficient in their operations, which can be tested in the frontier analyses, or that institutions as a whole are the mechanism of production and cannot be separated into its subunit components. This later statement essentially defines institutions as a whole being greater than the sum of its parts.

Indeed, Table 6.14 reveals significant relationships between revenue sources and outputs as the result of fixed effects regressions. State appropriations are negatively associated with the production of undergraduate degrees while tuition and fee revenues per FTE are associated with increases in degrees and graduation rates. A $1000 increase in state appropriations per student decreases BA degrees by roughly 12 while a $1000 increase in tuition and fee revenues per student is associated with approximately 50 more BA degrees, 29 more MA degrees, and improves both 4-year and 6-year graduation rates by 0.6 percentage points. In addition, federal operating grants and contracts per FTE are associated with an increase in MA degrees awarded. This may be due to additional funding that can be spent on teaching and research assistantships to help master's students pay for their degrees. However, it should be noted that these relationships do not fully persist when separate regressions are run by Carnegie classification. The fixed

Table 6.14

Results of Institutional Fixed Effects, Outputs and Revenues per FTE (in Thousands)

	BA Degrees		MA Degrees		FT Retention Rate	
State Appropriations	-12.02**	-12.13*	-3.73	-5.49	-0.25	-0.20
	(4.40)	(4.87)	(2.89)	(2.84)	(0.15)	(0.15)
Tuition and Fee Revenues	48.46**	51.53**	27.79**	29.57***	-0.57	-0.60
	(17.14)	(19.31)	(8.86)	(7.93)	(0.35)	(0.37)
Federal Operating Grants and Contracts	16.15	15.38	11.99*	13.23*	-0.57*	-0.48*
	(8.47)	(10.74)	(5.01)	(5.12)	(0.22)	(0.23)
Sales and Services of Auxiliary Enterprises	-39.82*	-39.91*	-7.83	-6.54	-0.31	-0.31
	(17.78)	(19.36)	(8.85)	(9.37)	(0.21)	(0.22)
Other Sources of Operating Revenues	2.42	2.84	-2.70	-2.99	-0.09	-0.06
	(4.86)	(4.98)	(2.12)	(2.17)	(0.11)	(0.10)
Other Sources of Nonoperating Revenues	-5.07	-5.50	2.67	2.37	-0.08	-0.09
	(7.71)	(8.90)	(4.18)	(4.33)	(0.09)	(0.10)
Admissions Rate		-0.54		0.00		-0.04**
		(0.46)		(0.23)		(0.01)
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Constant	1944.04***	2089.66***	607.91***	632.57***	73.01***	76.97***
	(4.72)	(32.50)	(3.77)	(16.62)	(0.15)	(0.96)
Within R-Squared	0.23	0.24	0.14	0.15	0.07	0.07
Between R-Squared	0.10	0.09	0.28	0.25	0.24	0.23
Total R-Squared	0.08	0.08	0.25	0.23	0.18	0.17
F-Statistic	20.88	18.38	15.47	13.86	10.13	11.95
Years	2005-2010	2005-2010	2005-2010	2005-2010	2005-2010	2005-2010
Observations	2769	2522	2769	2522	2736	2519
Groups	504	464	504	464	497	461

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table 6.14 (Continued)

Results of Institutional Fixed Effects, Outputs and Revenues per FTE (in Thousands)

	4-Year Graduation Rate		6-Year Graduation Rate	
State Appropriations	0.10	0.10	-0.12	-0.12
	(0.09)	(0.09)	(0.11)	(0.11)
Tuition and Fee Revenues	0.63***	0.63***	0.61***	0.61***
	(0.16)	(0.16)	(0.17)	(0.17)
Federal Operating Grants and Contracts	0.06	0.06	0.15	0.14
	(0.14)	(0.14)	(0.14)	(0.14)
Sales and Services of Auxiliary Enterprises	-0.03	-0.03	0.02	0.04
	(0.36)	(0.36)	(0.35)	(0.35)
Other Sources of Operating Revenues	-0.01	-0.01	-0.13	-0.13
	(0.05)	(0.05)	(0.09)	(0.09)
Other Sources of Nonoperating Revenues	-0.05	-0.05	-0.11	-0.10
	(0.10)	(0.10)	(0.12)	(0.12)
Admissions Rate		0.01		0.02**
		(0.01)		(0.01)
Year Fixed Effects	YES	YES	YES	YES
Constant	24.07***	23.65***	47.78***	46.09***
	(0.13)	(0.71)	(0.12)	(0.64)
Within R-Squared	0.08	0.09	0.08	0.08
Between R-Squared	0.32	0.31	0.28	0.24
Total R-Squared	0.29	0.28	0.26	0.22
F-Statistic	9.19	8.38	7.96	7.89
Years	2006-2010	2006-2010	2006-2010	2006-2010
Observations	2073	2073	2073	2073
Groups	452	452	452	452

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

effects model looks at changes within an institution, but the effects are diminished when only compared to institutions of the same type.

These findings are important because it reveals that the sources of revenues are indeed related to outputs. This suggests that despite expenses not having a direct relationship with outputs, the source of funding can affect outputs. Institutional budgeting and decision making may not be the best way of altering outputs. Instead, the decision falls to students. As tuition and fees increase, graduation rates and the number of degrees awarded both increase, meaning that students may be choosing to finish their degrees and do so more quickly because of the added expenses associated with additional studies. Increases in state appropriations, however, may help subsidize the cost that would otherwise be transferred to students and therefore slows the degree attainment process. Thus, students may be the ultimate producers of retention, degree completion, and time to degree, a finding consistent with that found by Titus (2006), who found that an individual's probability of graduating was linked to an institution's reliance on tuition and fee revenues. Altering the mix of tuition, state support, and financial aid may therefore be more effective policy levers than asking institutions to adopt academic or student service programs. However, additional research using student level data is needed in order to fully explore these relationships and the associated outcomes. The analyses of the present study simply present results based on institutional processes.

Stochastic Frontier Models

The relationships presented previously indicate that there are relationships between revenues and expenses and that there are relationships between revenues and outputs, but no direct link between institutional, school, or departmental expenses and outputs. As mentioned, this suggests that institutions as a whole are the production mechanism, but outputs may ultimately be determined by students. In essence, students may be more motivated by their payment and financial aid policy options more so than whatever institutions are able to do through instruction, academic support, or student services. Given the lack of findings between expenses and outputs, it then calls into question whether institutions are spending too much on their various programs. Institutions could spend ever increasing amounts on instruction, research, and public services with only marginal returns. Therefore, there is likely an optimal mix in spending and the production of outputs (Powell, Gilleland, & Pearson, 2012). Spending too much or too little would indicate there are inefficiencies in spending patterns in relation to outputs. If outputs can only be marginally affected by institutional spending, institutions should be trying to cut expenses to a level that keeps outputs constant but reduces expenditures as much as possible. Institutions may be overspending and might benefit by cutting expenses and reducing their reliance on state appropriations and tuition while keeping outputs roughly the same. Alternatively, institutions may be underspending in certain areas as well. If they are not operating at the optimal input to output mix, they could benefit by boosting their expenses in certain areas and produce greater outputs in a more efficient manner.

Following this line of reasoning, this section presents results from stochastic frontier analysis to look at the technical efficiency of institutions, department, and schools in their production of outputs. Rather than addressing the relationship between inputs and outputs, what Powell, Gilleland, and Pearson (2012) call effectiveness, this examines whether institutions are efficient in producing the outputs with an optimal mix of inputs given the performance of similar institutions. As outlined in the previous chapter, stochastic frontier analysis is a parametric approach with a specified model. The strengths of this approach is that it produces traditional measures of statistical significance and can use fixed effects to determine if institutions are moving closer to, or away from, the frontier. Alternatively, data envelopment analysis, which will be presented in the next section, is a cross-sectional approach that is non-parametric. This technique allows for the data itself to determine the frontier and institutions to be directly compared to each other. In addition, it allows for the introduction of multiple inputs and multiple outputs, unlike stochastic frontier analysis.

In these models, I am restricted by the number of variables that can be used in the regressions due to sample size (Avkrian, 2001) and computing constraints, and I therefore focus on state appropriations, tuition and fees, and federal operating grants and contracts for revenues. For expenses, I include instruction, research, academic support, institutional support, public service, student services, and scholarships and fellowships. Finally, I again include controls for tuition and admissions rates, where applicable. In the stochastic frontier analyses, the results for usigma and vsigma indicate the separation of the error term into measures of efficiency. These are translated into the tables of technical efficiency. The measures of technical efficiency range from 0 to 1 with values closest to 1 being the most efficient and closest to the frontier. For data envelopment analysis, there is no parametric model and therefore the results only include a ranking based on technical efficiency.

In general, the relationships presented in these analyses are different from the previous models because I only control for state appropriations, tuition, and federal grants rather than including every revenue source. This is because the stochastic frontier model and data envelopment models are restricted by the number of regressors that can be used in a model as a function of the sample size. When breaking out the results by Carnegie classification or department type, a key control used in the previous results, the sample sizes shrink and therefore limit the number of regressors that can be included. The second noticeable difference is the use of logged values instead of FTE values. This is again because of the mathematical structure of the frontier models. Therefore, I use a setup that is consistent across both stochastic frontier and data envelopment analyses.

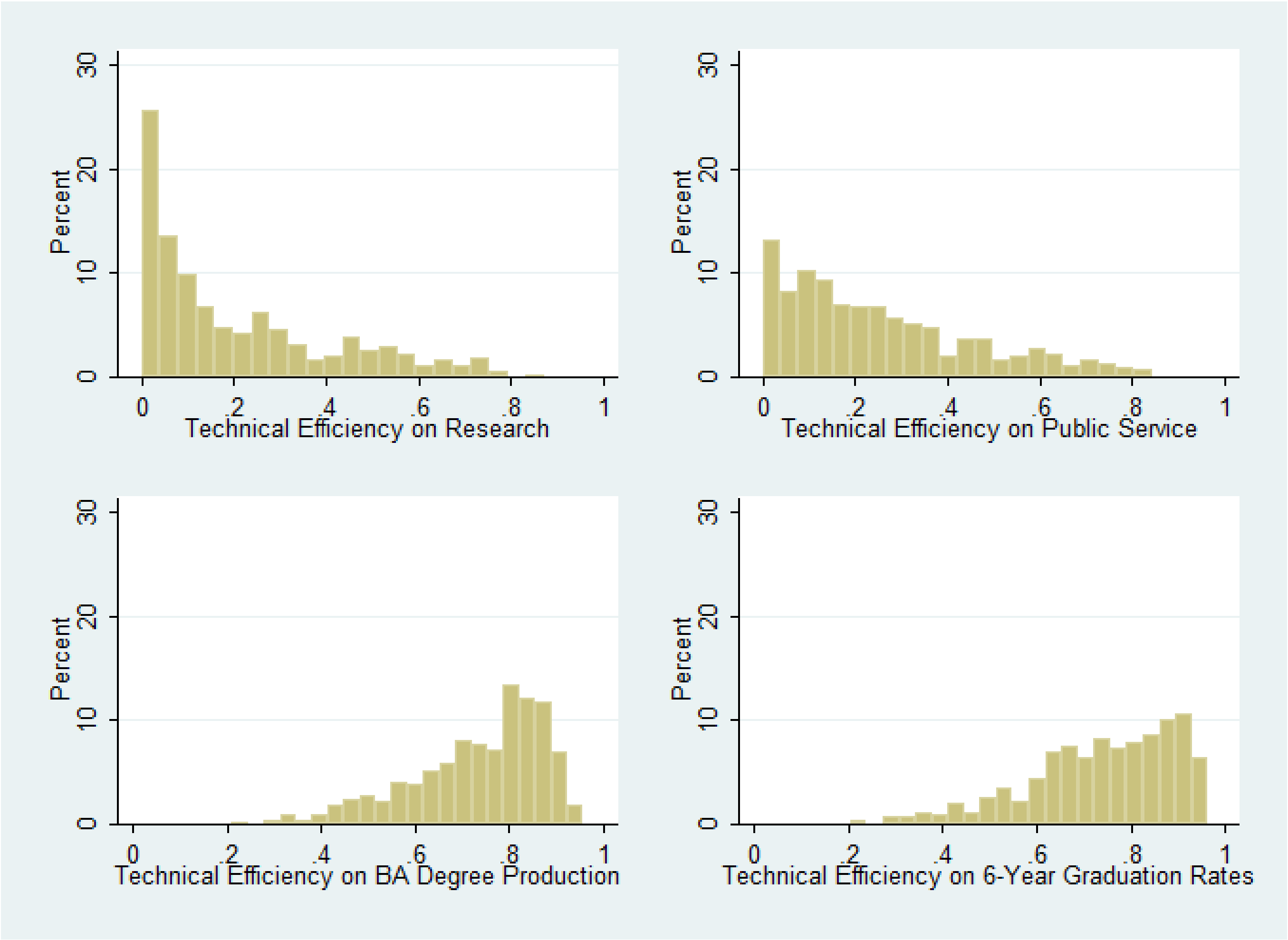
Institutional Level Stochastic Frontier Analysis

To begin, stochastic frontier analyses are presented for institutions, schools, and departments both cross-sectionally in AY2010 and using fixed effects. The stochastic frontier analyses present two outputs. The first output is a table of coefficients based on the specified model. This is similar to typical regressions using OLS or fixed effects. The coefficients are listed along with traditional levels of statistical significance. These tables are presented in the appendix since they mirror the models previously presented. In those tables presented in A.3, similar results emerge as those seen previously in looking at the relationships between inputs, expenses, and outputs. Indeed, tuition revenues are associated with every expense and output item. A 1% increase in tuition is associated with a 1.1% increase in expenses on research, a 0.93% increase in public service, and a 0.81% increase in instruction after holding all else constant. State appropriations show similar positive relationships, though much weaker, for every item except graduation rates. For student outputs, the results show that institutions that have a less selective admissions process are associated with greater numbers of undergraduate degrees while those that have a more selective admission process are associated with higher retention and graduation rates. These findings are not surprising given that large comprehensive and open access institutions have lower admissions standards than selective institutions and yet produce large numbers of degrees. Alternatively, more selective institutions have higher retention and graduation rates. In addition, institutions that spend more on instruction are positively associated with every student output, especially in degrees awarded. Similarly, expenses in academic support and student services help improve the number of undergraduate degrees awarded, though expenses on student services slows the time to degree attainment. Alternatively, research expenses have no direct relationship with student outputs. Again, these findings make sense given the previous findings and targeted nature of the expenses and institutions.

The second output of stochastic frontier analysis is a listing of technical efficiencies, showing which institutions are most efficient and which institutions are furthest from the frontier. These scores are displayed in Figure 6.5 for select models using the cross-sectional institutional comparison in AY2010. This figure graphically represents the distribution of technical efficiency scores for the relationships between revenues and expenses on research and public service once controlling for admissions rates. In addition, it presents the scores from two models on expenses to student outcomes on undergraduate degrees produced and 6-year graduation rates. It should also

Figure 6.5

Results of Stochastic Frontier Analysis by Institution, Distributions of Technical Efficiency



be noted that in the analysis on revenues to instructional expenses, there was very little variation in the technical efficiencies once controlling for student inputs.

In the results on research expenditures, those schools focusing on science, mining, and forestry performed the best. The New Mexico Institute of Mining and Technology, SUNY College of Environmental Science and Forestry, New Mexico State University, University of Wyoming, Montana Tech, and Colorado School of Mines all recorded technical efficiency scores over 0.70. However, non-research institutions such as Winston-Salem State University, Metropolitan State University, University of Arkansas at Pine Bluff, and New College of Florida also fared well. This suggests that while the research output at these institutions may be small, it is a big accomplishment given the limited resources provided to conduct research. In essence, they are acting efficiently given the small amount of resources they have. For public service, land grants, state flagships, and research institutions tended to have the highest efficiency scores. These included the University of Arkansas at Pine Bluff, University of New Mexico, University of Utah, and University of Kentucky all recording efficiency scores over 0.80. However, smaller schools, such as the Oregon Institute of Technology, again make an appearance in the top ranks of efficiency scores because of the output relative to their inputs.

Turning to the models on student outputs, the number of undergraduate degrees awarded showed high technical efficiency at larger schools with an instructional focus. The University of Central Florida, one of the largest institutions in the country, recorded a very high score of 0.94, indicating its ability to produce a large numbers of graduates with relatively low expenses. Alternatively, the California Maritime Academy produced few graduates but, when looking at the 6-year graduation rates, did so in an extremely timely fashion. Indeed, while it had one of the lowest scores in degree completion at 0.31, its graduates completed their degrees very quickly given the resources, with an efficiency score of 0.96.

When comparing the distribution of scores, output measures such as degree production and graduation rates were clustered toward the higher end of the scale with efficiency scores well above 0.60. Efficiency scores for expenditures on research and public service, however, were clustered toward lower scores. This might suggest that when comparing institutions of different types, the outputs relating to instruction place institutions on more equal footing. When trying to compare different types of institutions on their focus on research and public service, which, unlike instruction, is not a uniform interest across the sector, the scores are more varied and less efficient.

In general, whether looking at expenses or student outputs, BA and MA granting institutions were often at the bottom of the technical efficiency scores. This could be for a number of reasons. First, they may not have identified a good mix of inputs to outputs. In essence, they are either producing too few outputs or they are receiving too much or too little funding. However, the second reason is because the comparisons are for all institutions rather than narrowing by institutional type. Once separating these analyses by Carnegie classification, the wide range in efficiency scores narrows considerably. For example, once restricting to institutions with a similar Carnegie classification, there is essentially no difference in technical efficiency scores for instruction, research, or degree production. However, this is largely a function of the smaller sample sizes and comparisons once breaking out the results by Carnegie classification. For MA granting institutions, which are the largest Carnegie classification, no differences in technical efficiency appear for instruction, but there are differences for the other variables, albeit the range is smaller than when compared to the full sample. For example, the range of values for undergraduate degree completions is from 0.54 to 0.96 while the full sample for undergraduate degrees saw technical efficiencies as low at 0.21. In addition, while there may be some differences in the technical efficiency scores, the relative rankings are unaffected by the comparisons. The highest ranked MA granting institution in the full sample will always be the highest ranked institution once restricting to all other MA granting institutions. While the scores themselves may fluctuate based on their comparison peers, the relatively positioning will not.

By comparison, the technical efficiency scores see in these analyses are relatively high, regardless of the specification. Frontier analyses have been used frequently in the literature to assess inefficiencies in agriculture, manufacturing, transportation, and hospital services. For example, stochastic frontier analyses of dairy farms in Argentina, Chile and Uruguay reveal pooled technical efficiencies averaging 0.826 (Moreira & Bravo-Ureta, 2010). Similarly, efficiencies of hospitals in Germany revealed average efficiency scores around 0.86 but ranged from a low of 0.21 to a high of 0.99 (Herr, 2008). In the United States, similar results in health care have been found, with average efficiency scores for hospitals of roughly 0.82 with a wide range of variation based on the model specifications (Rosko & Mutter, 2011). In my full sample of four-year institutions, the results might be comparable to these various levels of efficiency seen in other industries, but once controlling for Carnegie Classification, the institutional results are much stronger. While efficiencies cannot be directly compared across industries to determine if one is more efficient than the other, it does show that after controlling for

Carnegie classification, institutions have relatively high average efficiencies with low variability.

Finally, I completed my analysis of institutions by using fixed effects to determine whether institutions were moving toward the frontier or away from the frontier over time. Unlike the previous results, which are a cross-sectional look at the relative positioning of institutions, this seeks to identify institutions that are making the most improvements in efficiency over time. In this analysis, presented in appendix table A.4, the models were only strong enough to find results for expenses on research, expenses on public service, and undergraduate degrees awarded.

For research, institutions were moving toward the frontier between 2005 and 2007. Since 2007, institutions have become less efficient, with average declines in technical efficiency of approximately -0.01 between 2007 and 2008, -0.13 between 2008 and 2009, and -0.14 between 2009 and 2010. Public service exhibits a similar pattern, with an improvement between 2005 and 2006 of 0.05, but this declined by less than 0.02 each year after until 2010, when the difference between 2009 and 2010 was nearly -0.12. Again, the same can be said about the number of undergraduate degrees, with a large improvement of 0.21 between 2005 and 2006 followed by a much smaller increase of 0.01. However, since 2007, there have been steady, albeit small, declines. This consistent pattern points to the effect of the Great Recession on higher education. Namely, the loss of funding has actually drawn institutions away from their optimal mix of inputs to outputs and is affecting their ability to act efficiently. Rather than producing more with less, the lower resources are damaging institutions' ability to produce outputs.

Once separating out by Carnegie classification, institutions with very high research activity were somewhat protected from the declines in efficiency post 2007. For research, while there has been a steady move toward the frontier of approximately 0.01 on average each year, yet this is offset by a decline of 0.03 between 2007 and 2008. For public service, the increases between 2005 and 2007 were 0.03 each year, followed by a decline of 0.02 and 0.05. However, between 2009 and 2010, the efficiencies of institutions again rose, though by only 0.01. In looking at research institutions with high activity, again the pattern of declines after 2007 is present. For the production of undergraduate degrees, 2005 to 2007 showed increases of 0.01 per year while slight decreases in technical efficiency were recorded from 2007 to 2010.

In general, these various results suggest that the relationships between revenues, expenses, and outputs are robust across the various specifications. When focusing on the efficiency of these relationships, there is a large amount of variation across the higher education sector, but this variation dissipates once controlling for Carnegie classification. Indeed, when comparing institutions of a similar type, there is much less variation in the institutional performance. Furthermore, when looking at changes over time, the Great Recession appears to have hurt institutional efficiencies, with reduced revenues moving institutions away from their optimal input-output mix and negatively impacting the institutional ability to produce outputs.

School Level Stochastic Frontier Analysis

At the school level, results are presented for undergraduate degrees and the total number of degrees. In addition to looking at the various expenses, I include controls for the number of majors, semester credit hours, tuition, and admissions rates. Again, the model coefficients are presented in the Appendix while the technical efficiency scores are graphically presented and listed below. The cross-sectional models again show a strong relationship between the number of majors and the number of degrees awarded. A 1% increase in majors is associated with a 0.65% to 0.77% increase in undergraduate degrees. In terms of total degrees, the relationship ranges from 0.83% to 1.13%. Travel expenses and miscellaneous expenses are significant in many of the models on the total number of degrees, though the magnitudes are quite small.

The distribution of technical efficiencies at the school level can be seen in Figure 6.6. In this figure, undergraduate degrees have a wider range in the efficiencies than the total number of degrees awarded once controlling for major, semester credit hours, and other institutional variables. Indeed, the technical efficiency scores for the total number of degrees are very high, with an average and mode around 0.90. This indicates that schools become more similar once including total degrees as an output rather than just focusing on undergraduate education. Schools that focus heavily on graduate education are at a disadvantage in the model on undergraduate degree production but perform much better in models on total degree outputs. Not including their focus on graduate education makes these schools look like they are performing poorly in comparison to their peers, when they are actually performing quite well once their graduate focus is included as an output.

To further explore these relationships, I compared the efficiency scores by school type to see if there were differences based on instructional focus. Table 6.15 shows that the least efficient schools in terms of undergraduate education tend to be schools of

Figure 6.6

Results of Stochastic Frontier Analysis by School, Distributions of Technical Efficiency

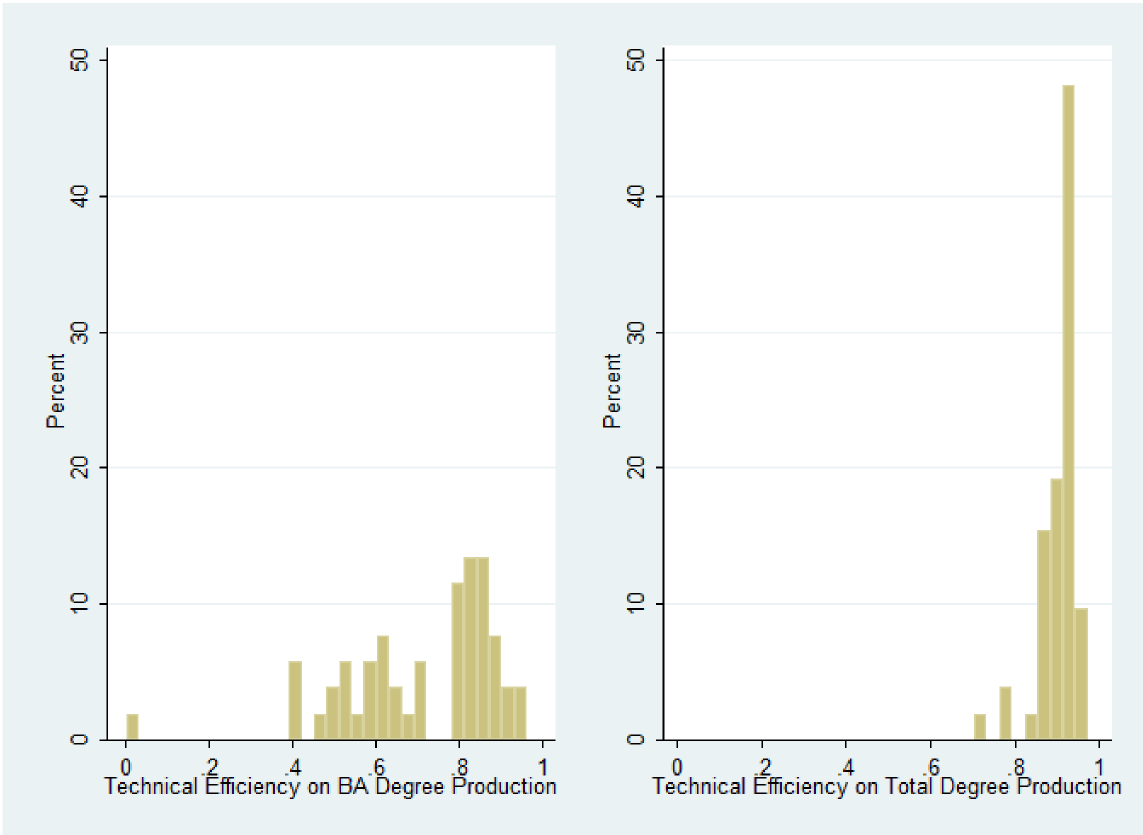


Table 6.15

Results of Stochastic Frontier Analysis by School, Rankings by Technical Efficiency

		BA Degrees	
1	Arlington	School of Nursing	0.9464
2	Austin	College of Communication	0.9399
3	UTSA	College of Business	0.9257
4	Austin	School of Law	0.9172
5	UTEP	Collapsed Liberal Arts and UC	0.9006
6	Austin	Collapsed Liberal Arts and LBJ	0.8826
7	Dallas	School of Management	0.8825
8	UTPA	College of Education	0.8748
9	UTSA	College of Liberal and Fine Arts	0.8698
10	Tyler	College of Business and Technology	0.8659
…			
48	UTSA	College of Engineering	0.4612
49	Austin	College of Education	0.4200
50	Dallas	School of Natural Sciences and Mathematics	0.4115
51	Arlington	School of Education	0.3955
52	UTEP	College of Education	0.0041
		Total Degrees	
1	Arlington	School of Education	0.9596
2	UTSA	College of Business	0.9585
3	Austin	College of Communication	0.9576
4	Austin	School of Information	0.9503
5	Austin	Red McCombs School of Business	0.9483
6	UTPA	College of Arts and Humanities	0.9433
7	Arlington	Collapsed Social Work and Public Affairs	0.9420
8	Tyler	College of Education and Psychology	0.9397
9	Tyler	College of Arts and Sciences	0.9372
10	UTSA	College of Liberal and Fine Arts	0.9368
…			
48	Austin	Cockrell School of Engineering	0.8557
49	Arlington	College of Engineering	0.8430
50	UTSA	College of Engineering	0.7787
51	Austin	Collapsed Sciences	0.7717
52	Dallas	School of Natural Sciences and Mathematics	0.7047

education while once including graduate degrees, the least efficient schools tend to be schools of engineering. For example, the School of Education at UT Arlington is one of the least efficient schools in terms of undergraduate education, but one of the most efficient in total degree production. This is because they offer 8 master's degrees and a doctoral degree, illustrating their focus on graduate education. Without including graduate education as an output, they appear inefficient, but they are very efficient in degree production once these types of degrees are included. On the other hand, many schools of engineering, mathematics, and science offer few graduate degrees when compared to business and education programs. Therefore, while these schools may be efficient in the production of undergraduate and pre-medical degrees, they perform worse once considering the high cost of graduate education despite the few degree outputs.

Unfortunately, the small number of schools in the sample, coupled with having only 3 years of data, limits the power to conduct fixed effects analysis. Indeed, the only fixed effects model that was significant was the basic model for undergraduate degrees before including controls for major, semester credit hours, tuition, or admissions rates. In this model, none of the expense items were significant. When looking at the average technical efficiency scores, schools became more efficient between 2008 and 2009 and less efficient between 2009 and 2010. However, the movement away from the frontier in the period from 2009 to 2010 was much larger, -0.04, as compared to 0.01 in the year prior.

Departmental Level Stochastic Frontier Analysis

Similar to the original OLS and fixed effects analyses, the benefits of the departmental level analyses over the school level analyses is the increased number of observations that can be used in the models. This allows for greater power in the models and the ability to separate the results by departmental type. The results of the cross-sectional analysis, presented in Appendix A.6, show a strong relationship between majors and degrees. In addition, average faculty salary and classified salaries are significant in the models for the total number of degrees awarded. However, the sign on classified salaries reverses once controlling for majors, tuition, and admissions rates.

When looking at the technical efficiency scores, the models for the total number of degrees show little variation once controlling for major. However, undergraduate degree production alone varies greatly. These scores can be seen in Table 6.16. In general, the relative rankings show little difference by model. For example, the UT-Arlington College of Nursing is one of the top 10 departments in terms of efficiency for every model except for the model on total degrees controlling for expenses, majors, and institutional variables. Even in this analysis, the technical efficiency score is only 0.00004 away from the frontier.

Unlike the institutional or school models, the departmental model collects information at the most detailed unit of analysis. Departments focusing on graduate education again perform better in the models on the total number of degrees, such as the Department of Educational Administration at UT-Arlington, but the differences are more subtle since they are not aggregated to the school or institutional levels. Given these differences in degree production by school and department, I separated the analyses by

Table 6.16

Results of Stochastic Frontier Analysis by Department, Rankings by Technical Efficiency

BA Degrees

Controlling for Expenses				Controlling for Expenses, Major, Tuition, & Admissions Rate			
1	Arlington	College of Nursing	0.8921	1	Austin	Communication Studies	0.9371
2	Austin	Advertising	0.8044	2	Arlington	College of Nursing	0.9059
3	UTPA	Criminal Justice	0.7861	3	UTSA	Department of Management	0.8718
4	UTSA	Department of Management	0.7639	4	UTEP	Marketing and Management	0.8546
5	Tyler	College of Nursing	0.7576	5	Tyler	College of Nursing	0.8534
6	UTSA	Department of Psychology	0.7489	6	Arlington	Finance and Real Estate	0.8371
7	Austin	Biological Sciences	0.7380	7	UTSA	Department of Psychology	0.8268
8	UTSA	Department of Health and Kinesiology	0.7293	8	UTPA	Master's in Public Administration	0.8255
9	UTSA	Department of Criminal Justice	0.7279	9	UTSA	Department of Biology	0.8252
10	UTPA	Rehabilitation	0.7271	10	UTSA	Department of Communication	0.8152
…				…			
246	Austin	School of Information	0.0026	228	UTSA	Department of Physics and Astronomy	0.1587
247	Austin	LBJ School of Public Affairs	0.0018	229	Arlington	Curriculum and Instruction	0.0098
248	Austin	Law	0.0016	230	UTEP	Teacher Education	0.0097

Total Degrees

Controlling for Expenses				Controlling for Expenses, Major, Tuition, & Admissions Rate			
1	Arlington	College of Nursing	0.8387	1	Austin	Communication Studies	0.9974
2	Arlington	Educational Administration	0.8079	2	Austin	Management	0.9974
3	Arlington	Curriculum and Instruction	0.7957	3	Tyler	School of Education	0.9973
4	Arlington	Management	0.7811	4	UTPA	Curriculum and Instruction	0.9973
5	Austin	Advertising	0.7746	5	UTSA	Department of Management	0.9973
6	Tyler	College of Nursing	0.7603	6	UTPA	Social Work	0.9973
7	UTPA	Criminal Justice	0.7520	7	Arlington	Educational Administration	0.9973
8	Austin	Management	0.7435	8	Arlington	Economics	0.9973
9	UTSA	Department of Psychology	0.7382	9	UTPA	Physician Assistant	0.9973
10	UTSA	Department of Management	0.7381	10	UTEP	Marketing and Management	0.9973
…				…			
246	UTB	Chemistry and Environmental Science	0.0797	228	UTSA	Department of Physics and Astronomy	0.9973
247	Austin	Center for Mexican American Studies	0.0479	229	UTPA	Bachelor's in Computer Engineering	0.9973
248	UTSA	Demography and Organization Studies	0.0276	230	UTSA	Demography and Organization Studies	0.9973

departmental type. This diminished the sample size, preventing the inclusion of institutional controls. For BA degrees, controls for majors are included while the total number of degrees does not include a control for major. These results are seen in Appendix A.7. Even more interesting are the relative rankings by departmental type. For undergraduate degrees, departments of humanities and departments of health and nursing exhibit little variation in their efficiency scores. Similarly, there is little variation in efficiency scores for the total number of degrees awarded in departments of science and math, arts, health and nursing, and business. The lowest recorded efficiency score in these models is 0.96, suggesting that when comparing departments of a similar type, most departments fall relatively close to the frontier. In essence, when there are fewer departments and these departments are all of the same type, the departments perform very similarly to one another.

In addition to these cross sectional analyses, I also used fixed effects to look at the changes in efficiency over time. In this analysis, which is limited to the full sample of departments, only the simplest model is significant for undergraduate degrees. On average, the efficiency scores move toward the frontier between 2008 and 2009, but are essentially offset by the average movement away from the frontier from 2009 to 2010. A similar pattern emerges when looking at the total number of degrees awarded. However, once controlling for the number of majors and institutional variables, there were gains in efficiency spanning both years. Between 2008 and 2009, technical efficiency improved, on average, by 0.004. Between 2009 and 2010, the improvement was 0.0002. This suggests that departments are becoming more efficient in their production of degrees over time. While institutions exhibited a decrease in efficiency over time, the internal departments themselves, at least in the U.T. System, showed the ability to become more efficient, suggesting that non-academic departments may be those institutional subunits contributing to institutional inefficiencies while academic departments continue to move toward the frontier for degree production.

Data Envelopment Models

The stochastic frontier analyses used parametric models to individually examine each link in the higher education production function. In data envelopment analysis, I am able to include multiple inputs and multiple outputs. These non-parametric models allow the frontier to develop based on the performance of each unit in the analysis rather than based on a specified model. However, while this approach benefits from the freedom of a defined model, it also comes with a few consequences. First, the number of inputs and outputs included in the model are again restricted by the sample size. Second, the rankings are based on the inputs and outputs included in the model. The models say nothing about the ranking or the efficiency of institutions on measures that are not included in the model. Finally, the model is defined by whether the focus is on inputs or outputs. While my original intent was to focus on output maximization, the previous results suggest that an input orientation is likely the better approach. If institutional expenses are only weakly associated with outputs, then focusing on minimizing inputs given fixed outputs may be preferred.

These specifications ultimately led me to adopt the model used by Abbott & Doucouliagos (2003). This uses an input orientation with variable returns to scale (VRS). The variable returns to scale accounts for differences in the scale of operation and efficiency, a key assumption given the importance of size and efficiency (Hoenack, 1982; Robst, 2001). Under constant returns to scale (CRS), it is assumed that large institutions have the same ability to efficiently turn inputs into outputs as small institutions and vice versa. Whether to use VRS or CRS has been tested previously (Avkiran, 2001) by looking at the correlations between the efficiency scores and institutional size. If the correlations are high, variable returns to scale are the preferred technique. Because of the differences in size between departments, schools, and institutions, the variable returns to scale is preferred. Regardless of the model setup, the key area of interest is the measure of technical efficiency. As with stochastic frontier analysis, this ranges from 0 to 1, where 1 is the point where the inputs are minimized given fixed outputs. This is somewhat easier to understand in the outputs based approach, which maximizes outputs given fixed inputs. Either way, it is representative of the proximity of a unit to the optimal ratio of inputs to outputs.

Institutional Level Data Envelopment Analysis

The institutional level analysis uses data from IPEDS to look at models with various inputs and outputs. These models follow the similar structure as previously, first presenting the efficiency scores for the relationship between revenues and expenses followed by expenses to outputs and, finally, revenues to outputs. Revenues include state appropriations, tuition and fee revenues, and federal operating grants and contracts. Expenses include instruction, research, academic support, institutional support, public service, student services, and scholarships and fellowships. Finally, outputs include undergraduate degrees, master's degrees, the full-time retention rate, 4-year graduation rate, and 6-year graduation rate.

In addition, I include various controls in the analyses. The controls for the inputs include those previously used in the other models as proxies for quality, published tuition and fees and admissions rates (Archibald & Feldman, 2008b; Breu & Raab, 1994; Zhang, 2005). The output based controls include the full-time equivalent enrollment, undergraduate and graduate credit hours, and research revenues. The control for published tuition and fees is not used when tuition and fee revenues are included in the model due to collinearity. Similarly, federal grants and contracts cannot be both a revenue input and a measure of outputs. There is much debate over whether research revenues are an input or an output. Some scholars (Abbott & Doucouliagos, 2003; Avkiran, 2001; Cave, Hanney, & Kogan, 1991; Tomkins & Green, 1993) believe that research revenues are actually a reflection of an institution's research output, essentially putting a market value on the research conducted at that institution. In line with this reasoning, I take a similar approach, using federal operating grant and contract revenues and research expenses as proxies for research output.

The choice of variables and the model setup is especially important in data envelopment analysis since the data drives the frontier. In addition, the number of variables that can be included is restricted by the sample size (Avkiran, 2001). Once separating by institutional type, not all of the models are applicable. For example, BA granting institutions and doctoral institutions have too few observations in many of the models because of the number of variables included. There should be at least 3 times as many observations as variables, meaning there need to be at least 36 institutions with full data in the largest models. Furthermore, many outputs are not applicable for each type of institution. For example, graduate degrees is not especially important at BA granting institutions.

The results of the analyses are presented in Table 6.17. This table reports the percent of institutions of each type operating on the frontier as well as the mean and standard deviation in technical efficiency. Similar results across the various models would suggest a robust efficiency of institutions in higher education.

In most of the models, the average efficiency score is above 0.90. This indicates that most institutions are operating very efficiently when compared to like peers. This is similar to the findings in the UK and Australia, where technical efficiency scores frequently average between 0.92 and 0.96 (Abbott & Doucouliagos, 2003; Avkiran, 2001; Johnes, 2006). In addition, this finding is even greater than the average technical efficiency of 0.76 found in the United States on the measure on value (Eff, Klein, & Kyle, 2012) and exceeds that seen in other industries such as hog farming in Hawaii (0.726) (Sharma, Leung, & Zaleski, 1997) or manufacturing in Italy (0.64) (Milana, Nascia, & Zeli, 2013). The only models in my analysis with average efficiency scores below 0.80 are the models comparing various inputs to retention and graduation rates. Whether it be using revenues or expenses as the input, retention and graduation rates show the least amount of efficiency across the various institutional types. This is somewhat concerning since these two measures are those most frequently used by policymakers in evaluating institutional performance (Rabovsky, 2013). Not only are the mean scores much lower for these measures of output, but the number of institutions operating on the frontier is also quite low. This suggests that there is inefficiency that

Table 6.17

Results of Data Envelopment Analysis with an Input-Orientation at the Institutional Level

Inputs	Outputs	RU/VH	RU/H	MA	
Revenues	*Expenses*				
Revenues	Expenses	75.81%	78.57%	43.72%	On the Frontier
		0.97	0.99	0.91	Mean
		0.07	0.03	0.10	SD
		62	70	247	Observations
Expenses	*Outputs*				
Expenses	BA Degrees, MA Degrees,	73.58%	61.54%	40.45%	On the Frontier
	FT Retention Rate,	0.94	0.93	0.86	Mean
	4-Year Graduation Rate,	0.12	0.11	0.16	SD
	6-Year Graduation Rate	53	65	178	Observations
Expenses with Controls	*Outputs with Controls*				
Expenses	FTE,	72.58%	75.71%	54.70%	On the Frontier
	BA Degrees, MA Degrees,	0.96	0.97	0.93	Mean
	Research	0.08	0.06	0.10	SD
		62	70	234	Observations
Expenses with Controls	FTE,	81.13%	82.26%	67.47%	On the Frontier
for Admission Rate and	BA Degrees, MA Degrees,	0.98	0.99	0.96	Mean
Published Tuition & Fees	Research	0.06	0.04	0.07	SD
		53	62	166	Observations
Expenses	FTE,	69.49%	74.29%	58.18%	On the Frontier
	Undergraduate Credit	0.96	0.97	0.93	Mean
	Hours,	0.08	0.07	0.11	SD
	Graduate Credit Hours,	59	70	220	Observations
	Research				
Expenses with Controls	FTE,	81.63%	84.75%	67.68%	On the Frontier
for Admission Rate and	Undergraduate Credit	0.98	0.99	0.96	Mean
Published Tuition & Fees	Hours,	0.04	0.04	0.08	SD
	Graduate Credit Hours,	49	59	164	Observations
	Research				
Expenses	FT Retention,	47.54%	18.57%	10.15%	On the Frontier
	4-Year Graduation Rate,	0.84	0.64	0.53	Mean
	6-Year Graduation Rate	0.20	0.23	0.24	SD
		61	70	197	Observations
Expenses with Controls	FT Retention,	48.98%	31.37%	6.73%	On the Frontier
for Admission Rate and	4-Year Graduation Rate,	0.91	0.87	0.78	Mean
Published Tuition & Fees	6-Year Graduation Rate	0.12	0.13	0.12	SD
		49	51	104	Observations

Table 6.17 (Continued)

Results of Data Envelopment Analysis with an Input-Orientation at the Institutional Level

Inputs	Outputs	RU/VH	RU/H	MA	
Revenues	*Outputs*				
Revenues	BA Degrees, MA Degrees,	44.26%	37.14%	24.70%	On the Frontier
	FT Retention Rate,	0.87	0.86	0.77	Mean
	4-Year Graduation Rate,	0.16	0.15	0.18	SD
	6-Year Graduation Rate	61	70	247	Observations
Revenues with Controls	*Outputs with Controls*				
Revenues	FTE,	46.77%	47.14%	22.05%	On the Frontier
	BA Degrees, MA Degrees,	0.90	0.91	0.81	Mean
	Research Expenses	0.12	0.11	0.15	SD
		62	70	254	Observations
Revenues with Controls for Admission Rate and Published Tuition & Fees	FTE, BA Degrees, MA Degrees, Research Expenses	55.74%	52.31%	31.90%	On the Frontier
		0.94	0.95	0.89	Mean
		0.09	0.08	0.11	SD
		61	65	232	Observations
Revenues	FTE,	48.39%	44.29%	22.83%	On the Frontier
	Undergraduate Credit Hours,	0.91	0.91	0.79	Mean
	Graduate Credit Hours,	0.11	0.11	0.17	SD
	Research Expenses	62	70	254	Observations
Revenues with Controls for Admission Rate and Published Tuition & Fees	FTE, Undergraduate Credit Hours, Graduate Credit Hours, Research Expenses	56.67%	52.31%	35.19%	On the Frontier
		0.94	0.95	0.88	Mean
		0.08	0.07	0.12	SD
		60	65	233	Observations
Revenues	FT Retention,	27.87%	15.71%	12.15%	On the Frontier
	4-Year Graduation Rate,	0.73	0.60	0.50	Mean
	6-Year Graduation Rate	0.23	0.25	0.27	SD
		61	70	247	Observations
Revenues with Controls for Admission Rate and Published Tuition & Fees	FT Retention, 4-Year Graduation Rate, 6-Year Graduation Rate	36.07%	27.69%	20.87%	On the Frontier
		0.87	0.85	0.83	Mean
		0.13	0.12	0.14	SD
		61	65	230	Observations

Notes: Revenues include state appropriations, tuition & fee revenues and federal grants.
Expenses include expenses on instruction, research, academic support, institutional support, public service, student services, and scholarships and fellowships.

exists in the production of retention rates and graduation rates when compared to peer institutions, but the research presented previously does not offer any clear linear link that might help improve performance on these measures. Instead, the results of data envelopment analysis simply provide a list of peer institutions operating efficiently that interested institutions may want to emulate in order to improve their performance.

Another result that stands out is the lower efficiency scores in models that compare MA granting institutions. MA granting institutions are the largest comparison group, meaning the frontier can be set by a small number of institutions while all of the other institutions are compared to this frontier. With smaller sample sizes, the proportion of institutions making the frontier is much larger, with fewer observations looking inefficient. Indeed, the percent of institutions operating on the frontier is highest in the RU/VH comparison group, which has the fewest number of observations. This is not necessarily true for average efficiency scores. While the percent operating on the frontier is a function of sample size, average efficiency scores reflect the relative proximities to the frontier, meaning that the institutions are performing similarly. For example, while the sample size at high research institutions often exceeds that at very high research institutions, the average efficiency scores are also frequently higher.

Finally, the various models also identify changes that happen once controlling for tuition and admissions rates as input controls. In each model that includes the control variables, the average efficiency scores improve. Most of the models saw a slight increase, but the models on retention and graduation rates, which had the lowest efficiency scores, had very large gains once including these controls. In the model with expenses as an input, the inclusion of the controls raised the average efficiency by 0.07

for institutions with very high research activity, 0.23 for high research institutions, and 0.25 for MA granting institutions. Similarly, in the model with revenues as an input, the efficiency scores raised by 0.14 for institutions with very high research activity, 0.25 for institutions with high research activity, and 0.33 for MA granting institutions. While part of this is due to the associated changes in sample size from missing data, it also shows that once controlling for the quality of student inputs and institutional affordability, efficiency scores raise when compared to peers. Indeed, the aforementioned 0.14 increase for very high research institutions occurred while keeping the sample size fixed.

In general, these various analyses at the institutional level suggest that institutions are performing well when compared to their peers. Once controlling for Carnegie classification, and then controlling for student and financial inputs, there is little variation in efficiency scores. Most institutions are performing on, or very near, the frontier. While this says nothing about the efficiency of the entire sector, it does highlight the efficiency of institutions operating within higher education in comparison to each other.

School Level Data Envelopment Analysis

At the school level, the inputs include the various measures of salaries and operating expenses while the outputs include degrees, majors, and semester credit hours both at the undergraduate level and including all levels of enrollment. In the first analysis, conducted with an output orientation, 43.48% of schools were operating on the frontier with variable returns to scale. Of the 46 schools included, 20 received a perfect efficiency score of 1. When looking at the input orientation, the percent operating on the frontier increased slightly to 46.15%, but only 26 schools were included in the analysis.

However, when using constant returns to scale, which does not account for size differences, 50 institutions were included in the analysis and 42% were operating on the frontier.

These results, presented in Table 6.18, show the relative ranks in this model. All of those schools operating on the frontier in the CRS model are also operating on the frontier in the VRS model. In addition, once allowing for variable returns to scale, the variation in the efficiency scores is much smaller. The mean efficiency score is 0.88 with a standard deviation of 0.14. The lowest recorded efficiency score is 0.56. This means that once introducing variable returns to scale, most schools were performing relatively efficiently.

In general, the technical efficiency scores reveal that schools of liberal arts performed at the top of the distribution while schools of business were around the midpoint of the efficiency scores and schools of engineering performed the worst. These findings seem intuitive since schools of liberal arts have large enrollments and are relatively cheap to operate. Their input-to-output mix, therefore, drives the definition of the frontier. When schools of engineering try to compete at this level, they find themselves looking inefficient. They have relatively small enrollments and are much more expensive to operate.

This natural grouping of efficiency scores suggests that subunit analyses may be important in future models. At the school level, there is not enough power to conduct subunit analyses, but this can be used at the departmental level to compare departments of a similar type.

Table 6.18

Results of Data Envelopment Analysis with an Input-Orientation at the School Level

Institution	College	Rank (VRS)	Theta (VRS)	Rank (CRS)	Theta (CRS)
UTPA	Business Administration			1	1.00
UTPA	Education	1	1.00	1	1.00
UTPA	Health Sciences & Human Services	1	1.00	1	1.00
UTPA	Social & Behavioral Sciences	1	1.00	1	1.00
UTB	Applied Technology & General Studies			1	1.00
UTB	Education			1	1.00
UTB	Liberal Arts	1	1.00	1	1.00
Arlington	Liberal Arts	1	1.00	1	1.00
Arlington	Nursing			1	1.00
Austin	Liberal Arts & LBJ	1	1.00	1	1.00
Austin	Sciences	1	1.00	1	1.00
Austin	Communication	1	1.00	1	1.00
Dallas	Management	1	1.00	1	1.00
Dallas	Natural Sciences & Mathematics			1	1.00
UTEP	Health & Nursing			1	1.00
UTEP	Liberal Arts & UC			1	1.00
Tyler	Arts & Sciences			1	1.00
Tyler	Nursing & Health Science			1	1.00
UTPB	Arts & Sciences	1	1.00	1	1.00
UTSA	Education & Human Development	1	1.00	1	1.00
UTSA	Liberal & Fine Arts	1	1.00	1	1.00
Tyler	Education & Psychology			22	0.98
Arlington	Education			23	0.94
Tyler	Business & Technology			24	0.94
UTSA	Sciences			25	0.91
UTEP	Business	13	0.91	26	0.90
Arlington	Business			27	0.83
UTSA	Business			28	0.76
Arlington	Science			29	0.75
Austin	Business	17	0.84	30	0.71
Austin	Engineering	21	0.78	31	0.69
UTEP	Engineering	19	0.78	32	0.65
UTPA	Engineering & Computer Science	16	0.85	33	0.65
Dallas	Engineering & Computer Science	18	0.81	34	0.62
Austin	Education	24	0.67	35	0.61
UTEP	Science			36	0.60
Dallas	Arts & Humanities			37	0.55
UTPA	Science & Mathematics			38	0.54
UTSA	Public Policy			39	0.51
Dallas	Economic, Political & Policy Sciences			40	0.51
UTEP	Education	14	0.89	41	0.48
Dallas	Behavioral & Brain Sciences	15	0.87	42	0.48
Arlington	Engineering	22	0.73	43	0.47
UTSA	Architecture	25	0.64	44	0.47
Arlington	Social Work & Public Affairs			45	0.36
Tyler	Engineering & Computer Science			46	0.34
UTSA	Engineering	20	0.78	47	0.33
Austin	Fine Arts	23	0.72	48	0.32
Austin	Nursing & Pharmacy	26	0.56	49	0.30
Austin	Architecture			50	0.15

Departmental Level Data Envelopment Analysis

The model for the departmental analysis is the same as that in the school analysis. It again uses an input orientation with variable returns to scale. It also uses the same inputs as in the school level analysis. However, the outputs do not include semester credit hours since these are not available at the departmental level. These results exhibit a similar pattern as that seen at the school level. The model with constant returns to scale again has a much larger sample size than the model using variable returns to scale, 182 as opposed to 110, and a lower percentage of departments operating at the frontier, 5.49% compared to 13.64%. However, it does not account for scale efficiency as a function of size and operations.

As can be seen in Table 6.19, departments in this analysis are much further from the frontier than in any of the other analyses. Like with the school analysis, this raised the question of whether this was because the model was trying to compare departments of multiple types. Much like the approach at the institutional level, I next separated the results by departmental type. When comparing similar departments, the percent operating on the frontier increased greatly, from 13.64% in the full analysis on all departments to a minimum of 37.84% departments operating on the frontier for departments of humanities. In addition, the average efficiency score by department was quite high, from 0.79 in departments of science and mathematics to 0.98 for departments of engineering. Indeed, 6 of the 7 departmental types had average efficiency scores of over 0.85.

Table 6.19

Results of Data Envelopment Analysis with an Input-Orientation at the Departmental Level

	Percent Operating On the Frontier	Minimum Score	Observations	Mean	Standard Deviation
Science & Math	43.33%	0.57	30	0.79	0.16
Humanities	37.84%	0.54	37	0.86	0.15
Arts	73.33%	0.79	15	0.87	0.14
Engineering	46.67%	0.47	30	0.98	0.05
Health & Nursing	66.67%	0.51	21	0.92	0.12
Behavioral & Social Sciences	53.13%	0.66	32	0.95	0.12
Business	68.18%	0.69	22	0.91	0.12
Total	13.64%	0.39	110	0.95	0.09

Note: These results all use variable returns to scale.

Overall, these results are relatively consistent with the other analyses. Departments, once comparing to departments of a similar type, are generally efficient. In most cases, over half of departments of a given type operate on the frontier and the average efficiency scores are frequently over 0.85. Stated otherwise, for those departments not operating on the frontier, their efficiency scores are relatively high once imposing a structure that controls for variable returns to scale. Even the standard deviation in the efficiency scores is relatively small, under 0.16, indicating not only high scores, but the clustering of scores at the top of the distribution.

Summary of Findings

These findings have empirically examined the relationships found in the higher education production function. Using data from IPEDS, the University of Texas System, and Texas Higher Education Coordinating Board, I have been able to conduct cross-sectional and longitudinal analyses using ordinary least squares regression, fixed effects regressions, stochastic frontier analysis, and data envelopment analysis. These models have looked at the relationship between revenues and expenses, expenses and outputs, revenues and outputs, and the measures of relative technical efficiency when compared to peers. In addition, these models are conducted, where possible, on three levels of analysis: institutions, schools, and departments. In the next chapter, I present the implications of these findings, looking at the patterns that are robust across the various analyses and comparing across the various models and levels of analysis. I also discuss the importance of these findings to the research literature and to higher education policy.

CHAPTER VII

DISCUSSION & IMPLICATIONS

The findings from the previous chapter exhibited relationships that were consistent with the literature and the higher education production function. As expected, institutional budgets are dominated by revenues from tuition, state appropriations, and federal operating grants and contracts. These patterns vary based on an institution's Carnegie classification and size, a finding that is consistent across the various models. Indeed, institutions with the same Carnegie classification but located in different states are more similar than institutions within a state who have different classifications. A pattern that is seen throughout higher education is the increasing reliance on tuition and federal grants as primary sources of revenue, while state appropriations have fallen. This trend could threaten the public nature of higher education as institutions become increasingly competitive for tuition dollars and research funds. Rather than focusing on educating students in-state, institutions may compete for out-of-state students of a higher caliber and who are willing to pay higher tuition and fees. This willingness to pay for higher education could further exacerbate the increases in tuition. These two components, a nationwide search for talented students and increasing tuition, could result in further limitations for access to in-state, public higher education for many students. In addition, as research becomes a more important as a source of revenue, particularly in the face of declining state appropriations, institutions may drift in their orientation, looking for alternative revenue streams and thereby changing their operations.

Similar to the revenue side of budgets which focus on tuition, state appropriations, and federal grants, institutional expenses focus on instruction and research. These expenses, once looking within institutional budgets, are primarily designated for salaries and benefits. In addition, expenses on scholarships and fellowships are a large expense item in the general and educational budget. Other expenses, such as utilities, capital projects, and auxiliary enterprises, are large items, but budgeted in separate funds.

When taking this information to examine the first research question addressing revenues and expenses, strong patterns emerged. Expenses on instruction were associated with revenues from state appropriations and tuition. Similarly, expenses on research were associated with funds from federal grants and contracts. These findings were not surprising given the strong association between the funding source and the intended use of the funds. This confirms previous research conducted by Leslie and colleagues (2012). For example, students are paying tuition in order to receive instruction, a strong and logical association. However, other links were less apparent. While federal grants showed a strong relationship with research, they also showed a relationship with instructional and public service expenses as well. This could indicate the use of federal funds to help offset overhead and indirect expenses that go to support non-research enterprises. In general, these findings showed strong links between revenues and expenses that operated in the expected fashion. The accountability question of whether funds are being used for their intended purpose is therefore generally unfounded as illustrated by this analysis. Money coming from funders interested in instruction does indeed show a strong relationship with expenses on instruction. The same can be said for research. These strong links between the source of funding and the expected use of funding reveals high congruence in higher education spending, suggesting that institutions are tightly aligned to their principal funders (Ferris, 1991; Lane, 2007). In addition, this finding holds even in the face of the Great Recession. Many of the relationships found previously (Leslie et al., 2012) are still significant, hold for many types of four-year institutions, and operating in the same direction as those found before the economic decline.

Moving to the second research question, I looked at the links between expenses and outputs. In these models, the relationships were very weak across all of the levels of analysis. Whether it be at the institutional level, the school level, or the departmental level, expenses were not strongly associated with outputs. Instead, many of the links were between revenues and outputs. These results indicate that revenues have an indirect impact on outputs. Rather than seeing strong relationships between individual expense items and outputs, the combined efforts of multiple spending and revenue sources at the institutional level are what manifest as being most important. In essence, the institution operates as a whole rather than as separate, independently operating expense items. Increasing expenses on instruction, for example, is not likely to improve degree production, full-time retention rates, or graduation rates. However, once combined with other expenses and aggregated to the original source of the funds, the relationships are significant. For example, while instructional expenses were not significant with their relationship to outputs, tuition revenues were associated with higher graduation rates. This also revealed another interesting finding. When coupled with the finding that expenses on scholarships and fellowships were associated with decreased four-year graduation rates, it could be suggested that students are the primary drivers of outputs more so than institutions. This is somewhat similar to the finding by Marvin Titus (2006) that an individual's probability of graduation is a function of an institution's reliance on tuition. My findings differ from Titus's in that I focus on the institution as the unit of analysis. As institutional policies around tuition and scholarships change, there are changes in institutional outputs such as graduation rates. This might suggest that students who have to pay higher tuition and fees may try to finish their degree faster. However, increased aid from scholarships and fellowships slows the time to degree. It should be noted that my study cannot speculate about the behavior of individual students and how they might respond to changes in tuition or aid. Rather, it simply points out that institutions as producers of degrees do exhibit significant variations in aggregate measures of production as the out-of-pocket expense charged to students changes. Indeed, once controlling for student inputs and institutional type, students are most likely the ultimate producers of outputs, above and beyond anything to which institutions choose to spend their money. More simply, the behavior of students in response to changing institutional policies may be driving the changes seen in institutional outputs more so than the behavior of institutions as a means of production.

The findings also suggest that the expenses-to-outputs link in the production function is weak. The outputs themselves are relatively stable, with little variation over time. While there is variation in outputs between institutions, much of this is explained away once controlling for Carnegie classification. These weak relationships call into question many of the current reforms for higher education. Performance funding and the increased attention by the Obama administration on college scorecards may be misplaced. Descriptively, college outputs are clearly important to the higher education landscape.

Potential students and parents have an interest in knowing an institution's retention and graduation rates. However, this should not be interpreted as institutional performance. Whether a student graduates in 6 years is not a function of the institution, but of the individual student. In the regressions that move beyond the descriptive statistics and control for student inputs and institutional type, the associations between institutional initiatives and outputs disappear. Institutional expenditures are not likely to significantly change their performance.

However, it should be noted this study focuses on aggregate expenditures. Institutions may be able to change their performance by altering what they spend their money on rather than the total amount of money. This would echo Craven's (1975) suggestion that higher education can be better improved through the effective allocation of resources rather than the total amount of resources. Yet even this proposition by Craven assumes that institutional administrators are acting inefficiently. The hypotheses surrounding resource dependency theory (Bowen, 1970, 1980; Froelich, 1999; Hopkins & Massy, 1981; Massy, 1996; Massy & Wilger, 1992; Niskanen, 1971; Pfeffer, 1997; Pfeffer & Salancik, 1978; Scott, 1995) suggest that inefficiencies are built into the system in order to maximize revenues. In essence, it suggests that administrators are intentionally acting inefficiently. They know a way to maximize their performance but are not doing so in order to maximize future revenues. In higher education, this is likely not the case. The discussion of the efficiency measures, which follows later in the chapter, reveals that institutions are, in large part, acting relatively efficiently when compared to their peers. That is not to say that the system as a whole cannot be improved, but simply that institutions are performing in relatively similar fashions.

Therefore, these high efficiency scores suggest that administrators have not intentionally built inefficiencies into their management of their institutions but are actually acting in the most efficient way they see possible. Where inefficiencies do exist, it's more likely that administrators do not know what to do, do not have a good model to emulate, or simply are providing a service to a special population that makes them look more inefficient than they actually are. Instead of focusing on the total amount spent in relation to institutional outputs, policymakers and administrators might be challenged to evaluate how the money is spent programmatically. If the links between expenses and outputs is so weak, as suggested, then the amount of money being spent may not be as important as how it is being spent. Even more so, this has to take place at a very fine level of analysis, down to the program level, since aggregate categories such as instruction or academic support were not found to be predictors of output. Thus, if institutions are to be truly evaluated on their performance, they might better learn from being evaluated on their internal allocations, policies, and programs.

Another way institutions can improve their outputs is by improving the quality of their inputs. Therefore, rewarding institutions on their performance essentially privileges institutions with better inputs. Similar to the findings by Brooks (2005) and Ehrenberg (2002b) in looking at rankings lists, institutions can game the system by focusing on specified targets and benchmarks. This could push institutions towards highly competitive admissions processes where only certain students with high probabilities of retention and graduation are admitted. This setup has the potential to further stratify higher education, giving more resources to institutions that already have high quality inputs while those institutions needing additional resources suffer because of the types of populations they serve. Indeed, institutions that serve non-traditional, low-income, minority, or other underserved populations could suffer from this gamesmanship as they could be punished because of their low measures of performance which reflect the types of students served more than it does on actual institutional performance. Similarly, publishing scorecards that grade institutions based on their descriptive measures could further push quality students to certain types of institutions, which help these institutions perform even better on these measures while other types of institutions fall in the ratings.

This also has implications for performance funding. Funding institutions based on their performance, which, as noted, is a function of their inputs rather than their actual performance, is not directly addressing institutional operations. States should not be concerned about how institutions spend their money as the results of this analysis indicate that funding is indeed allocated to related expenditures. However, if states want to reward institutions based on their institutional performance, there is little evidence that institutional expenditures can improve performance on measures such as degrees awarded, retention rates, and graduation rates. Therefore, linking future inputs to current outputs may not be the best approach since there is little variation in outputs and institutional expenditures do not have strong links to output generation. Instead, states may be more interested in looking at the efficiency of institutions in relation to their peers.

These policy reforms in higher education, including scorecards, performance funding, vouchers, and public charters, have serious implications for states, institutions, and students. The efficiency evaluation perspective of governors, legislators, and state boards of higher education has placed increased attention on the performance of institutions. This has involved giving institutions more autonomy in setting their own tuition, aid, and other policies in order to make them more competitive and market-oriented. Accompanying these structural policies has been a focus on higher education as a private good and students as consumers. This is reflected by the voucher arrangement in Colorado and increasing out-of-pocket expenses elsewhere. However, the drive for efficiency has the potential to threaten equity and the very public nature of higher education if simple measures of retention rates, graduation rates, and degree completions are the standard for efficiency (Dowd, 2003). By focusing on this type of efficiency, the incentive structure essentially pushes institutions towards a model that maximizes these potential outputs, causing premier institutions to focus on improving their inputs by admitting only those students who are likely to increase their perceived institutional performance. This would then result in higher future funding. Other institutions, which serve more at-risk populations, would be threatened by such an arrangement as their performance would look poor when compared to these elite, public institutions. However, open access and minority service institutions serve a purpose other than pure efficiency on institutional outputs. If they wanted to maximize their outputs, they would undertake a similar behavior, but they are charged with a mission to serve underrepresented populations, make higher education more accessible, and provide the resources necessary to help alleviate past educational and socioeconomic inequalities. The types of students at these institutions come from a background with fewer resources or opportunities. Pure competition with the elite public institutions would push these types of institutions out of the market since their relative performance is much lower. Yet the purpose they serve promotes the equality of opportunity argument made by Okun

(1975). These institutions are meant to provide an opportunity to students who might otherwise not receive a chance in a pure market and efficiency based system. These considerations are necessary given the current state of reform. In the example of the voucher program in Colorado, institutions compete heavily for students and the associated tuition and state voucher funds. The 2009 WICHE report points out some of the negatives of this arrangement. Namely, underrepresented and non-traditional students were less likely to enroll at institutions in Colorado as a result of this policy. Not only does this threaten the financial stability of minority serving institutions that have to compete for students, but it illustrates the potential stratification of higher education that can occur if policies are designed to encourage a system based on market competition and financial incentives that are based on performance. If issues of equity and access are not considered in performance or efficiency based systems, certain populations of students might be pushed into lower-tier or two-year institutions at the expense of an opportunity to study at a four-year institution devoted to serving those populations most at risk.

Given these findings, and the weak link between expenses and outputs in the higher education production function, I turned to frontier analyses to look at the production function more holistically. Rather than thinking of revenues, expenses, and outputs as having a linear relationship, I looked at them in terms of efficiencies in the input-output mix. Indeed, previous research suggests that institutions need to focus on the point that maximizes the input-output ratio (Powell, Gilleland, & Pearson, 2012) and simultaneously produces instructional and research outputs without the expense of either (Massy, 1996; Nerlov, 1992). Stochastic frontier analysis used a parametric approach to employ the same models as in my previous analyses to determine the relative efficiencies of institutions, schools, and departments. Data envelopment analysis used a non-parametric approach to evaluate multiple inputs in relation to multiple outputs. These models suggest that there is an optimal mix of inputs to outputs. Institutions should try to move toward this point, where the ratio of outputs to inputs is maximized.

In echoing back to the discussion on equity and access, one of the key findings from these models is that efficiency is largely a function of an institution's mission. Much like the descriptive and multivariate regressions, Carnegie classification is a major predictor of efficiency. When trying to compare all types of institutions, technical efficiency varies greatly in the different models. However, once separating out the comparison groups to institutions of a similar type, most institutions perform relatively well compared to their peers. The variation in efficiency scores for institutions of the same type is quite small. This finding holds for the school and departmental analyses as well. Again, once using a comparison group of similar peer units, most units were found to be relatively efficient. This is consistent with the findings in the UK and Australia (Abbott & Doucouliagos, 2003; Athanassopoulos & Shalle, 1997; Avkiran, 2001; Izadi et al., 2002; Johnes & Johnes, 1993; Johnes & Johnes, 1995; Tomkins & Green, 1988) that institutions of higher education in these countries were largely efficient. This finding is especially important because it emphasizes the need to compare institutions with a similar mission and orientation in order to produce realistic measures of efficiency. The efficiency of a research institution should not be compared to a minority serving institution, even if they are in the same state. Their missions are vastly different, the populations and background of their students are vastly different, and they should be compared to peers of a similar type rather than those in a similar region.

Once controlling for Carnegie classification, where inefficiency does exist, the school and departmental analyses suggest that the sources of the inefficiencies are likely non-academic in nature. Had the academic models shown inefficiencies, these might be attributed to cost disease or the academic ratchet, which argue that faculty and research are driving up costs and producing inefficiencies. However, the subunit analyses showed little variation in their technical efficiency once controlling for school or department type. Because the institutional academic subunits were efficient, the sources of inefficiency within an institution would likely have to be non-academic in nature. This may be a function of the mission creep related to non-academic expenses and administration, a result of the rapid expansion in the number and professionalization of academic staff, known as the academic lattice (Levin, 1991; Massy, 1996; Massy & Wilger, 1992; Zemsky & Massy, 1990). Non-academic expenses, which have been seen to increase rapidly (Getz & Siegfried, 1991b; Harter, Wade, & Watkins, 2005), may be causing the educational mission of institutions to suffer. Knowing this, institutions might want to examine their non-academic units for potential areas of improvement.

In addition to looking at institutions, schools, and departments, I also looked at efficiencies over time, introducing unit and year fixed effects to the analysis where possible. This limited the power in models with too many regressors, but the models that were significant showed longitudinal changes in efficiency. For institutional models, efficiencies were seen to decline since 2007. Institutions became less efficient, likely a function of the Great Recession. As the economy continued to decline and the funding models changed, institutions moved away from the optimal input-output mix. Without the resources, particularly state appropriations, institutions became less efficient in their production of outputs, namely in their production of degrees. However, the same pattern did not manifest for schools or departments. This finding suggests that institutions are becoming less efficient over time while its subunits are relatively stable, if not improving. It again highlights that academic subunits are performing well when compared to units of a similar type and that institutional inefficiencies, where they exist, could be a result of non-academic units. The results reveal that despite academic units improving over time, institutions are becoming more inefficient, therefore non-academic units must be contributing to the decline.

Summary of Implications

The above findings suggest that the higher education production function is limited by its outputs. While the link between revenues and expenses is strong, the link between expenses and outputs is weak. However, when looking at the overall efficiency, institutions were performing roughly the same as their peers once controlling for Carnegie classification. This suggests that the production of outputs may not be a linear function of the inputs or processes, with additional expenses leading to greater outputs. Rather, institutions should look to perform at the optimal mix of inputs and outputs, as established by the market and their peers. When taking this viewpoint, institutions are indeed efficient in their production of outputs when compared to others. This does not rule out the possibility that higher education as a sector is performing inefficiently, but just that institutions are performing, in general, on par with other institutions of the same type. Therefore, measuring institutional performance based on their outputs alone, as is common with scorecards and performance funding, may not be the best option.

Maximizing outputs may not be feasible given the lack of variation in many output measures and the fact that most institutions are already performing at, or near, the frontier of production possibilities. Instead, the focus may need to shift to inputs, which exhibit greater variation and are more easily controlled by policymakers and administrators. If the actual production of outputs is only weakly related to expenses, then focusing on controlling the inputs may be the better option. With this approach, the model focuses on keeping outputs constant while reducing inputs. Rather than trying to increase graduation rates by an additional percentage point, which may be very expensive, this would cut inputs until the point where graduation rates were poised to decline. However, the measures of efficiency using this approach show that most institutions are already operating at the frontier. Changes in funding accompanying the cuts associated with the Great Recession have actually caused institutions to stray from their efficient point of operation. Further cuts may hurt the ability of institutions to produce educational outputs even more. If cuts must be made, they should focus on the non-academic aspects of institutions, the only area which is not directly related to student outputs and has the potential for improvements to efficiency. While such an input based approach may be a money saving option, it could threaten the publicness of higher education, leading to increased competition that stratifies institutions, threatens affordability, and limits enrollment opportunities. Therefore, the economic model of efficiency optimization and cost cutting may not be the socially responsible model.

CHAPTER VIII

CONTRIBUTION, FUTURE RESEARCH, & CONCLUDING REMARKS

In this final chapter, I conclude by describing the contribution to the field, the limitations of the study, and offer suggestions for future research. Overall, this study has sought to take the vantage point used by policymakers in their dealings with higher education. In particular, I use the efficiency evaluation perspective, which focuses on policies of governors, state legislators, and state boards of higher education to evaluate performance by measuring institutional outputs. In order to set up this approach, I began with an overview of the higher education landscape and the ongoing debate between the public and private nature and outputs associated with higher education. This is especially relevant given the current state of the economy and changing funding structures for institutions. State appropriations are rapidly declining while tuition and fees are becoming increasingly important to institutional operations. On the expense side, while instructional expenses have remained relatively stable, non-academic expenses have driven up the costs of higher education and, as identified in the later analyses, have contributed to the inefficiencies seen within institutions.

By taking this efficiency perspective, I used literature in the fields of higher education, political science, organizational theory, and economics to develop a production function for higher education in the modern era. This production function modified previous models to fit the non-profit nature of higher education and put additional focus on how higher education has changed since the Great Recession. This framework alone is a contribution to the literature, incorporating previous theory into a holistic model that accounts for modern day trends.

In addition, I gathered data from the Integrated Postsecondary Education Data System, University of Texas System, and Texas Higher Education Coordinating Board to empirically test the relationships in this type of a framework. This unique dataset combined information at the institutional, school, and departmental levels, allowing for the analysis to be conducted and compared across the different levels. The longitudinal nature of the data also allowed for the comparisons to be conducted over time. Again, the level of detail and the panel data provide a dataset that contributes to the understanding of how institutions work.

The results of the various analyses were relatively robust across the different model specifications. Whether it be using multivariate regression, fixed effects, stochastic frontier analysis, or data envelopment analysis, the results showed strong links between revenues and expenses. This was consistent to similar studies conducted before the onset of the Great Recession. However, the same strong relationships could not be found in the links between expenses and outputs. In addition, the frontier models suggested that no matter the model choice and setup, higher education is relatively efficient once controlling for the unit type. These findings are especially relevant to the literature because they take a holistic look at higher education, testing and re-testing the relationships in the higher education production function under different model specifications. The multitude of analyses, across the different levels, with the different models, and the different time frames provide a consolidated source describing the ins-and-outs of the higher education production function in the modern era.

Finally, the contribution extends beyond that of an academic nature. The efficiency perspective that I identify also provides lessons to state officials and institutional administrators. In particular, the chapter on implications extended the discussion of the higher education production function and how it applies to policy. First, funders have little to worry about in terms of congruence between funding and spending. Revenues are strongly associated with their relevant expenditures. However, given the lack of a strong relationship between institutional expenditures and outputs, it suggests that using performance funding may not be the best approach for managing higher education. Instead, students are likely the ultimate drivers of outputs. Rewarding institutions based on their outputs essentially funds them based on the quality of their inputs and their admissions. Colorado was used to illustrate one example where states took a student centered approach. However, the WICHE evaluation in Colorado suggested that there were unintended consequences which manifested through increased competition, a reduction in underrepresented and non-traditional students, and a potential stratification of the public higher education sector. Using performance funding, student centered vouchers, and other market mechanisms could lead to rapidly increasing tuition, reduced access, and future threats to equitable opportunities for underrepresented populations. Finally, the measures of efficiency suggested that higher education is operating efficiently when compared to peers. While it says nothing about the sector as a whole, institutions, schools, and departments are all competing at a similar, high inputs-to-outputs mix as their peers. This indicates that institutions are likely performing better than indicated by scorecards and rankings once taking their mission orientation into account. These policy relevant contributions can help inform future discussions around performance funding, vouchers, scorecards, and other reforms seeking to evaluate the performance and efficiency of higher education.

Limitations & Future Research

While this research has provided new insight into the higher education production and the relationships between inputs, processes, and outputs, there is still much work that can be done in this area. To begin, there are a few limitations to this study that can be improved upon in future research. As with many designs, the results are limited by the data. In this study, IPEDS has longitudinal data dating back decades, but it is fraught with missing observations on certain variables. Whether it be issues with the parent-child relationships, poor imputation by NCES, or simple nonresponse, missing data is problematic, particularly for smaller institutions. However, IPEDS is the best source of national and longitudinal data and should not be dismissed. In future research, a survey may need to be designed to help fill the gap in the knowledge of the higher education production function left by the inadequacy of IPEDS on certain items and directly ask questions regarding the inputs, processes, and outputs at an institution.

Moving to the other sources and levels of data, the data is limited to the University of Texas system. This limits the interpretation of the results to a single system within a single state. Gathering data at the institutional, school, and departmental level from institutions across the country would clearly be a better approach. However, this would be an incredibly costly endeavor both in terms of money and the time required to create panel data for the nation's hundreds of public, four-year institutions. Furthermore, the U.T. System included budget data from academic years 2008 to 2012, but the data from the Texas Higher Education Coordinating Board, which included output information, was limited to 2008 to 2011 and even further restricted to 2008 to 2010 for graduation information. This means the regressions with year fixed effects were limited to 3 years of data. This is a real threat to the study since fixed effects are best applied to panels with a long history and many observations per unit of analysis. This is the main reason that the cross-sectional results are also included. While fixed effects are the preferred model, the data is limited and thus the cross-sectional approach provides at lease a simplified model for analysis. Future research could benefit by replicating this study in other states, with a sample of institutions nationwide, and by collecting more data over time.

In addition, future research may benefit from additional specifications and models. For example, additional variables may be important as inputs or outputs. This approach focused on degree completions, retention rates, graduation rates, majors, semester credit hours, and the like. The literature identified these as being key variables of importance to policymakers (Rabovsky, 2013). However, variables such as publications, impact scores, test scores, and other measures of quality might be preferred by other researchers. Higher education offers a number of social services and benefits that are not fully captured by my variables alone; nor are they fully captured in any state funding model. While the performance of an institution on these variables may look to be inefficient, their devotion to other services may be just as important and warrant further consideration in subsequent models. Where possible, I tried to justify my choice in the model specification by using previous literature, but other specifications could easily be utilized. For example, this could be especially important when looking at differential outputs for non-traditional, low-income, and minority populations. In addition, while I focused on OLS, fixed effects, and frontier based models to test independent relationships and measures of efficiency, the case could be made that a model such as structural equation modeling could be an alternate approach, particularly given the setup of the production function framework.

Qualitative and mixed methods could also help contribute to the higher education production function. While this study has examined the relationships between inputs, processes, and outputs, future research could interview state policymakers and institutional administrators to uncover how allocations decisions are made, why institutions create programs, how these programs perform in producing outputs, where stakeholders see areas for improvement, and how these various answers, among others, match up to the empirical findings. Indeed, Craven's (1975) suggestion to learn how best to spend money and programmatically allocate money may be even more important than the amount appropriated.

Finally, the conceptual framework and lessons from these results can be applied to the evaluation of higher education reform and policy. Performance funding, accountability, vouchers, deregulation, scorecards, and other types of reform are still in their infancy. As the state of the economy has changed and the landscape of higher education has been forced to adapt, the findings from this study can help to inform policymakers and set up the evaluation of these policies and programs. In addition, these findings might be used to develop future policies that understand the key inputs and operations in the production of educational outputs while being cautious about the potential for unintended consequences and the lessons previously learned from reforms undertaken elsewhere. While many of these policies may look economically efficient, they could have detrimental social effects on certain student populations, exacerbating the threats to access and affordability rather than solving them through market reforms.

Conclusion

This study developed a new conceptual framework, tested this framework across multiple levels of analysis with a unique dataset and utilizing multiple models and specifications, linked the results to previous literature, and offered insight into the implications of these findings and how they are likely to affect current and future policy. In conclusion, not only has this study contributed to the academic literature, but it has situated itself within the broader field of higher education, paved a path for future research, and provided information to stakeholders interested in policy formulation and evaluation.

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APPENDIX

Table A.1

List of Public Universities Classified as Having Very High Research Activity (AY2013)

Institution Name
Arizona State University
Colorado State University-Fort Collins
Florida State University
Georgia Institute of Technology
Georgia State University
Indiana University-Bloomington
Iowa State University
Louisiana State University
Michigan State University
Mississippi State University
Montana State University
North Carolina State University at Raleigh
North Dakota State University
Ohio State University
Oregon State University
Pennsylvania State University
Purdue University
Rutgers University-New Brunswick
Stony Brook University
SUNY at Albany
Texas A & M University-College Station
University at Buffalo
University of Alabama at Birmingham
University of Alabama at Huntsville
University of Arizona
University of Arkansas
University of California-Berkeley
University of California-Davis
University of California-Irvine
University of California-Los Angeles
University of California-Riverside
University of California-San Diego
University of California-Santa Barbara
University of California-Santa Cruz
University of Central Florida
University of Cincinnati
University of Colorado-Boulder
University of Connecticut
University of Delaware
University of Florida
University of Georgia
University of Hawaii at Manoa
University of Houston
University of Illinois at Chicago
University of Illinois at Urbana-Champaign
University of Iowa
University of Kansas
University of Kentucky
University of Louisville
University of Maryland-College Park
University of Massachusetts-Amherst
University of Michigan-Ann Arbor
University of Minnesota-Twin Cities
University of Missouri-Columbia
University of Nebraska-Lincoln
University of New Mexico
University of North Carolina at Chapel Hill
University of Oklahoma-Norman
University of Oregon
University of Pittsburgh
University of South Carolina-Columbia
University of South Florida
University of Tennessee
University of Texas at Austin
University of Utah
University of Virginia
University of Washington-Seattle
University of Wisconsin-Madison
Virginia Commonwealth University
Virginia Tech
Washington State University
Wayne State University

Table A.2

Results of Fixed Effects by Functional Form, Expenses and Revenues per FTE (AY2008-2010)

	Instruction		Research		Public Service	
State Appropriations	0.05 (0.06)	0.33** (0.11)	-0.06 (0.03)	0.27*** (0.07)	0.01 (0.02)	0.00 (0.02)
Tuition & Fee Revenues	0.18** (0.07)	0.16* (0.07)	0.17*** (0.04)	-0.36*** (0.09)	0.04 (0.02)	0.04 (0.02)
Federal Operating Grants & Contracts	0.03 (0.07)	0.03 (0.07)	0.43*** (0.10)	0.36*** (0.10)	0.06 (0.04)	0.05 (0.04)
Sales & Services of Auxiliary Enterprises	0.07 (0.13)	0.10 (0.13)	-0.10 (0.08)	-0.24* (0.10)	0.02 (0.04)	-0.05 (0.05)
Other Sources of Operating Revenues	-0.17*** (0.04)	-0.17*** (0.04)	-0.17** (0.06)	-0.19** (0.06)	-0.04 (0.05)	-0.04 (0.05)
Other Sources of Nonoperating Revenues	-0.04 (0.04)	-0.05 (0.04)	0.08* (0.04)	0.15** (0.05)	0.01 (0.01)	0.01 (0.01)
Admissions Rate	-0.21 (0.41)	-0.00 (0.00)	-0.56* (0.26)	-0.00* (0.00)	-0.15 (0.11)	-0.00 (0.00)
Student-Faculty Ratio	-0.12*** (0.03)	-0.12*** (0.03)	-0.01 (0.01)	-0.01 (0.01)	-0.01* (0.01)	-0.01* (0.01)
State Appropriations Squared		-0.01** (0.00)		-0.01** (0.00)		
Tuition & Fees Squared				0.03*** (0.01)		
Sales & Services of Auxiliary Enterprises Squared				0.02* (0.01)		0.01* (0.00)
Other Nonoperating Revenue Squared				-0.01* (0.01)		
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Constant	2.38*** (0.53)	3.25*** (0.62)	0.83** (0.26)	-0.18 (0.51)	0.37** (0.13)	0.26 (0.15)
Within R-Squared	0.43	0.44	0.35	0.43	0.05	0.05
Between R-Squared	0.44	0.36	0.80	0.61	0.23	0.17
Total R-Squared	0.42	0.36	0.80	0.61	0.21	0.16
F-Statistic	44.75	41.72	14.19	16.75	4.54	4.40
Observations	1295	1295	1295	1295	1295	1295
Groups	457	457	457	457	457	457

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table A.3

Results of Stochastic Frontier Analysis, Logged Values for Institutional Models in AY2010

	Instruction	Research	Public Service	Student Services	Scholarships & Fellowships
Frontier					
State Appropriations	0.05***	0.08*	0.10***	0.04***	0.09***
	(0.01)	(0.03)	(0.03)	(0.01)	(0.01)
Tuition & Fee Revenues	0.81***	1.10***	0.93***	0.63***	0.66***
	(0.02)	(0.09)	(0.07)	(0.02)	(0.02)
Federal Operating Grants & Contracts	0.01**	0.19***	0.11***	-0.01**	-0.01
	(0.00)	(0.02)	(0.02)	(0.01)	(0.00)
Admissions Rate	-0.24***	-0.64	0.19	-0.18**	0.00
	(0.05)	(0.35)	(0.23)	(0.06)	(0.08)
Constant	3.78***	-3.45	-3.51*	5.66***	4.40***
	(0.35)	(2.60)	(1.64)	(0.50)	(0.47)
Usigma Constant	-11.71***	2.78***	2.35***	-3.74	1.74***
	(0.11)	(0.17)	(0.20)	(4.80)	(0.28)
Vsigma Constant	-2.42***	-1.15*	-1.32***	-2.00***	-3.90***
	(0.08)	(0.50)	(0.24)	(0.31)	(0.70)
Chi-Squared	3580.39	306.99	349.58	1381.91	1203.12
Significance	0.00	0.00	0.00	0.00	0.00
Observations	454	445	448	454	453

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table A.3 (Continued)

Results of Stochastic Frontier Analysis, Logged Values for Institutional Models in AY2010

	BA Degrees	MA Degrees	FT Retention Rate	4-Yr Graduation Rate	6-Yr Graduation Rate
Frontier					
State Appropriations	0.04***	0.03	0.00*	0.00	0.01
	(0.01)	(0.02)	(0.00)	(0.01)	(0.00)
Tuition & Fee Revenues	0.76***	0.97***	0.06***	0.15***	0.13***
	(0.02)	(0.05)	(0.01)	(0.03)	(0.02)
Federal Operating Grants & Contracts	-0.02***	-0.01	-0.00	0.02**	0.00
	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
Admissions Rate	-0.10	-0.48***	-0.11***	-0.32*	-0.16**
	(0.05)	(0.12)	(0.02)	(0.13)	(0.06)
Constant	-5.97***	-8.85***	3.70***	1.98*	2.30***
	(0.39)	(1.00)	(0.13)	(0.85)	(0.47)
Usigma Constant	-1.97***	1.07***	-4.19***	-0.47*	-1.69***
	(0.29)	(0.12)	(0.19)	(0.18)	(0.17)
Vsigma Constant	-2.79***	-2.60***	-5.53***	-2.07***	-3.67***
	(0.19)	(0.25)	(0.17)	(0.24)	(0.26)
Chi-Squared	2342.37	490.29	314.99	95.07	165.12
Significance	0.00	0.00	0.00	0.00	0.00
Observations	454	454	451	448	443

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table A.3 (Continued)

Results of Stochastic Frontier Analysis, Logged Values for Institutional Models in AY2010

	BA Degrees	MA Degrees	FT Retention Rate	4-Yr Graduation Rate	6-Yr Graduation Rate
Frontier					
Admissions Rate	0.16**	-0.15	-0.08***	-0.29***	-0.14**
	(0.05)	(0.16)	(0.02)	(0.09)	(0.04)
Published In-State Tuition & Fees	-0.29***	-0.25	0.08***	0.88***	0.38***
	(0.05)	(0.16)	(0.02)	(0.08)	(0.05)
Instructional Expenses	0.69***	0.93***	0.07***	0.19*	0.14**
	(0.06)	(0.14)	(0.02)	(0.09)	(0.05)
Research Expenses	-0.01	-0.01	0.00	0.00	0.01
	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)
Academic Support	0.08**	0.15*	0.01	0.05	0.04
	(0.03)	(0.07)	(0.01)	(0.08)	(0.04)
Institutional Support	0.00	0.01	0.00	0.04	-0.02
	(0.04)	(0.13)	(0.01)	(0.06)	(0.04)
Public Service	-0.01	0.01	-0.01***	-0.02	-0.02*
	(0.01)	(0.02)	(0.00)	(0.01)	(0.01)
Student Services	0.22***	0.04	-0.00	-0.17**	-0.01
	(0.04)	(0.12)	(0.01)	(0.05)	(0.03)
Scholarships & Fellowships	0.01	0.04*	-0.00	-0.03	-0.02
	(0.01)	(0.02)	(0.00)	(0.02)	(0.02)
Constant	-9.72***	-12.81***	3.36***	1.64*	1.94***
	(0.38)	(1.36)	(0.14)	(0.67)	(0.45)
Usigma Constant	-1.67***	1.06***	-4.18***	-0.47***	-1.70***
	(0.14)	(0.13)	(0.16)	(0.12)	(0.15)
Vsigma Constant	-3.54***	-2.22***	-5.92***	-2.94***	-4.59***
	(0.23)	(0.19)	(0.18)	(0.23)	(0.39)
Chi-Squared	3581.00	506.67	510.91	315.43	303.26
Significance	0.00	0.00	0.00	0.00	0.00
Observations	444	444	441	439	434

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table A.4

Results of Stochastic Frontier Analysis, Logged Values for Institutional Models with Fixed Effects

	Research	Public Service	BA Degrees
Frontier			
State Appropriations	0.01	0.03	
	(0.03)	(0.03)	
Tuition & Fee Revenues	1.20	0.79	
	(2.23)	(0.57)	
Federal Operating Grants & Contracts	-0.06	-0.03	
	(0.05)	(0.04)	
Admissions Rate	0.23	0.03	
	(1.01)	(0.14)	
Instructional Expenses			-0.03
			(0.51)
Research Expenses			-0.05*
			(0.02)
Academic Support			0.21**
			(0.07)
Institutional Support			0.23
			(0.29)
Public Service			-0.06
			(0.15)
Student Services			0.26
			(0.57)
Scholarships & Fellowships			-0.04
			(0.15)
Usigma Constant	1.13***	0.44	-2.62
	(0.23)	(0.27)	(2.38)
Vsigma Constant	-43.09***	-40.52***	-34.01***
	(0.08)	(0.13)	(6.61)
Chi-Squared	28.00	54.43	66.00
Significance	0.00	0.00	0.00
Observations	2623	2655	2927
Groups	455	458	502

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table A.5

Results of Stochastic Frontier Analysis, Logged Values for School Level Models in AY2010

	BA Degrees			Total Degrees		
Frontier						
Average Faculty Salary per FTE	0.25	0.47*	0.23	0.34**	0.37	0.23
	(0.22)	(0.23)	(0.29)	(0.13)	(0.29)	(0.14)
Average Classified Salary per FTE	0.14	0.07	-0.29	0.15	0.06	-0.46
	(0.37)	(0.37)	(0.45)	(0.28)	(0.36)	(0.26)
Administration Salary	-0.08	-0.09	-0.08	-0.08	-0.06	-0.08*
	(0.06)	(0.05)	(0.05)	(0.05)	(0.04)	(0.03)
TA Salary	0.04	0.01	0.01	0.02	0.01	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Wages	0.02	0.01	0.05	-0.03	-0.03	0.03
	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)
Travel Expenses	-0.04	-0.03	-0.02	-0.07**	-0.06*	-0.06**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
Miscellaneous Other Expenses	0.02	0.04	-0.01	0.04*	0.03*	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Majors	0.77***	0.65***	0.71***	1.04***	0.83*	1.13***
	(0.02)	(0.05)	(0.05)	(0.05)	(0.36)	(0.10)
Semester Credit Hours		0.25**	0.13		0.23	-0.09
		(0.09)	(0.08)		(0.41)	(0.10)
Published In-State Tuition and Fees			0.82			0.57**
			(0.47)			(0.22)
Admissions Rate			-0.27			-0.54***
			(0.24)			(0.16)
Constant	-1.42	-2.62*	-0.70	-3.90***	-3.58**	-0.70
	(1.13)	(1.24)	(1.52)	(0.91)	(1.11)	(1.24)
Usigma Constant	-1.11	-1.49	-1.58	-2.31***	-3.33	-4.53**
	(0.59)	(0.81)	(0.97)	(0.58)	(2.91)	(1.38)
Vsigma Constant	-2.96***	-3.07***	-3.71**	-3.55***	-2.91	-3.48***
	(0.36)	(0.58)	(1.23)	(0.68)	(1.62)	(0.59)
Chi-Squared	2176.08	1394.24	3858.39	1056.25	355.70	760.12
Significance	0.00	0.00	0.00	0.00	0.00	0.00
Observations	58	55	52	58	55	52

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table A.6

Results of Stochastic Frontier Analysis, Logged Values for Departmental Level Models in AY2010

	BA Degrees			Total Degrees		
Frontier						
Average Faculty Salary per FTE	0.10	0.11	0.22	0.38*	0.08	0.26*
	(0.24)	(0.10)	(0.13)	(0.19)	(0.15)	(0.13)
Average Classified Salary per FTE	0.79*	0.52	-0.10	0.63*	0.21	-0.47*
	(0.35)	(0.28)	(0.25)	(0.31)	(0.21)	(0.19)
Administration Salary	0.09*	0.00	-0.03	0.06	0.01	-0.03
	(0.04)	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)
TA Salary	-0.01	-0.00	-0.03	0.04	0.00	-0.03*
	(0.04)	(0.02)	(0.02)	(0.03)	(0.01)	(0.01)
Wages	0.11	-0.03	-0.05	0.10*	-0.01	-0.04
	(0.07)	(0.03)	(0.03)	(0.05)	(0.02)	(0.02)
Travel Expenses	-0.14	0.00	0.09	-0.10	-0.05	0.03
	(0.09)	(0.05)	(0.07)	(0.07)	(0.03)	(0.04)
Miscellaneous Other Expenses	0.09	-0.05	-0.01	0.05	-0.05	0.01
	(0.10)	(0.04)	(0.06)	(0.07)	(0.03)	(0.03)
Majors		0.69***	0.69***		0.91***	0.95***
		(0.01)	(0.01)		(0.04)	(0.03)
Published In-State Tuition & Fees			1.35**			1.58***
			(0.41)			(0.30)
Admissions Rate			-0.09			-0.20
			(0.15)			(0.11)
Constant	2.09	-1.85*	-2.57	1.19	-2.70***	-3.72***
	(1.50)	(0.90)	(1.47)	(1.19)	(0.72)	(1.10)
Usigma Constant	1.90***	-0.02	-0.33	0.46	-9.92***	-11.38***
	(0.11)	(0.26)	(0.37)	(0.26)	(0.30)	(0.12)
Vsigma Constant	-1.56**	-2.35***	-2.28***	-0.84**	-1.42***	-1.70***
	(0.49)	(0.45)	(0.40)	(0.30)	(0.18)	(0.19)
Chi-Squared	41.63	6635.01	5756.65	77.90	1276.66	1565.78
Significancce	0.00	0.00	0.00	0.00	0.00	0.00
Observations	248	248	230	248	248	230

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001

Table A.7

Results of Stochastic Frontier Analysis, Logged Values for Departmental Level Models in AY2010 by Department Type

	BA Degrees			Total Degrees				
	Humanities	Health & Nursing	Behavioral & Social Sciences	Science & Math	Humanities	Arts	Health & Nursing	Business
Frontier								
Average Faculty Salary per FTE	-0.14	-1.66***	0.05	1.82	0.35	0.36	-2.56**	0.87
	(0.12)	(0.43)	(0.21)	(1.12)	(0.39)	(1.91)	(0.88)	(0.80)
Average Classified Salary per FTE	0.44	1.48***	0.58	-0.61	0.04	-1.38	3.16***	2.56**
	(0.41)	(0.40)	(0.35)	(1.19)	(0.65)	(0.87)	(0.78)	(0.87)
Administration Salary	0.13*	0.03	0.02	0.09	0.13	0.56***	0.16*	0.47*
	(0.06)	(0.04)	(0.03)	(0.13)	(0.22)	(0.07)	(0.06)	(0.19)
TA Salary	-0.02	0.15*	-0.01	0.12	0.07	0.02	0.19	-0.04
	(0.02)	(0.06)	(0.05)	(0.08)	(0.10)	(0.09)	(0.13)	(0.08)
Wages	0.01	-0.11	-0.03	0.27*	0.16	0.09	0.37*	-0.10
	(0.04)	(0.09)	(0.03)	(0.12)	(0.17)	(0.06)	(0.18)	(0.17)
Travel Expenses	0.09	0.12	-0.00	-0.21	0.32	0.20***	0.05	0.12
	(0.09)	(0.12)	(0.08)	(0.27)	(0.35)	(0.06)	(0.23)	(0.14)
Miscellaneous Other Expenses	0.10	-0.15	0.04	0.28	-0.23	0.05	0.25	-0.01
	(0.07)	(0.08)	(0.06)	(0.21)	(0.27)	(0.10)	(0.17)	(0.13)
Majors	0.79***	0.71***	0.72***					
	(0.04)	(0.05)	(0.02)					
Constant	-2.08	1.58	-2.24*	-2.93	2.54	5.83	4.03	-8.22*
	(1.41)	(1.37)	(1.13)	(4.47)	(2.48)	(6.81)	(2.94)	(3.76)
Usigma Constant	-10.39***	-9.13***	-2.08**	-6.35***	0.21	-11.20***	-6.08***	-7.52***
	(0.38)	(1.16)	(0.75)	(0.57)	(0.83)	(0.32)	(1.49)	(1.49)
Vsigma Constant	-2.51***	-2.34***	-3.16***	0.15	-1.19	-2.41***	-0.74**	-1.21***
	(0.23)	(0.27)	(0.53)	(0.16)	(1.01)	(0.37)	(0.23)	(0.23)
Chi-Squared	944.78	785.12	3364.75	23.40	17.04	733.50	95.52	49.42
Significancce	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Observations	38	21	42	32	38	15	21	24

Standard errors in parentheses
* p<0.05 ** p<0.01 *** p<0.001