2018

STATE SUBSIDY COMPOSITION IN HIGHER EDUCATION: POLICY AND IMPACTS

Alex Eugene Combs
University of Kentucky, alex.combs383@icloud.com
Digital Object Identifier: https://doi.org/10.13023/etd.2018.370

STATE SUBSIDY COMPOSITION IN HIGHER EDUCATION:
POLICY AND IMPACTS

_____

DISSERTATION

_____

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
Graduate School at the University of Kentucky

By
Alex Eugene Combs

Lexington, Kentucky

Director: Dr. Eugenia Toma, Wendell H. Ford Professor of Public Policy

Lexington, Kentucky

2018

ABSTRACT OF DISSERTATION

STATE SUBSIDY COMPOSITION IN HIGHER EDUCATION:
POLICY AND IMPACTS

Higher education is the third largest state expenditure behind K-12 and Medicaid but is generally more discretionary than most other budget categories. As demographic trends and economic downturns constrain state budgets, the delivery of state subsidies in higher education has increasingly shifted toward students via grant aid and away from institutions via appropriations. Since the 1990s, many states have changed the composition of their state subsidies in higher education to varying degrees.

There is a rich literature that examines the effects of state subsidies on various aspects of the higher education market. This dissertation aims to contribute to the literature on two broad fronts. First, rather than state subsidy levels, theoretical and empirical emphasis is placed on subsidy composition, or the distribution of subsidies across three primary modes of delivery—appropriations, need-based grants, and non-need-based grants. This focus is meant to reflect the policy decision faced by states, especially during times of fiscal stress, and reveal insights into important economic considerations. Second, differential impacts of state subsidies are examined not only with respect to student ability and income but also college inputs of academic quality and amenities. College amenities are an important input in the higher education market in need of more theoretical and empirical analysis.

The introduction briefly discusses the economic rationale for public subsidies in higher education and the complexity confronting states to subsidize the cost of college under various constraints and policy goals. Chapter 2 aims to orient the reader to the policy, trends, and research pertaining to state subsidies in higher education. Chapter 3 theoretically examines the response in student demand for educational resources and amenities to changes in state subsidy composition from which several policy implications and directions for future research are considered. Chapter 4 focuses on subsequent effects that changes in demand between educational resources and amenities may have on institutions. State subsidies and institutional expenditures between 1990 and 2016 are examined in order to determine whether the composition of state subsidies causes in-state institutions to alter expenditures in a way that reflects a divergence between educational and amenity inputs. Chapter 5 considers the role of college student migration with respect

to state subsidies and student outcomes. State subsidies impact college choice, and in turn, alter the distance students migrate to attend college. The effect of distance on college student success is theoretically and empirically examined. Chapter 6 concludes with a summary and discussion of the main findings as well as ideas and directions for future research.

KEYWORDS: Higher Education, Public Finance,
            Economics of Education, State Budgeting

                              Alex Eugene Combs

                              September 5, 2018
                              Date

STATE SUBSIDY COMPOSITION IN HIGHER EDUCATION:
POLICY AND IMPACTS

By

Alex Eugene Combs

Eugenia F. Toma
Director of Dissertation

Eugenia F. Toma
Director of Graduate Studies

September 5, 2018

To my parents Jack and Sherry.
Any odds I've overcome
you made probable.
Any achievements I've earned
you made possible.

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

iv

LIST OF TABLES

LIST OF FIGURES

[1]
INTRODUCTION

PUBLIC INVESTMENT IN HIGHER EDUCATION

Higher education in the U.S. garners a substantial public investment. The federal government spent approximately $45 billion on higher education programs in 2014, excluding loans, and forewent another $35 billion in related tax expenditures (Oliff, Robyn, & Thiess, 2017). In addition, $1.3 trillion in student loan debt, almost all of which is serviced by the federal government, costs about $5 billion to administer each year and the CBO estimates $130 billion in losses on loans through 2026 (Cooper, 2016). State and local governments spent $90.5 billion on higher education in 2016, most of which is provided by states and represents the third largest spending category behind K-12 education and Medicaid.

This work examines the policy and impacts of state higher education subsidies across different modes of delivery. Before addressing such matters, let us first consider why governments make such investments. Behind the ongoing debate concerning public support for higher education lays two primary economic justifications for government to subsidize the cost of college: insufficient capital markets and positive externalities. Though policy might differ depending on which of the two government considers the dominant issue, they are not mutually exclusive. In fact, the case can be made that government intervention on the basis of insufficient capital markets is a narrower approach that still implies the presence of positive externalities that, in turn, ultimately explains the full assortment of public investment currently observed.

Attending college presents substantial upfront costs to an individual, while most of its economic benefit accrues over his or her lifetime via higher wages. Loans are a common financial product available to those wishing to purchase high-cost items with long-run returns, such as a house or car. The discount rate and risk of default inherent in all loans are accounted for in a loan's interest rate and requirement to provide collateral, such as the house or car just purchased, to be repossessed in the event of default. However, most prospective college students do not have such collateral to offer, and lenders have yet to devise a way to repossess a student's education.

The high risk of college loans translates to high interest rates in the private loan market that would presumably cause a nontrivial portion of the population to forego or delay college if not for public intervention. The federal government supplies an array of loans with lower interest rates and more generous repayment terms than the private market provides. For instance, in 2017-18 undergraduates were able to borrow at a rate of 4.45 percent through federal loans, while the average variable rate and fixed rate in the private market was 7.81 and 9.66 percent, respectively (Dickler, 2017). Without federal investment the private loan market would surely grow but not to comparable size nor offer comparable rates. As a result, the costs of college would rise, and college enrollment would decline.

Is fewer people going to college due to higher borrowing costs a negative outcome? Without much more information such a question is not remotely answerable. Whether public funds should be used to lower the cost of borrowing for college at all on economic grounds can be answered somewhat more easily. It depends. If higher education generates positive externalities, then a necessary condition has been met that potentially warrants the use of public funds to lower the cost of college. If capital markets are insufficient, then college loans are a promising area for public investment.

The chapters that follow are predicated on the presence of positive externalities in higher education. In other words, attainment of a college credential produces benefits that are not fully captured in the return received by the individual. In this respect, the higher education market is economically inefficient. Too few credentials would be pursued relative to what is socially optimal if left entirely to private market mechanisms. Standard theory suggests government can correct this inefficiency via subsidies commensurate with the value of the public benefit.

Additional options for public investment exist beyond college loans, namely direct subsidies to students in the form of grant aid or institutions in the form of appropriations. Again, provision of federal college loans on the basis of insufficient capital markets is another option. Of course, spending public funds with no intent of direct repayment, as is the case with grants and appropriations but not the case with loans, implies a degree of public benefit that many may find dubious (Rosen & Gayer, 2010). The extent to which the public should support higher education is under constant

debate and there is significant variation in that support at the federal and state levels over time.

The question of whether and how much government should subsidize higher education is not examined here. Instead, this work examines the effects of state subsidies as they are or have changed over time. Still, the normative issues regarding public subsidies in higher education provide important context to their effects. As policymakers decide how to finance higher education each year, the normative debate serves as a reminder there are potentially broad societal impacts with such decisions. This intersection between the normative and positive economics of higher education is particularly critical and complex at the state level.

STATE SUBSIDIES IN HIGHER EDUCATION

Unlike K-12 education, the public benefit of higher education is not so abundantly clear to the U.S. electorate as to gain enough consensus around the idea of free college for everyone. Although states such as Tennessee and New York are experimenting with free college under certain conditions, there remains considerable opposition to the notion of a completely democratized postsecondary system. The case against free college for all typically highlights the substantial private return of a degree and that an oversupply of college degrees would reduce that return. Moreover, there are issues other than positive externalities to consider when subsidizing higher education, such as equity or competing demands for public funds.

Measuring the public benefit of higher education is a challenge compared to the private monetary return of earning a degree. The latter is demonstrated via the wage differential between high school and college graduates, which suggests a private rate of return between 15 and 22 percent (Abel & Deitz, 2014; Zimmerman, 2014). Perhaps more important for policy, the college wage differential is easily observed by the public. Nevertheless, research consistently finds positive externalities associated with higher education. In a thorough review of this literature as well as his own analyses, McMahon (2009) determines that the total value of a bachelor's degree far exceeds its personal value, over half of which consists of public externalities. McMahon concludes 52 percent of the total investment in higher education should be publicly funded (p. 252).

However, the decentralized and fragmented nature of higher education complicates McMahon's recommendation that government should fund roughly half of the market. States are the legal administrators of higher education, but financial provision spans all levels of government. Federal government finances students via loans and grants as well as a significant portion of institutional research, state government primarily supports institutions but also students, and local government is an important contributor to community colleges. Even appropriations within the same state are not uniformly distributed across institutions in many cases (Chingos, 2017). Parsing out benefits that accrue to different levels of government so that each can invest accordingly is difficult.

Mobility of those who receive a degree presents yet another complication. Federal and state government invest in individuals' pursuit of a degree with the expectation of some return on that investment, but the way in which they do so differs substantially. Approximately 41 percent of federal spending on higher education is in the form of grant aid provided directly to students and only 5 percent is support to institutions. By contrast, about 13 percent of state spending is grant aid and 73 percent is appropriations. This difference between federal and state investments is due in part to the risk of losing on said investment under the assumption that benefits accrue to the government in which one resides. The likelihood that an individual exits the U.S. is lower than the likelihood he or she exits a state. Therefore, the federal government can attach most of its subsidy to the individual, while state governments direct most public funding to immobile institutions to lower tuition for in-state residents but also subsidize other aspects of institutional operations.

Meanwhile, state spending on higher education is being squeezed by rising costs in less discretionary budget categories such as K-12 education, Medicaid, pensions, and prisons (Kane, 2003; Delaney, 2011). Demographic trends and recent recessions have exacerbated state funding scarcity, leading to dramatic cuts to higher education. This, in turn, diminishes the positive externalities that would help reduce costs in competing budget categories (Muennig, 2000; Lochner & Moretti, 2002; McMahon, 2002). Moreover, a slow economic recovery has led to competition for new jobs through business tax incentives that further limit revenues. Recent trends have been described as a self-perpetuating cycle of disinvestment in higher education (Newfield, 2016). State

commitment to higher education as a public good, rather than a private enterprise, has come under intense scrutiny. Stated in a recent report from the State Higher Education Executive Officers Association (SHEEO), "For the first time in our nation's history, more than half of all states relied more heavily on tuition dollars to fund their public systems of higher education than on government appropriations" (2017).

State financing of higher education has changed in terms of levels as well as composition. Institution-specific funding per full-time equivalent student began declining in the late 1970s (Kane, 2003), but the sharpest decline has occurred during the years surrounding the recessions of 2002 and 2008 (Hurlburt, 2012). State support declined 12 percent in constant dollars nationwide between 2006 and 2015, falling from 61 percent to 52 percent of total institutional funding (SHEEO, 2015). Meanwhile, state expenditures on grant aid rose 31 percent. Since 1993, merit-based aid has become a popular option for state higher education finance. As of 2015, 25 states had broad-based merit-aid programs, and of the 10.5 billion dollars in grant aid awarded, exclusively merit-based aid accounted for 18 percent of all aid to undergraduates, while programs with both need and merit components accounted for another 34.5 percent (NASSGAP, 2015).

The preference to allocate or reallocate state funds to financial aid rather than appropriations is referred to as the high-tuition, high-aid model (HTHA) and is a central theme in the chapters that follow. The rationale for HTHA policies is they increase economic efficiency and equity. Decreasing appropriations increases statewide tuition, but it provides more funding for financial aid to insulate low-income students from the price shock. The result is a removal of subsidies for students who can afford the full cost of college (Hansen, 1971; Hearn, 1985; Hoenack, 1971; Windham, 1976).

However, the economic case for HTHA policy is with respect to need-based aid. The proliferation of merit-based aid complicates the debate over HTHA as it disproportionately benefits higher-income students (Heller, 2002; Heller, 2004) and crowds-out funding for need-based aid (Dynarski, 2002; Heller, 2002b; Long, 2007). Throughout this work, HTHA is used as a sort of shorthand for the broad state budgetary decision to allocate funds to grants rather than appropriations. While the level of funds available to subsidize higher education may be at the mercy of the demands of other

budget categories, states presumably have more control over the composition of subsidies.

COMPLEXITY OF STATE SUBSIDIES FOR HIGHER EDUCATION

A mixed methods study exploring state trends and decision-making in higher education finance revealed that many states desired to implement HTHA policy but lacked a coherent strategy to link available funds to policy choices (Hossler, 1997). A report by SRI International (2012) echoes this revelation, noting that "in many cases, [state] higher education funding policies are a historical mash-up of different priorities and strategic decisions" (p. 3). While to some this may indicate incompetence in state government, if one considers merely the broad economic and political factors involved in policy to provide subsidies in higher education, then the challenge confronting state policymakers seems rather daunting. Challenges compound considering that different subsidies may be more or less effective at achieving different goals, such as access versus degree completion, and there is not even clear consensus on what should be the primary goal.

States essentially have three modes of higher education finance: appropriations, need-based financial aid, and non-need-based financial aid.[1] In addition to the absolute amount of funding, there are two policy levers states have at their disposal with respect to the three modes of finance. First, states can alter the composition of funding. For example, South Carolina allocates almost 40 percent of funds to aid, almost all of which is non-need based. Virginia allocates a similar proportion to aid but divides it about evenly between need and non-need aid. Both Pennsylvania and Georgia allocate 20-30 percent to aid, but the former uses only need aid while the latter funds only non-need aid. Meanwhile, New Hampshire allocates 100 percent of funds to appropriations (NASSGAP, 2015).

The second policy lever pertains to financial aid eligibility criteria both in terms of whether a student is eligible for any funds as well as how much funding is available to each eligible student. Need-based aid is a fairly standard formula across states using the difference between cost of attendance (COA) and expected family contribution (EFC),

---

[1] Aid based on a mix of need and merit could be considered a fourth mode but is excluded here for the sake of parsimony.

but the amount at which need aid is capped varies. Accounting for differences in COA, two states could allocate the same amount of total funds for need aid, one of which has a relatively high cap that provides greater subsidy for fewer students, whereas a low cap ensures more students receive funding that does not cover as much of COA.

The criteria for non-need aid varies widely across states. These programs can be exclusively merit-based or a mix of need and merit. Merit can be based on high school GPA, scores on college entrance, state, or advanced curriculum exams, or class rank. The total amount awarded varies as well as the amount each merit component may be worth. Also, merit aid programs and their criteria are not very stable over time. The total number of programs fluctuates, and states modify criteria somewhat regularly, making it difficult for scholars and policymakers to stay up to date on the landscape. Though likely outdated now, Delaney and Ness (2010) developed a typology of state merit aid programs based on award magnitude and academic rigor. Their typology demonstrates the degree to which states differ with respect to the breadth of students whose college education is subsidized as well as the size of subsidy each offers.

As with any budget decision, how a state finances higher education reflects its politics and policy goals. Whatever those goals may be, state governments need to understand how each type of funding affects various types of students and institutions not only with respect to their own higher education market but also those in other states with which it interacts. Based on the variation across states, it is not clear if states have any common understanding regarding the impacts of its subsidies, their goals, or both. Perhaps the most broadly applicable description of state financing in higher education, given the discussion thus far, is that states are simply making tradeoffs among policy preferences in a budget-constrained environment.

Suppose a state government with no particular political or economic motivation other than to maximize the public benefits of higher education begins drafting the next budget. Economic downturn and structural budgetary imbalances require cuts in order to satisfy its balanced budget mandate, a portion of which must fall on appropriations. The cost of college will increase as a result, and in turn, decrease enrollment. Shifting a portion of the cut in appropriations to need-based grants can help insulate low-income students whose enrollment is most sensitive to the increase in price. This is a progressive

redistribution of wealth, though, and has limitations that depend on politics, but it is possible the state can maintain or even increase total enrollment while spending less on higher education if low-income students are induced to attend college by the larger subsidy. However, policymakers suspect such students are less likely to complete a degree and failing to do so places a burden on the student and possibly the state. Moreover, the smaller subsidy for higher-income students not eligible for need-based aid reduces the financial incentive to attend an in-state college. Attending an out-of-state college lowers the likelihood they will reside in state after graduation.

In response to these concerns, the state considers directing a portion of funds toward merit-based aid instead. On one hand, this will disproportionately subsidize college for high-income students who would have attended college anyway. On the other hand, it benefits talented and motivated students. Merit aid may also help retain some of the students who would have left the state to attend a higher quality college. However, by nature of their higher achievement and income as well as having more employment prospects, these students are more mobile after college graduation. Using public funds for merit aid poses its own political and economic issues regarding redistribution though. Of course, all of this is with respect to only a state's own market. States also stand to benefit from enacting policy that attracts and retains out-of-state students.

ORGANIZATION OF DISSERTATION

A few broad questions arise that if answered could help inform a coherent strategy in financing higher education at the state level regardless of a particular objective. These include:

1. How does a reallocation of state funds from appropriations to need- and/or merit-based aid affect student demand of higher education?
2. How might colleges and universities financially adapt to less guaranteed funding in exchange for potential grant dollars over which they must compete?
3. What effects will such changes have on student access and success?

This work attempts to contribute answers to each of the above questions through exposition of theory or empirical analysis.

Chapter 2 aims to orient the reader to the policy, trends, and research pertaining to state subsidies in higher education. There are many perspectives from which trends in appropriations and grant aid can be viewed. The change in subsidy composition over time across states is emphasized as motivation for further inquiry. In addition, state subsidy programs are numerous, and their governance varies across states. An overview of how different subsidies operate, and their common characteristics is provided to add context for proceeding chapters. Lastly, existing literature pertaining to state subsidies in higher education is reviewed and discussed. For state governments, guidance for the above questions is dispersed across several lines of research in need of consolidation and, in some cases, reconciliation.

Chapter 3 theoretically examines the response of college students to changes in state subsidy composition. A model of student demand is developed to demonstrate the effect of state subsidies across various subsets defined by the change in price they experience. Specific attention is given to how effects vary according to dimensions of student ability and income as well as institutional inputs of educational resources and non-academic amenities. Policy implications and directions for future research are then considered in the concluding remarks.

Chapter 4 focuses on the subsequent effects changes in demand pressures may have on institutions. State subsidies and institutional expenditures between 1990 and 2016 are examined in order to determine whether the composition of state subsidies causes in-state institutions to alter expenditures. Of particular interest is if the shifting of funds from appropriations to grant aid results in a state's postsecondary market becoming more heterogeneous with respect to educational quality and amenities. Provided institutional expenditures reflect college students' preferences, changes in demand are expected to manifest through expenditures.

Chapter 5 considers the role of college student migration with respect to state subsidies and student outcomes. Various higher education policies impact college choice, in turn, altering the distance students migrate to attend college. Evidence suggests that behavior among states and institutions reflect financial incentives to attract more out-of-state students, and whether state subsidy composition is a direct cause or not, college students are traveling farther to go to school. However, research concerning the effect of

distance on college student success is sparse. A theoretical framework that incorporates distance into the processes of college choice and success is developed to demonstrate that variation in distance has heterogeneous effects on success by type of degree pursued and sector of institution attended.

Chapter 6 concludes this dissertation with a summary and discussion of the main findings throughout the previous chapters. Additionally, ideas and directions for future research are considered. The debate concerning how much of higher education should be financed publicly is unlikely to end any time soon. Nevertheless, the fact that subsidies exist suggests state governments expect a return on this investment. As long as provision of higher education remains neither fully private nor public, what types of students receive subsidies and how much will remain a critical question.

[2]
STATE SUBSIDIES IN HIGHER EDUCATION:
TRENDS, POLICY, AND RESEARCH

TRENDS IN SUBSIDIES AND DEFINING HIGH-TUITION, HIGH-AID

The level and composition of state subsidies in higher education have changed substantially over the past three decades. Under mandates to keep budgets balanced, demographic trends and economic recessions have exacerbated state funding scarcity and allocations to K-12 education, Medicaid, pensions, and corrections generally take precedent over higher education (Kane, 2003; Delaney, 2011). **Figure 2.1** displays average state appropriations and undergraduate aid in constant dollars per FTE between 1990 and 2016. In this span, real appropriations have declined from $8,250 to $7,100, with significant drops corresponding to economic recessions. In contrast, grant aid per FTE has risen from $500 to $1,000 during this time.

Behind the rise in grant aid is a considerable change in the type of grants provided by states. States can provide grants to students solely on the basis of need, solely on the basis of merit, or a mix of need and merit. The latter two types are jointly described as non-need grant aid. **Figure 2.2** separates the average grant aid trend in figure 1 by need and non-need components. Non-need aid was virtually non-existent in 1990. By 2016, states provided almost as much non-need aid as they did need aid. In fact, non-need aid accounts for roughly 80 percent of the rise in total grant aid.

Of course, states vary along economic, political, and demographic dimensions, which are overlooked when depicting nationwide averages. **Figure 2.3** displays the percent change from 1990 to 2016 in appropriations on the horizontal axis and undergraduate grant aid on the vertical axis for each state. The dashed lines are located at zero percent change, thus creating a quadrant depicting whether states increased or decreased appropriations and grant aid. Only a few states have managed to maintain or increase appropriations, while most have decreased appropriations by 10 to 30 percent. Meanwhile, most states exhibit modest to substantial percent increases in grant aid since 1990. The majority of states are located within or very near the upper-left quadrant. These states have altered the composition of subsidies, shifting toward grants over appropriations, and it is clear these shifts differ significantly in magnitude.

Figure 2.1 - Average State Grant and Appropriations Dollars, 1990-2016
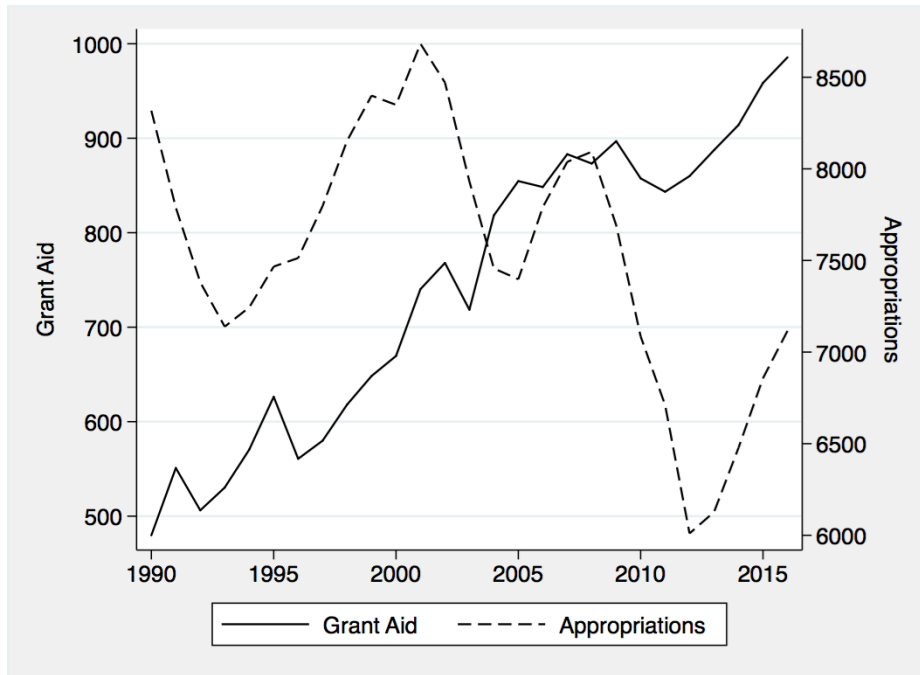
Figure 2.2 - Average State Need and Non-Need Grant Dollars, 1990-2016
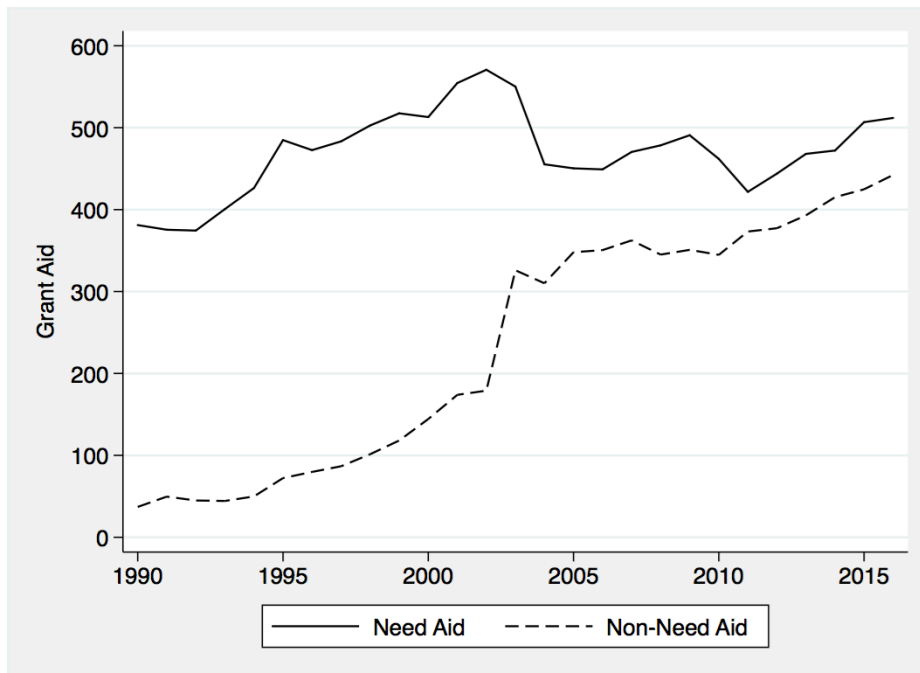
Figure 2.3 - Percent Change in Grant Aid and Appropriations by State
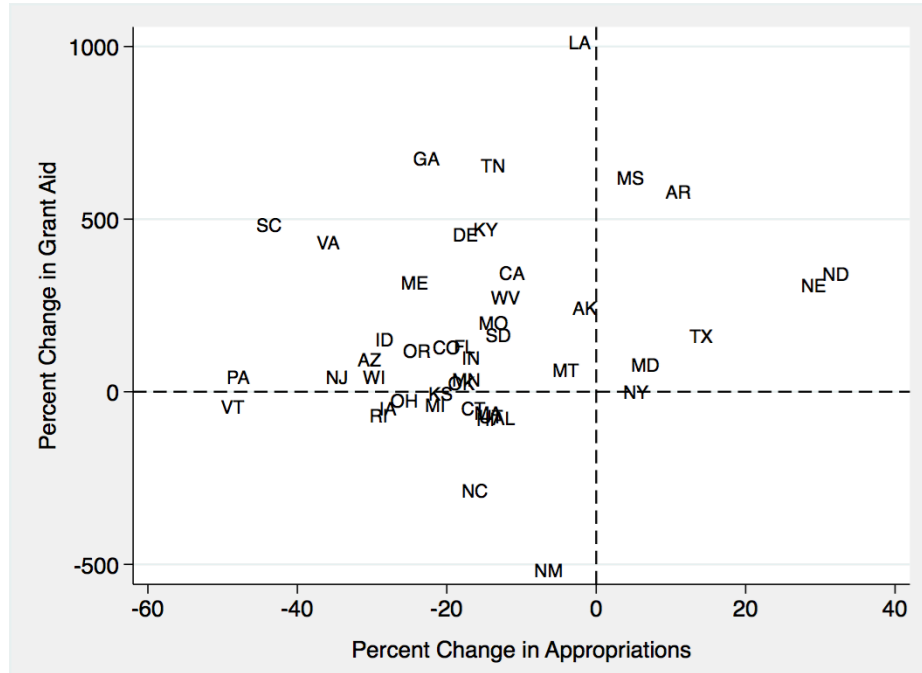
A decline in appropriations coupled with stable or increasing aid levels is commonly referred to as the high-tuition, high-aid model (HTHA). This name can be misleading in several respects. It is not used to suggest that a decline in appropriations necessarily leads to an increase in tuition, though it often does but not in exact proportion since institutions can decrease cost or raise other revenues instead of tuition. In any case, HTHA refers more to appropriations than tuition. Perhaps a more accurate term then is low-appropriations, high-aid (LAHA). Still, these names lead one to wonder high or low relative to what? One option is to use national average per capita ages 18-24 as a baseline (Toutkoushian & Shafiq, 2010).

Figure 2.4 displays state appropriations and grant aid per capita ages 18-24 in 2016. The dashed lines correspond with the average of each subsidy across all states. By this metric, a plurality of states falls into the low-appropriations, low-aid quadrant, though the distribution is fairly balanced across all quadrants. The examination of levels for each subsidy does not reflect the HTHA (or LAHA) narrative. According to figure 2.4, it would seem HTLA (or LALA) is more accurate. This is because the increase in aid has not kept pace with the decrease in appropriations, which is precisely the outcome to

Figure 2.4 - State Grant and Appropriations Dollars Per Capita Ages 18-24
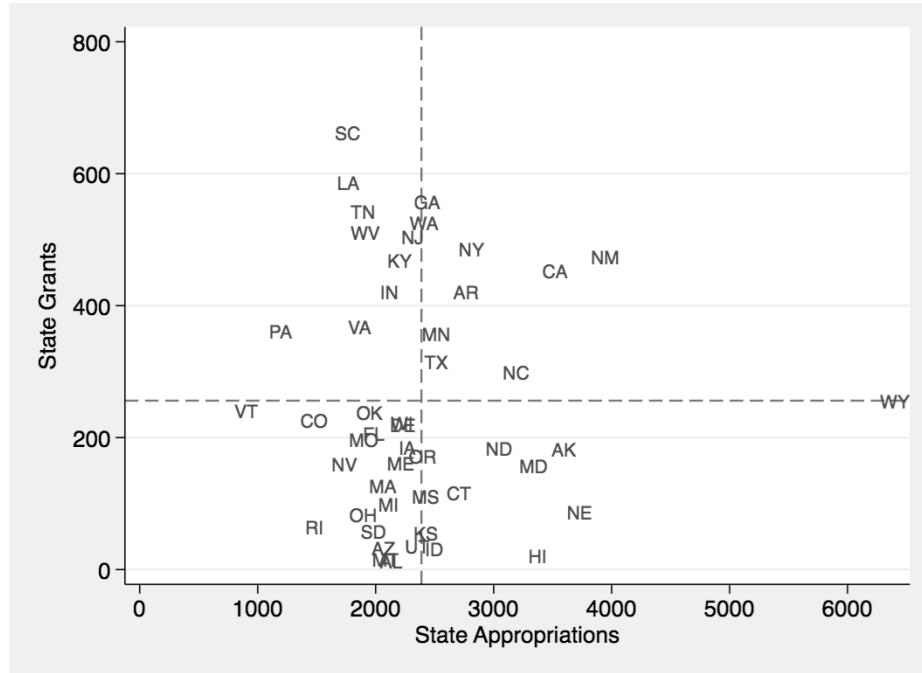
expect given states have decreased total subsidies in higher education over time. Instead, HTHA more accurately describes the change in subsidy composition. For instance, only 7 states were considered high-aid, while 35 states were considered high-appropriations in 2006. Ten years later, the number of high-aid states has increased to 18, while the number of high-appropriations states has decreased to 18.

This work examines the policy and impacts of state subsidies in higher education with particular focus aimed at their composition, of which HTHA has been a fairly dominant trend since at least 1990. Moreover, basic economic theory suggests HTHA is a sensible strategy to increase the efficiency of state subsidies. As a result, HTHA will occur frequently throughout. Given the various perspectives one can use to examine state subsidies, it is therefore important to establish a clear definition of HTHA for the purposes of the work that follows.

As a fundamental budgetary decision, whether forced by declining revenues or driven by political will, HTHA is an increase (decrease) in the proportion of total subsidies provided via grants (appropriations) regardless of total subsidy levels. HTHA is typically described in the context of total subsidy decline but can also occur when there is

14

an increase in total subsidies. In other words, HTHA represents the decision to target whatever amount of state funds are available at a subset of the college student population on the basis of some characteristic(s) that subset shares rather than distribute funds more equally across all in-state students who attend an in-state public institution.

Figure 2.5 shows average need- and non-need undergraduate grant aid as a proportion of total subsidies (undergraduate grants plus appropriations) in real dollars for selected years. Despite current trends, the former remains a small proportion of total subsidy—10 percent—relative to appropriations. Nevertheless, the change in composition is rather substantial. The proportion of need grants has nearly doubled from approximately 3 percent in 1990 to almost 6 percent in 2016. The proportion of non-need grants has increased from less than 1 percent in 1990 to over 4 percent in 2016.

Figure 2.6 displays total undergraduate need- and non-need-based grant aid as a proportion of total subsidies in 2016, the remainder of which represents appropriations. For a few states, grant aid accounts for more than 20 percent of their total subsidy, all of which can be in the form of need-based aid, as is the case in Vermont, non-need-based aid, as in South Carolina or West Virginia, or a combination of the two. Similarly, a few states allocate their total subsidy via appropriations, such as Alabama or Hawaii.

Figure 2.5 - Mean Need- and Non-Need Grants as Proportion of Total Subsidy

15
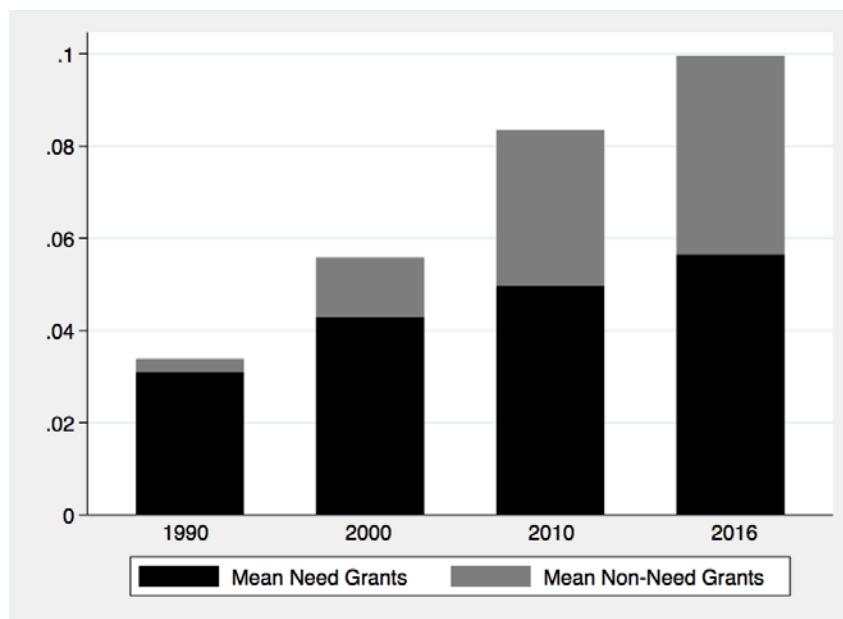
Overall, these trends demonstrate the basic motivation for examining the impacts of change in state subsidy composition. It should also be evident that the way in which higher education is publicly funded varies considerably across states. Driving these trends are numerous state grant aid programs and appropriations policies with various eligibility and payment features. It is important to understand how these state subsidies operate on a basic level as well as their general components over which states may or may not differ.

Figure 2.6 - State Proportions of Need, Non-Need, and Appropriations, 2016
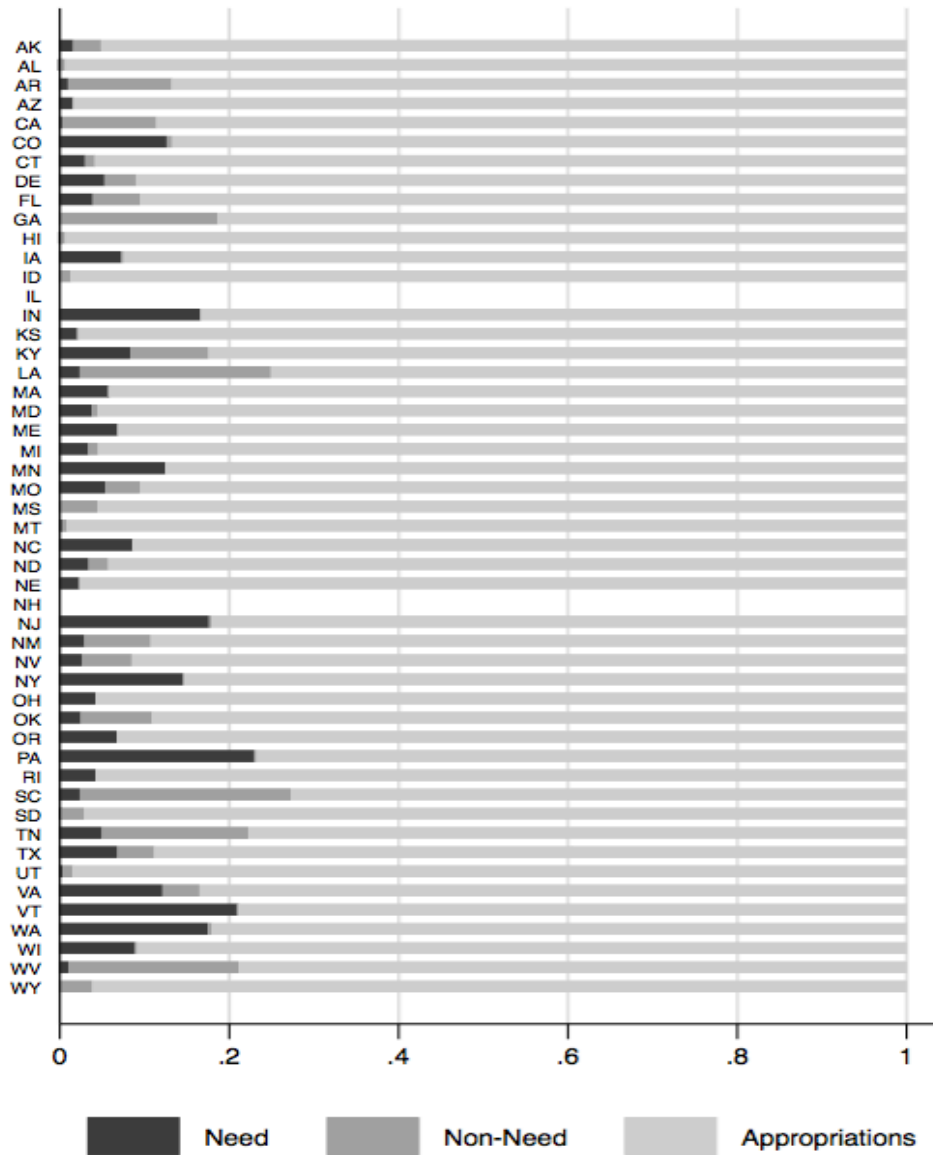
The National Association of State Student Grant and Aid Programs (NASSGAP) has conducted annual surveys since 1970 to report the landscape of financial aid provided at the state level. As of 2016, NASSGAP identified 583 unique state programs. **Figure 2.7** shows the distribution of these programs by type. Though states subsidize higher education through various programs, such as loans, tuition waivers, and work-study, almost 65 percent of all programs are grants. Of the $12 billion awarded in total, grants accounted for almost 90 percent and involve nearly 98 percent of recipients across all state programs. State grants may not make up the entire landscape of state subsidies targeted to students, but they represent most of it.

There is considerable variety in characteristics across grant programs, such as eligibility that is based residential status, whether the student attends an in- or out-of-state institution, enrollment intensity (e.g. full-time, half-time), and class (e.g. undergraduate, graduate). As previously mentioned, a key distinction between grant programs is whether they are awarded on the basis of need, merit, or a combination of both. **Figure 2.8** shows the total number of grant programs according to this distinction for 2016. Over half of

Figure 2.7 - Total Grant and Aid Programs by Type, 2016
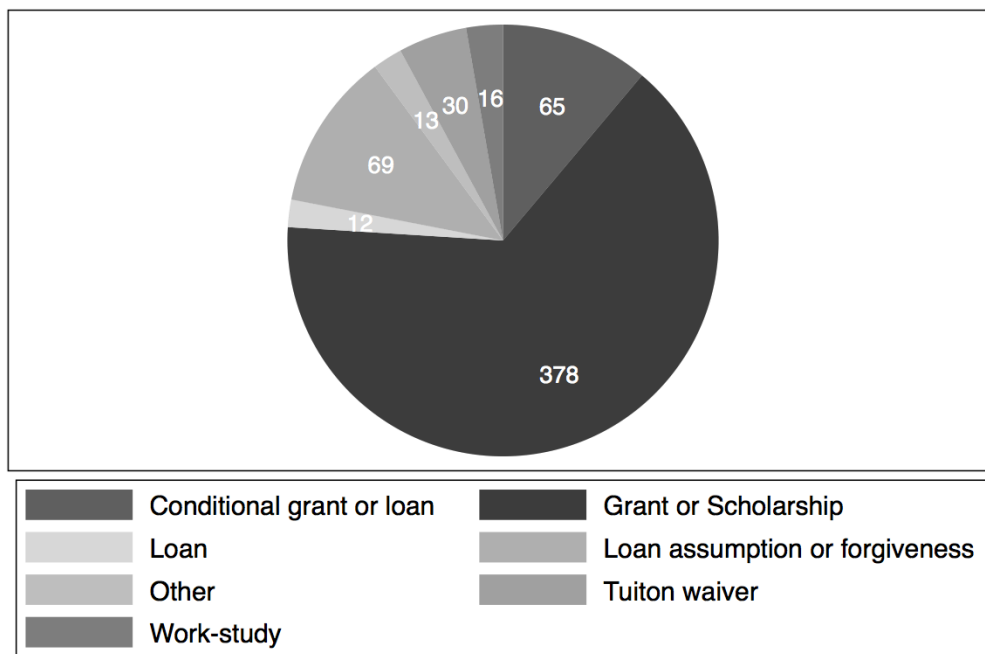
Figure 2.8 - Total Grant Programs by Type of Aid, 2016
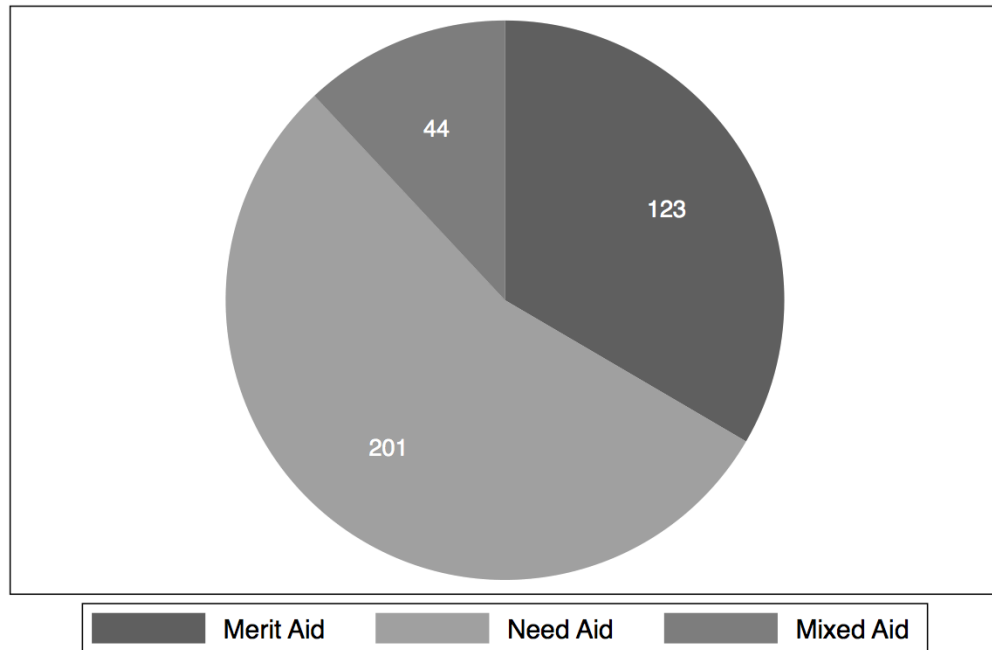
all grant programs are exclusively based on need, one-third are based only on merit, while mixed aid accounts for the remaining 12 percent.[2]

Determining eligibility on the basis of need is fairly uniform across states. Need is calculated as the cost of attendance (COA) at the chosen institution minus expected family contribution (EFC). Tuition and fees, room and board, books, supplies, transportation, loan fees, and other miscellaneous expenses are included in the calculation of COA. To determine EFC, a family's taxed and untaxed income, assets, benefits, family size and the number of family members attending college during the year are used. Students or families with incomes below $25 thousand have a $0 EFC.[3]

States determine how much to allocate to grant programs, so total expenditures on need grants is not mechanically responsive to the formula for need. Nevertheless, trends in COA and EFC determine how many students are in need and the size of award, which can place pressure on states to increase or decrease the total amount allocated. For example, the combination of rising tuition and stagnant incomes leads to more students needing larger awards. In turn, fewer eligible students receive aid if a state does not increase its allocation. In 2016, 24 percent of need grants funded all eligible students.

---

[2] The number of merit aid programs includes those that are not considered broad-based merit programs.
[3] https://studentaid.ed.gov/sa/fafsa/next-steps/how-calculated

A variety of additional features can be used to impact how need grants are distributed across students. One such feature is the maximum award a student can receive. All else equal, a high max relative to COA implies fewer students will have more of their cost subsidized. **Figure 2.9** displays the distribution of primary state need grant programs according to the proportion of the state's COA that is covered by the maximum award in 2015. Most states cover between 0 and 20 percent of their average COA, though there is considerable positive skewness. Since students eligible for state need grants are also likely eligible for federal Pell Grants, it is expected that states do not cover the full COA. Taking the maximum Pell award for 2015 into account, the median percentage of remaining COA covered by the max state award is 44 percent. Without EFC, it is unclear how many programs approach the full COA accounting for family wealth. From a programmatic perspective, half of states have structured their maximum need awards so that over half of COA minus Pell is covered for students with a $0 EFC.

There has long been concern over the perverse incentive for institutions to manipulate tuition so as to maximize the amount of revenue received through need-based grants. Award caps guard against this incentive going unchecked. Similarly, some states also place caps on EFC or income eligible to receive funding regardless of need, thus

Figure 2.9 - Proportion of COA Covered by Max Need Award, 2015
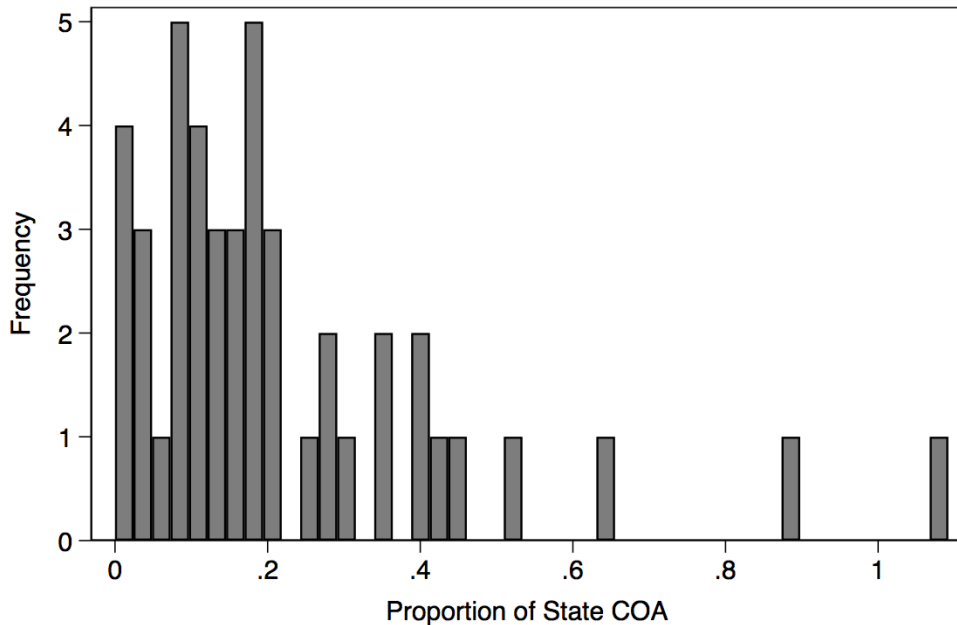
preventing need-based aid going to higher-income students who attend institutions with high tuition. Additionally, some states condition eligibility on attending a public institution, which typically does not have autonomous control over its tuition.

Comparatively, determining merit is much more variable across states. Specific eligibility criteria and how each are weighted in determining award amount are virtually unique to each state that has such a program. However, there are a few components over which merit programs can be categorized.[4] **Table 2.1** reports the percentage of merit and mixed grant programs that include common measures of merit, their source of funding, and the average award per recipient in 2016. Grades are the most commonly used merit component for both types of aid, followed by test scores for which the ACT or SAT are typically used. Relatively few programs use class rank or some other performance metric such as extracurricular involvement or community service.

Most of these programs receive general funds from the state, though some are funded via a state lottery. Very few are funded by a special tax or pooled tuition. The use of lottery funds for merit aid potentially complicates the narrative of state governments determining the composition of subsidies. Lottery funds are typically earmarked for

Table 2.1 - Merit and Mixed Aid Characteristics, 2016

	Merit Aid	Mixed Aid
Merit Components		
Test score	41%	31%
Class rank	20%	14%
Grades	81%	91%
Other	20%	11%
Funding Source		
General Funds	76%	70%
Lottery	15%	9%
Special Tax	1%	2%
Tuition	0%	2%
Average Award	$5,844	$2,709
Total	123	44

---

[4] For a more formally developed typology of merit aid, see Delaney and Ness (2010).

certain programs. Therefore, the decision-making process is not as straightforward as dividing a common pool of funds across types of subsidy.

A common criticism of merit-based aid for which there is some evidence is that it crowds-out funding for need-based aid (Rizzo & Ehrenberg, 2006; Long & Riley, 2007; Adelson, 2006; Dynarski, 2002; Heller, 2002). However, the counter has been made that much of this criticism assumes funding for merit-based aid would be automatically transferred to need-based aid. Merit-based aid programs have been characterized as a kind of entitlement in many states since all eligible students are guaranteed funding, in turn, making any attempt to shrink such programs difficult compared to need-based programs (Doyle, 2010). This may especially be the case for lottery funded programs. Still, even among the broad merit-based programs that are at the center of this debate, more are funded via general funds than lottery (Delaney & Ness, 2010).

Much of the concern over merit-based grant programs stems from what some consider to be an inequitable distribution of subsidies toward higher-income students. **Figure 2.10** compares how awards are distributed across income groups between the three types of grant aid using average dollars age 18-24 per capita in 2016. As expected, the amount of money distributed on the basis of need is decreasing in income with those

Figure 2.10 - Average Dollars Distributed Age 18-24 Per Capita by Income, 2016
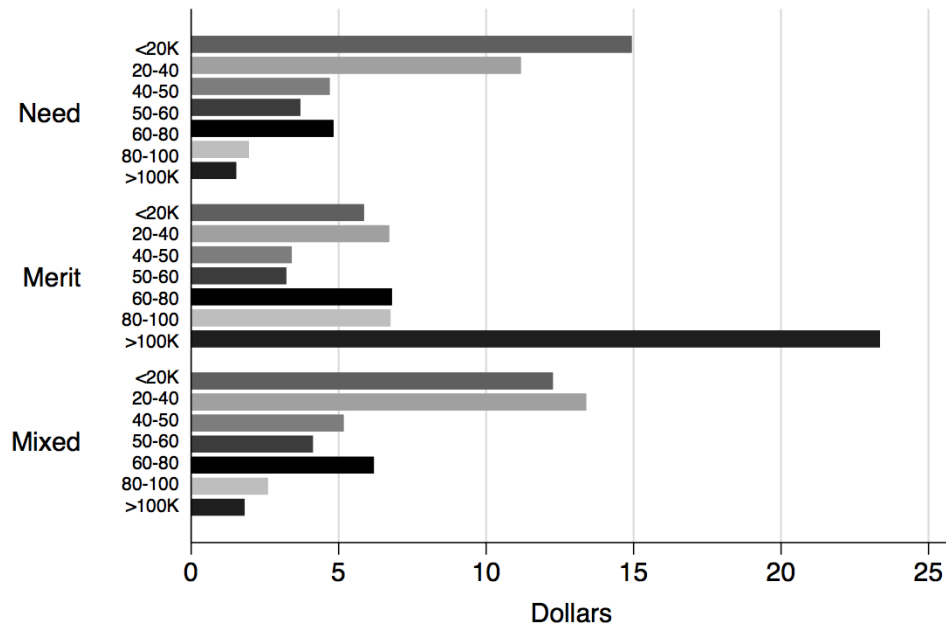
in the below $20 thousand and $20-$40 thousand receiving significantly more money on average than those in higher income groups. Mixed grants follow a similar pattern except that those in the $20-$40 thousand range receive slightly more than those below $20 thousand presumably due to the inclusion of merit. The distribution of merit-based grant aid is drastically different. Those with incomes above $100 thousand receive the most funds; more per capita than the low-income groups for need or mixed grants. Interestingly, the distribution is fairly uniform across the low- and high-income groups with somewhat less going to the middle-income groups.

The final type of subsidy to consider here is appropriations. Unlike financial aid, there is not a well-known compendium of information on state appropriations policy. Aside from the general decline in the level of appropriations and the recent popularity of performance-based budgeting in higher education, differences in appropriations policy across states receives little attention compared to financial aid. Though appropriations are primarily driven by enrollment, the specific components upon which the amount of funding institutions receive from the state is determined vary considerably.

A 2012 SRI International report provides perhaps the most recent and comprehensive information regarding state appropriations according to Chingos & Baum (2017). **Figure 2.11** comes directly from the report and displays the different methods states use for allocating appropriations. According to the report, 17 states use a formula to determine institutional funding, while another 14 states use a hybrid method where a formula may be used for some institutions or sectors but not all. Funding in 18 states is non-formula-based, the two most common varieties of which include a "Base Plus" method (i.e. incremental change from last year's allocation) and funding based on legislative priorities, such as peer equity with other states.

State formulas vary, and many states do not fully fund the amount indicated by the formula in times of fiscal stress. SRI International found that formulas typically consist of a subset of 10 budgetary functional areas, but three elements are common across all states: 1) instructional activities based on either enrolled or completed credit hours, 2) operations and maintenance of the physical plant, and 3) other components based on a percentage of the instructional funding level and therefore indirectly tied to enrollment levels (SRI, 2012). The result of this complexity and variation is significantly

Figure 2.11 - States' Methods for Distributing Appropriations
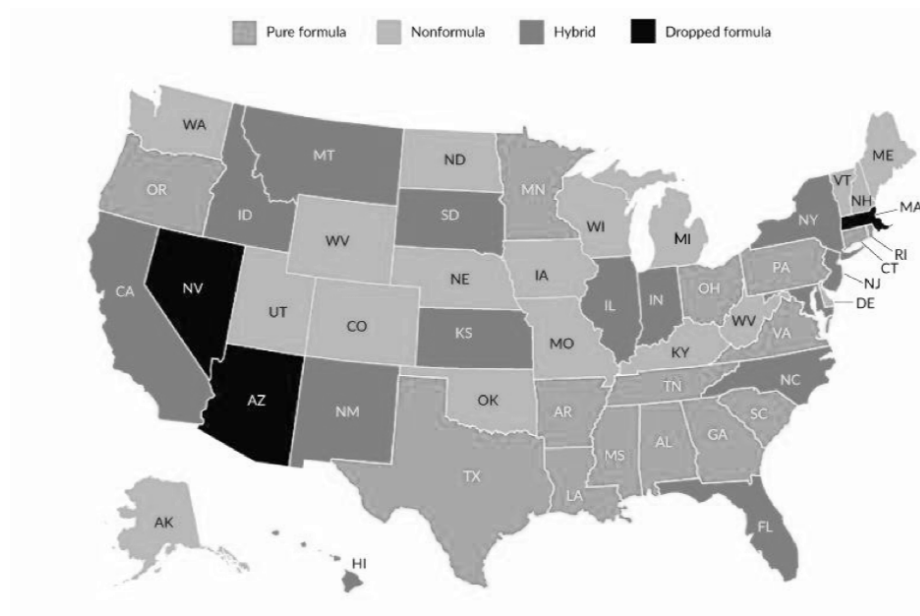
Source: SRI International, *States' Method of Funding Higher Education: Report for the Nevada Legislature's Committee to Study the Funding of Higher Education* (Arlington, VA: SRI International, 2012, 8).

different funding across institutions within states. According to a report from the Urban Institute, "In 18 states, the best-funded research university receives more than twice as much state appropriation per student as the research university with the lowest funding. The range is more than $10,000 a student in five states" (Chingos & Baum 2017, p. 8).

The within-state variation in appropriations has not been well-examined theoretically or empirically. Though not particularly impactful for the proportion of total subsidy that is ultimately allocated to institutions rather than students, it is important to be aware of the underlying mechanics of appropriations and their differences across states. These details highlight key comparisons when considering the allocation of state funds across subsidies. On one hand, appropriations are tied to enrollment and therefore share the fundamental purpose with grant programs to subsidize college. On the other hand, appropriations are distributed to institutions and fund operations with which students do not regularly interact or even observe. Whether or to what extent grant aid can substitute appropriations without significantly distorting the higher education market is unclear. As the next section will demonstrate, there is considerable literature examining

the effects of subsidies on aspects of higher education, but the specific impacts of subsidy composition need more study.

RESEARCH ON STATE SUBSIDIES IN HIGHER EDUCATION

To some, the decline of state appropriations for public colleges and universities may seem like a recent phenomenon, but institution-specific funding per full-time equivalent (FTE) student began declining in the late 1970s (Kane, 2003). Some of the earliest research on state subsidies emerged just prior to this, examining the distributional effects of changes in California's subsidies (Hansen, 1969; Pechman, 1970; Hansen, 1971). The key question was whether state funding of broad-based subsidies via appropriations disproportionately benefit higher-income students (i.e. regressive).

Hoenack (1971) derived maximizing conditions for the state of California under various objectives of increasing equality between student income quartiles. He concluded that greater equality can be achieved if the state redirected its subsidies toward the bottom quartiles, but this comes at the cost of lower enrollment among the top quartiles, choosing to enroll into private institutions or out-of-state. Eventually, equality results in lower overall enrollment and a significant cost to the state. Enrollment changes were simulated using an estimated demand for higher education for each quartile. To estimate demand Hoenack used differences in travel costs between high schools and campuses, representing one of the first direct connections made between state finance policy and student migration. The results of the simulation showed that appropriations in California were regressive.

The prevailing thought was efficiency and equity could be improved by diverting appropriations to need-based aid (Hansen, 1971; Hearn, 1985; Hoenack, 1971; Windham, 1976), but this argument has been challenged by more recent empirical work that found appropriations to be primarily neutral or slightly progressive (Johnson, 2006). Toutkoushian and Shafiq (2010) developed an economic model for optimal state funding between appropriations and need-based aid. They concluded that a state should implement a system of subsidy exclusively on the basis of need if the goal is to maximize college enrollment. The authors reach this conclusion assuming the positive externality of enrollment is the same for all students, thus the gain in positive externalities due to higher

enrollment among low-income students exceed any loss from lower enrollment among high-income students.

Broadly, the research indicates that appropriations increases overall enrollment and retention of college students within the state (Mixon & Hsing1994; Mak & Mancur, 2003; Groen, 2004; Long, 2004; Perna & Titus, 2004; Orsuwan & Heck, 2009; Toutkoushian & Hillman, 2012). The effect of need-based aid is mixed in this regard (Heller, 1999; Perna & Titus, 2004; Somers, 1993; Kane, 1995; Toutkoushian & Hillman, 2012). Lastly, the evidence is consistent that merit-based aid has a positive effect on enrollment and retention of resident students (Dynarski, 2002a; Kane, 2003; Cornwell, Mustard, & Sridhar, 2006; Desjardiins & McCall, 2009; Domina, 2014; Harrington, 2016).

Rizzo and Ehrenberg (2004) stand out in the literature for modeling a system of simultaneous equations for need-based grant aid, resident tuition, nonresident tuition, and nonresident enrollment among flagship universities across states. Theirs represents the first attempt to empirically examine the effect of appropriations on nonresident enrollment. They find no evidence that institutions raise nonresident enrollment in response to a decline in appropriations, but rather, increase resident and nonresident tuition. They also find institutions raise resident and nonresident tuition as the average tuition in the region increases, and students migrate more when tuition in their region is higher. In sum, as states decrease appropriations, institutions raise tuition, and students respond with a higher likelihood to migrate out-of-state.

Similarly, Jacquette and Curs (2015) investigated nonresident enrollment response to state appropriations utilizing a larger sample of four-year institutions during a more recent time period when state funding was changing more dramatically. They find decreases in appropriations are associated with higher nonresident enrollment but not resident enrollment. In other words, institutions increased the share of nonresident students as a source of additional revenue. The authors mention they could not determine how institutions achieved this change in nonresident enrollment but hypothesize that institutions utilize enrollment management techniques (e.g. prospective student searches and recruitment). The possibility that student demand also changes such that students are

more willing to migrate out-of-state, thus complementing institutional response to increase the supply of nonresident openings is not seriously considered.

Perna and Titus (2004) analyze the relationship between a variety of state policies and student choice of public versus private as well as in-state versus out-of-state institutions using a multilevel model controlling for various student- and state-level factors. State appropriations, need-based grant aid, and tuition are included in the analysis. They find a decline in state appropriations increases the likelihood of attending a public out-of-state or private institution, while an increase in need-based aid increases the likelihood of in-state attendance to both public and private four-year institutions. The authors also include a composite measure of student SES to demonstrate systematic differences in college choice. They find out-of-state and in-state private four-year attendance is increasing in SES, while in-state public four-year attendance was strictly decreasing in SES. This suggests state policies that redistribute subsidies on the basis of wealth will have heterogeneous effects across students and college sectors.

Using state-level panel data, Toutkoushian and Hillman (2012) examine similar relationships but also include state merit-based grant aid. They find appropriations to increase enrollment among in-state residents. Increases in merit-based aid had a larger impact on in-state enrollment than appropriations and reduced out-of-state enrollment. Lastly, there was no evidence that need-based aid had an effect on in-state or out-of-state enrollment. Overall, their study shares the most in common with this work in terms of framing state financing of higher education across these three types of subsidies.

Work by Epple, Romano, and Sieg (2006), Epple, Romano, Sarpca, and Sieg (2013), and Hoxby (1997; 2000) are particularly influential in considering the impacts of state subsidies on the higher education market when students differ along dimensions of ability and income. Each work develops partial or general equilibrium models of higher education to demonstrate a variety of outcomes. One outcome common across these models is that greater competition generally leads to higher costs/tuition, and greater stratification across institutions along student ability and income. This result is in part driven by the assumption that educational inputs, such as libraries or faculty quality, generate a greater return when used by higher-ability students or among higher ability peers. Institutional profit, quality, or prestige—however their objective may be

conceived—is increasing in the ability of its student body and therefore continually increase educational inputs to attract students of higher ability, which is positively correlated with income and requires higher income to attend.

Hoxby (2000) identifies specific drivers of market competition which include technological advances in telecommunication and travel, more transparency with regard to institutional and student quality, and tuition reciprocity agreements between states. She shows in-state attendance has declined consistently among public universities during 1949-1994 and the percentage of all students who applied to at least one out-of-state bachelor's-granting college has increased from 23.4 percent in 1972 to 43.2 percent in 1992. Moreover, the deterrence of distance-from-home on college choice has declined, a phenomenon that has since been examined in some more detail (Long, 2004).

Though not considered by Hoxby, a change in state subsidy composition consistent with HTHA also drives competition, analogous to school vouchers at the K-12 level. Rather than public funds going to institutions on a more egalitarian basis vis-à-vis appropriations, funds are provided to students over which institutions must compete. Also, it is possible HTHA policy is similar to tuition reciprocity agreements with respect to interstate tuition differentials. For students who are ineligible for aid, the in-state cost of college is expected to increase, approaching the unsubsidized price of college, thus approaching the tuition of out-of-state options.

Using their model of the market, Epple et al. (2013) simulate the impact of a $1,000 decrease in appropriations accompanied by a $1,000 increase in tuition for both in- and out-of-state students. Enrollment in state colleges declines 8 percent primarily among low-income students, while enrollment at private colleges increases slightly. This increase in demand for private colleges allows them to replace some higher-ability middle-income students for lower-ability higher-income students as well as increase tuition and expenditures. Meanwhile, the decrease in public college demand leads them to increase the ability admission threshold to in-state students (the authors model institutions to be quality-maximizing) and decrease the threshold for out-of-state students. As a result, the proportion on nonresident students increases.

The work by Epple et al. (2013) and Hoxby (1997, 2000) complement many of the studies previously discussed, revealing some of the mechanisms responsible for the

observed effects of subsidies on student and institutional behavior. For instance, not only do public institutions seek more nonresident students to recoup revenue lost through lower appropriations, as Jacquette and Curs (2015) conclude, but the heterogenous demand across student ability and income also contribute to this compositional change in students. Student heterogeneity in ability and income is critical to the discussion of HTHA, as it represents a shift in funding based on those very same dimensions. Though not examined, a decrease in appropriations accompanied by an increase in grant aid among subsets of students based on ability or income would likely compound some of the outcomes already discussed.

Models of the higher education market generally conceive institutional inputs as a single dimension of quality, which is indicative of the ubiquity of the human capital framework that explains college-going behavior as a function of the return to a degree. However, studies have shown college choice is also affected by college inputs that likely do not contribute to the value of a degree and instead a student's consumption while in college (Jacob, McCall, & Stange, 2018; Tuckman, 1970; Mixon, 1992; Mixon & Hsing, 1994). Including amenities as an input separate from educational quality could lend new insights into how changes to state subsidies affect students and institutions.

Recent work by Jacob, McCall, and Stange (2018) is especially relevant to the emergence of college amenities as an important factor in the higher education market. They are the first to demonstrate differential demand elasticities for educational quality, measured as expenditures on instruction and academic support, and amenities, measured as expenditures on student services and auxiliary enterprises across student ability and income. Higher-ability students, as measured by standardized math scores, have a substantially greater demand for academic spending but similar demand for consumption amenities. Conversely, higher-income students have a higher demand for consumption amenities than lower-income students but similar demand for academic spending.[5]

The theoretical models just discussed only account for heterogeneous demand for academic quality as a function of ability and/or income, not amenities. Furthermore, no

---

[5] The authors also include distance in their analysis and find that higher-ability and wealthier students are less sensitive to distance. I interpret this to be a byproduct of their higher demands for academic quality and/or amenities given that each are weakly increasing in distance—a subject that will be revisited in Chapter 5.

work has theoretically or empirically examined institutional supply-side behavior of academic quality along with amenities. Inclusion of amenities is arguably a small extension to existing theory, but it has serious implications for policy, including policy pertaining to state subsidies.

To reiterate, state subsidy composition involves the weighing of various priorities; to provide subsidies on an approximately egalitarian basis and lower the cost of college for all students or to target subsidies toward a subset of students on the basis of need (i.e. income) or merit (i.e. ability). The prevailing HTHA trend within many states decreases the cost of college for lower-income and/or higher-ability students and allows costs to rise for any student ineligible for aid. This presumably alters the ability and income distribution of enrolled students as well as which institutions—high/low academic quality, high/low amenities—experience an increase or decrease in demand. In turn, HTHA presumably has a secondary effect of altering institutional expenditures in response to changes in demand pressure. And, if state higher education finance is altering the colleges chosen by students, it is necessarily altering the distances they migrate to pursue a degree. Might there be unintended consequences for student success? The remaining chapters set out to investigate these possibilities.

[3]
STUDENT DEMAND AND STATE SUBSIDY COMPOSITION

This chapter develops a theoretical model of student demand to demonstrate the effects of composition in state higher education subsidies. Existing models of the higher education market offer insight into the effects of subsidizing the price of college when demand for college differs across student ability and income (Hoxby, 1977, 2000; Epple et al., 2006, 2013, Jacob et al., 2018), but the following work deviates in two notable ways. First, rather than model college quality as a single attribute related to academic quality (e.g. instruction, peer ability), college quality is conceived to consist of academic as well as non-academic resources referred to as amenities. This two-attribute conceptualization of college quality allows for heterogeneous demand for academic quality and amenities across levels of student ability and income that is evident in recent research (Jacob et al., 2018). Second, features of eligibility and distribution unique to state subsidy programs are thoroughly examined, among which student ability and income are key factors. The theoretical results explain certain higher education market phenomena in a novel way and motivate numerous avenues for future research which are discussed in the concluding remarks.

The proceeding sections give a somewhat technical treatment to a straightforward idea regarding the relationship between state subsidies and college student demand, the broad strokes of which are helpful to describe at the outset. College goods and services can be categorized as either an educational resource or amenity. Student demand for educational resources is increasing in student ability, and student demand for amenities is increasing (or at least non-decreasing) in income. A shift of state funds from appropriations to need-based aid diverges prices among students on the basis of income, while a shift of state funds from appropriations to merit-based aid diverges prices among students on the basis of ability. Moreover, for students ineligible to receive aid, the price of public in-state college approaches the price of out-of-state or in-state private college, making these institutions more likely to be chosen among students who generally have higher demand for amenities, especially if merit-based aid is part of a state's subsidy composition. In short, the HTHA trend in state subsidies present over the last 25 years

drives a divergence in demand between educational resources and amenities that has not been thoroughly examined.

HETEROGENEOUS STUDENT DEMAND FOR COLLEGE INPUTS

Assume students differ continuously along exogenous ability *a* and income *y*. Each college offers a package of educational inputs *e*, such as the quality and number of faculty, labs, and libraries, as well as non-educational, amenity benefits *b*, such as dormitories, cafeterias, and fitness facilities. Colleges differ continuously along these two inputs, both of which enter into student utility. Though colleges are discreet units, the higher education market is large and variable such that the college inputs over which students maximize utility—*e* and *b*—can be treated as continuous. The cost of attending a college given its bundle of *e* and *b* is denoted as *P*. Lastly, colleges set a minimum ability threshold for admission denoted $\underline{a}$, for which there is a function $g(\underline{a})$ that maps to the quantity of per-student educational resources the institution supplies.

Since Manski and Wise (1983) college choice is generally modeled theoretically and empirically using some variant of McFadden's (1973) choice model where a student chooses the institution that generates the greatest utility compared to all other feasible options, including the option of not attending college. Incorporating the terms described above choice can be represented by the following condition in which student *i* chooses college *j* if

$$U_{ij}\big(e_j(a_i), b_j(y_i), d_{ij}, (y_i - P_{ij}), \epsilon_{ij}\big) \geq U_{ik} \ \forall \ j \neq k \ with \ P_{ij} \leq y_i; \ \underline{a} \leq a_i \qquad (1)$$

where *d* is the nonmonetary cost of migrating the distance between a student's home to the college, $(y_i - P_{ij})$ is numeraire consumption of all other goods.[6] The error term ϵ is an idiosyncratic preference the student has for an institution and is assumed to be independent and identically extreme value distributed. Equation (1) leads to the estimation of the probability that student *i* attends feasible college *j* conditional on educational resources, amenities, ability, income, and price.

It is assumed student utility is increasing in educational resources $\frac{\partial u}{\partial e} > 0$ and amenities $\frac{\partial u}{\partial b} > 0$ at decreasing rates $\frac{\partial^2 u}{\partial^2 e} < 0$ and $\frac{\partial^2 u}{\partial^2 b} < 0$. Student ability and income are

---

[6] The role of distance in college choice and success is explored in detail in Chapter 5.

included in the arguments for *e* and *b* in (1), respectively, due to the following assumptions regarding utility and student type:

$$\frac{\partial^2 u}{\partial e \partial a} > 0 \tag{2}$$

and

$$\frac{\partial^2 u}{\partial b \partial y} \geq 0 \tag{3}$$

where (2) states the marginal utility of an additional unit of educational resources is increasing in ability, and (3) states the marginal utility of an additional unit of amenities is nondecreasing in income.[7] It is therefore assumed that demand for educational resources is increasing in ability

$$\frac{\partial \left(\frac{\partial u / \partial e}{\partial u / \partial y} \right)}{\partial a} > 0 \tag{4}$$

and demand for amenities is nondecreasing in income

$$\frac{\partial \left(\frac{\partial u / \partial b}{\partial u / \partial y} \right)}{\partial y} \geq 0. \tag{5}$$

Figure 3.1 illustrates the effect of these assumptions on demand between *e* and *b* as income increases—also known as the income expansion path (IEP)—between two hypothetical students. Student A has higher ability than student B. The solid lines illustrate demand if student preferences are homothetic (equations 3 and 5 equal 0). As income increases, the quantities demanded of *e* and *b* between students increasingly diverge with student A demanding a greater quantity of educational inputs relative to amenities and student B demanding greater quantities of amenities relative to educational resources. The dashed lines illustrate IEPs if demand for amenities is increasing in income. The quantity demanded of *e* and *b* is still divergent between students, but the quantity demanded of educational inputs relative to amenities is no longer constant.

---

[7] The intuition for (2) being positive is that educational inputs contribute to the production of human resource capital and ability is the technology one possesses that serves as a multiplier in the production process. The intuition for (3) being positive is less clear. It could be due to students reaching a limit to how much educational resources they can consume, mistakes in distinguishing amenities from educational inputs while ability and income are positively correlated, or amenities being close substitutes with other goods but at a lower per-unit price due to cost sharing across students. Jacob et al. (2018) find no evidence of heterogenous demand for amenities by income when using a random coefficients model.

Figure 3.1 - Example Income Expansion Paths
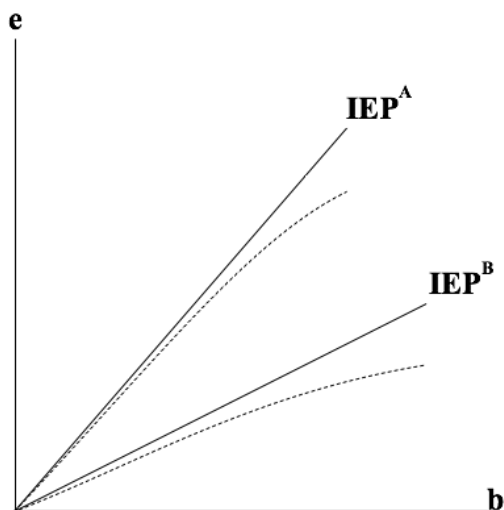
There are 4,275 Title IV participating, 2-year-and-above, degree-granting institutions in the U.S. according to the Integrated Postsecondary Education Data System (IPEDS). One could imagine these institutions placed in the figure above according to their per-student quantities of *e* and *b*, providing a virtual continuum of options that make marginal changes in demand possible. Intuitively, the probability that a student chooses to attend a particular institution is represented by its proximity to the student's optimal choice within the two-good space in figure 3.1, allowing for randomness in choice due to idiosyncratic preferences for certain institutions. This optimal choice is the latent student demand for colleges' attributes from which we observe a student's choice of the college that most closely supplies the optimal quantity of educational and amenity inputs.[8]

The unsubsidized price of college can be represented by the following equation

$$P = p_c(e + b) \tag{6}$$

where p_c is the per-unit price of *e* and *b*. Equation (6) asserts that educational resources and amenities are essentially inseparable in price, but their quantities can be separately observed. Moving forward the primary focus will be the effect of state subsidies on p_c and the subsequent effects on demand between *e* and *b*. State subsidies do not

---

[8] An alternative theoretical approach is the (linear) attributes model (Lancaster, 1966) where students are limited to consumption between one institution and at least one other good contributing to two or more activities that directly generate utility. Features of the higher education market do not translate naturally to this model, however. For example, there is not a continuous quantity of the institution attached to price.

discriminate between the costs of *e* and *b*, thus they would not distort the price ratio between the two if (6) were modeled with two prices.[9]

From (1) it is obvious that subsidies decrease *P* at a given level of *e* and *b,* and therefore increases the likelihood that a student chooses the subsidized institution over the unsubsidized institution, all else equal. A change in p_c operates like a change in income with respect to optimal choice of *e* and *b* as there is no substitution effect between the two to consider. In this case, a detailed analysis of choice between *e* and *b* as price changes would be unnecessary if subsidies were simply lump-sum provided to all students, as is the case with appropriations. Whatever the demand of *e* relative to *b* in a state is would not be altered, only the absolute quantities. However, it is the fact that grants are targeted on the basis of ability or income and that demand for *e* relative to *b* is heterogeneous in these dimensions that makes changes in p_c due to allocative decisions across various subsidies lead to potentially novel results and important implications for policy.

STATE SUBSIDIES

A state has three modes of subsidy: appropriations, need-based grants, and merit-based grants. The following assumptions are made regarding their provision: 1) the state allocates a total amount of funds between the three subsidies, thus making their respective allocations fully interdependent, 2) appropriations are delivered to in-state public institutions based on enrollment and fully pass through to reduce the cost of attendance by the amount allocated per-student, 3) need-based grants can be applied to only in-state public colleges, 4) merit-based grants can be applied to any in-state college, and 5) merit-based grants do not displace need-based grants.[10]

---

[9] Some amenities are clearly separated in prices, such as room and board, while others are included in tuition. How many resource categories are separated from tuition as well as how many of them are mandatory versus à la carte varies across institutions.

[10] These assumptions are an approximation and the rules pertaining to grants vary across states as discussed in Chapter 2. In states where grants have a different funding source from appropriations, allocations are unlikely to be fully interdependent. Full pass-through of appropriations assumes colleges do not increase inputs. A majority of states' primary need-based grant programs do restrict funds to public in-state colleges, while some states have separate need-based programs for private in-state colleges. Extenuating circumstances can lead to state grant funds being applicable to out-of-state colleges. Information on displacement between need- and merit-based grants is not readily available. At the federal level, Pell grants are not displaced by other funding sources.

Let $P^{[O,R,U]}$ denote a student's total expenditure on college given income, prices, and quantities chosen of e and b. Also, let l denote state appropriations, m merit-based grants, and n need-based grants, all of which are expressed as per-student amounts. According to the above assumptions, students potentially face three alternative prices based on the type of college and grant eligibility, and given quantities of e and b, represented by the following equations:

$$P^O = p_c(e^* + b^*)$$
$$P^R = [p_c - m(a)](e^* + b^*) \tag{7}$$
$$P^U = [p_c - l - m(a) - n(EFC(y))](e^* + b^*)$$

where P^O is the total expenditure on college outside of the state, P^R is the total expenditure on in-state private college, and P^U is the total expenditure for in-state public college.

The amount of merit-based grant earned is a function of ability given by the following equation

$$m = \min\{\bar{m}, \max[c_m \cdot (a - \underline{a}), 0]\} \tag{8}$$

where $\bar{m}$ is the maximum merit-based award, c is a non-negative constant multiplier, and $\underline{a}$ is the minimum ability required to receive a merit-based award. Equation (8) means students either receive the maximum merit-based award, an amount that is a linear function of his ability above some minimum threshold, or no award. Let S denote the total population of students in a state and s_m denote eligibility for a merit-based grant where $s_{mi} = 1$ if $a_i > \underline{a}$ and 0 otherwise. Therefore, the total number of students eligible for a merit-based grant is

$$S_m = \sum_{i=1}^{S} a_i^{RU} > \underline{a} \tag{9}$$

where students are indexed by i. The superscripts R and U correspond with (7) in that only students attending in-state private or public institutions are eligible to receive a merit-based grant. Eligibility versus actual receipt of a grant is a technical distinction. Equation (9) could alternatively be written without the superscripts, thus broadening the definition of eligibility to include any students who could receive a grant depending on the type of institution chosen. This distinction is relevant when considering how much

35

funding a state is actually liable for allocating and involves college choice to be discussed in a later section.

A state can alter its program via the minimum ability threshold, which alters the number of eligible students, the maximum award, or the constant multiplier, both of which alter the amount each eligible student receives. As student ability increases, the amount awarded to them increases. Equation (8) assumes this relationship to be linear and so the marginal change in merit-based grants with respect to ability is

$$\frac{\partial m}{\partial a} = \begin{cases} 0 & if \ a < \underline{a} \\ c_m & if \ \underline{a} < a < \frac{\overline{m}}{c_m} + \underline{a} \\ 0 & if \ \ \frac{\overline{m}}{c_m} + \underline{a} < a \end{cases} \tag{10}$$

which is simply the value of the constant multiplier. As the quantity of e demanded increases in a student's ability ($\frac{\partial e^*}{\partial a} > 0$), the provision of a merit-based award simultaneously decreases p_c by c_m, amplifying the divergence in demand for e and b between higher- and lower-ability students.

Figure 3.2 illustrates the effect of merit-based grants on choice between e and b among two hypothetical students in a state that also subsidizes via appropriations. Student A has lower ability than student B and is not eligible for a merit-based grant. Therefore, he faces the same budget constraint for out-of-state and in-state private colleges.[11] Due to state appropriations, student A could consume greater e and b at a public institution. Student B faces the same constraint as student A does for out-of-state colleges but her higher ability earns a merit-based grant that allows her to consume greater quantities at in-state private institutions at point E as well as public institutions on top of the state appropriations at point F. Note also that the ability constraint is higher for student B than it is for student A and is nonbinding in this case. If the state market comprised only of the two students in figure 3.2, then the effect of merit-based grants on demand for higher education amplifies the divergence in quantities of e and b demanded.

---

[11] It is important to note that, as in figure 3.2, these budget constraints do not exhaust all income. Therefore, a student could choose optimal e and b anywhere along the IEP depending numeraire consumption. This is why a point such as D can be optimal. If x was included in the figure, then point D would be at the intersection of the academic and the exhaustive budget constraint. The implicit assumption in these figures when comparing two students is they allocate the same portion of income to numeraire consumption.

Figure 3.2 - Effect of Merit-based Grant on Choice
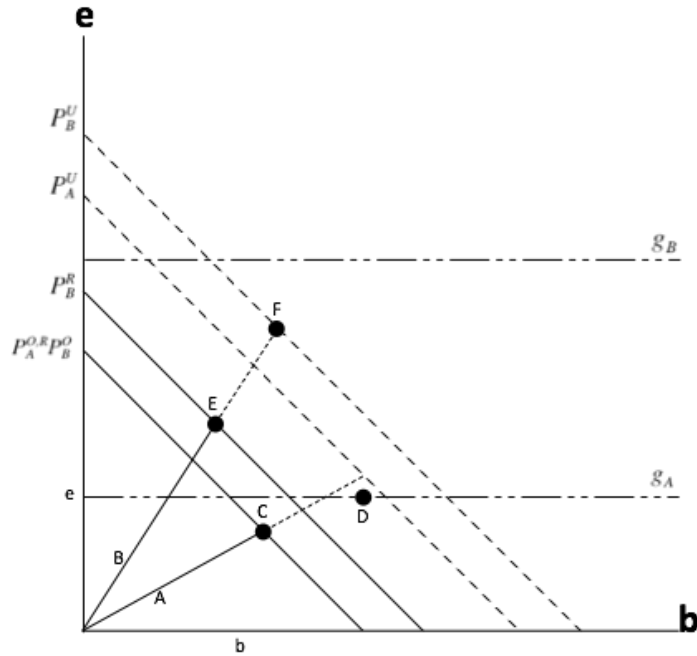
The amount of need-based grants is a function of income and total expenditures on public in-state college given by the following equation

$$n = \min\{\bar{n}, \max[P^U - EFC(y), 0]\} \qquad (11)$$

where $\bar{n}$ is the maximum need-based award and EFC is expected family contribution.[12] Equation (11) establishes that a student receives either the maximum need-based award, the amount necessary to offset the difference between total expenditure and EFC, or no award. Eligibility for a need-based grant is denoted as s_{ni} where $s_n = 1$ if $P_i^U > EFC$ and 0 otherwise. The total number of students eligible for a need-based grant is therefore

$$S_n = \sum_{i=1}^{S} P_i^U > EFC(y_i) \qquad (12)$$

EFC is a fairly complex formula that involves student dependency, income, assets, and family size. For simplicity, let EFC follow the formula

---

[12] As discussed in Chapter 2, need-based grant aid is determined by COA-EFC. COA includes costs not captured by P as it has been defined here, so (16) is only representative of how need-based aid is determined. This distinction should not make much difference on the demand side but potentially has important implications if the supply-side was considered. For instance, tuition at public institutions is partially controlled by state government in many cases whereas amenity categories are not. If a public institution cannot raise tuition enough to offset a reduction in state appropriations, it may be inclined to raise the cost of room or board to recoup lost revenue since these items are included in COA.

$$EFC(y) = \max[c_n(y - \underline{y}), 0] \tag{13}$$

where $0 < c_n < 1$ and $\underline{y}$ is a minimum income threshold. Therefore, the change in EFC with respect to income can be described by the following conditional equation

$$\frac{\partial EFC}{\partial y} = \begin{cases} 0 \; if \; y < \underline{y} \\ c_n \; if \; y > \underline{y} \end{cases} \tag{14}$$

Holding numeraire consumption constant, P^U in (11) changes for two reasons. The first is a change in per-unit price p_c. The marginal change in need-based grant awarded with respect to p_c is

$$\frac{\partial n}{\partial p_c} = \begin{cases} 0 \; if \; P^U < EFC \\ 1 \; if \; EFC < P^U < EFC + \bar{n} \\ 0 \; if \; EFC + \bar{n} < P^U \end{cases} \tag{15}$$

meaning there is a one-to-one offset in price for those eligible for need-based grants up to the maximum award. a one-dollar decline in, say, appropriations would be offset by a one dollar increase in need-based grants for those eligible who do not reach the maximum award and attend a public institution. If colleges were allowed to price discriminate in this model, (15) motivates the concern that need-based grants enable colleges to extract greater rents. A college could simply raise its price of attendance on eligible students until the maximum award is reached.[13] The second case in which there is a change in P^U is with a change in income. The change in EFC due to a change in income must also be considered. Doing so, the marginal change in need-based grant with respect to income is

$$\frac{\partial n}{\partial y} = \begin{cases} 0 \; if \; P^U < EFC \\ \frac{\partial P^U}{\partial y} - c_n \; if \; EFC < P^U < EFC + \bar{n} \\ 0 \; if \; EFC + \bar{n} < P^U \end{cases} \tag{16}$$

which implies there is less than a one-to-one offset for each dollar allocated toward college as income increases unless income is below the minimum threshold in which case $c_n = 0$.

Figure 3.3 illustrates the effect of need-based grants on choice between e and b among the same hypothetical students in figure 3.2. The overall effect is similar to merit-

---

[13] Epple et al. (2013) demonstrate this result with respect to federal grant aid (i.e. Pell) and private institutions. Since states can limit the extent to which public universities raise tuition and many states limit the receipt of need-based grants to attendance at public institutions, this perverse incentive is less of a concern.

based grants in that the budget constraint shifts outward, potentially increasing the divergence in demand between e and b. However, since need-based grants are a function of income, which itself enters into the graph, how the budget constraint moves in response to price is somewhat more complicated.

The maximum need-based award $\bar{n}$ establishes a floor beneath which every dollar allocated to e or b at an in-state public institution is fully matched for those students whose income is below the minimum threshold $\underline{y}$.[14] All of these low-income students share this minimum budget constraint, and since the funds cannot be allocated toward other goods, optimal choice falls on line Z regardless of preferences. Beyond line Z, each dollar allocated toward college is offset by a proportion equal to $1 - c_n$. As a result, this proportion is equal to the amount an eligible student's budget constraint expands.

Suppose line Y represents the budget constraint for an in-state public institution if there were no need-based grants and given an allocation to other goods. The budget constraint with a need-based subsidy expands outward by the percentage of each dollar offset by the grant to line Y′. However, in this example, the maximum award is reached

Figure 3.3 - Effect of Need-based Grants on Choice

---
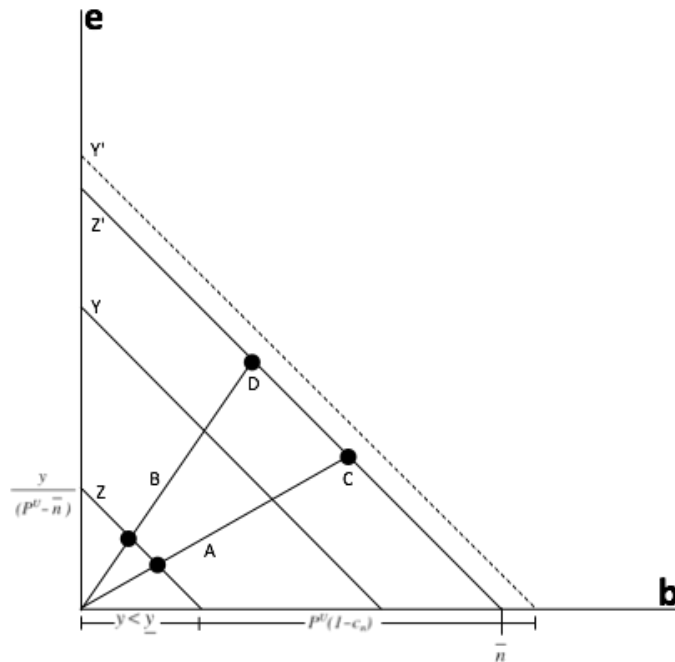
[14] For example, dependent students in a family with an income below $25,000 automatically qualify for zero EFC.

at line Z′ beyond which a student receives no additional aid. Therefore, optimal choices are at points C and D along line Z′. Lines Y and Y′ move in tandem and whether optimal choice is on line Y′ depends whether it is above or below the maximum award constraint Z′.

Lastly, relative to grants, the allocation of state appropriations and their effect on student budget constraints are quite straightforward. Since appropriations are allocated to institutions, student income or ability obviously do not affect amounts directly. Appropriations are a lump-sum subsidy based on enrollment and all students who attend an in-state public institution are beneficiaries. Figure 3.2 already demonstrated the effect of appropriations on student budget constraints relative to other institution types. Regardless of the type of institutions for which grant funds can be applied, in-state public institutions have the outward-most budget constraints due to the additional reduction of l assuming its value is positive. The marginal change in the per-unit price of e and b with respect to l is equal to 1, and the change in quantity demanded depends on the marginal change of P^U with respect to price.

COMPOSITIONAL CHANGE IN SUBSIDIES

As the previous section demonstrates, state government has numerous options to modify its subsidy programs for higher education, any of which fundamentally involve a change in level or composition. The overall increase or decline in state subsidies in higher education is an important policy issue that impacts how much students must personally pay for college as well as how institutions must fund themselves. The composition of state funds across different subsidy types, on the other hand, involves *which* students receive public funding and represents a policy decision to target public funds to a subpopulation of students on the basis of income or ability rather than a more egalitarian basis. The previous section examined how levels of each subsidy may affect student demand on a theoretical basis, but there are additional dynamics to consider regarding changes in subsidy composition, especially those that reflect actual trends.

Chapter 2 made clear that the dominant trend in state financing of higher education—in terms of how total funds are allocated across different types of subsidy— follows the high-tuition, high-aid (HTHA) model. Particularly during times of economic

stress, states decrease appropriations while largely maintaining or even increasing state grant aid. Moreover, these compositional changes tend to stick. Appropriations do not recover to pre-recession levels quickly if at all and grants appear more difficult to reduce once citizens have been entitled to them.

Let us now examine the potential impacts of an HTHA compositional change in state subsidies on student demand between e and b. It is assumed that the primary goal of a state that implements an HTHA policy is to reduce total spending on higher education by reducing appropriations while a proportion of the reduction may be reallocated to need- and/or merit-based grants. Let t denote the per-student amount subtracted from appropriations, v denotes the amount of t reallocated toward need-based grants, and w the amount of t reallocated toward merit-based grants. Together, v and w comprise the total replacement r, all of which can be described by the following equations

$$w = \frac{\partial m}{\partial t} t$$

$$v = \frac{\partial n}{\partial t} t \tag{17}$$

$$r = w + v$$

where it must be the case that

$$0 \leq r \leq \frac{s}{s_n + s_m} t \tag{18}$$

to ensure the state spends less on higher education after the HTHA policy. The post-HTHA expenditure given an optimal quantity of e and b for each type of institution is now

$$P'^O = p_c(e^* + b^*)$$

$$P'^R = [p_c - (m + w)](e^* + b^*) \tag{19}$$

$$P'^U = [p_c - (l - t) - (m + w) - (n + v)](e^* + b^*)$$

In other words, r is the total amount of funds a student receives in return for the reduction in appropriations.[15]   Also note that HTHA potentially increases the price only of in-state public schools, while the price of in-state private schools potentially decreases.

---

[15] It is assumed students/families do not receive additional income via lower state taxes allowed by the reduction in appropriations. Since HTHA is typically an attempt to balance the budget in times of fiscal stress, it seems fair to assume state taxes are not a serious omission in demonstrating impacts on demand, at least in the short-run.

If $r = t$, then eligible students receive an amount of grant aid equal to the amount lost in appropriations ($P^R = P'^R$ and $P^U = P'^U$ for all S_n and S_m). However, another trend made clear in Chapter 2 is that the average increase in grant aid has not kept pace with the average decrease in appropriations. Therefore, it is likely that r is strictly less than its upper-bound in (18) and that $r < t$ for a majority of students. Clearly, as r varies, so too do the effects of HTHA on student demand. Moreover, because w and v are not necessarily equal or change in proportion, and receipt of financial aid depends on student income and ability, effects can vary for any given value of r depending on the relation between v and w, as well as the ratio of total students to students eligible for each grant type.

A few basic conclusions can be reached regarding state grant funding limitations according to the general HTHA case described by (17)-(19). First, in order for all eligible students to receive an amount of grant aid greater than or equal to the amount lost in appropriations ($r \geq t$), then $S_n + S_m \leq S$. Therefore, the value of r relative to t is a policy decision that involves not only the proportion reallocated to grants but also the eligibility criteria that determines the size of recipient groups. If a state structures its grant programs such that $S_n + S_m > S$, then only for those eligible to receive both types of grant aid is it possible for $r \geq t$. For all remaining students, the result is an increase in the price of in-state public higher education. If a state is concerned with achieving a particular value of r, it seems unlikely without strategically linking decisions between appropriations and grant aid policy.

It is assumed that $S_n \neq S_m$, though it may possible for a state to structure its eligibility criteria so that the two are equal. Nevertheless, it is highly unlikely the distribution of student ability and income would result in the two subsets being equal. Given the two subsets of students do not perfectly overlap, in order for all eligible students to receive an amount of financial aid greater than or equal to the amount lost in appropriations, then it must be the case that $v = t$ and $w = t$, and thus $\frac{\partial n}{\partial t} = \frac{\partial m}{\partial t} = 1$. However, this would exceed the upper-bound of r in (18) if, say, $S_n + S_m = S$. Substituting (17) into (18) and algebraic rearrangement shows that it must be the case that $t \leq \frac{S}{S_n + S_m}$ for all eligible students to receive aid greater than or equal to their loss in

appropriations. More generally and regardless of a particular goal for r, it must be the case that

$$\frac{\partial n}{\partial t} S_n + \frac{\partial m}{\partial t} S_m \leq S \tag{20}$$

in order for a state not to exceed the upper-bound of r, increasing its expenditures compared to before the HTHA policy.

Values of w and v are not necessarily equal across all eligible students. They depend on the mechanisms through which a state chooses to alter its grant programs described by (8) and (11). For merit-based grants, a state can increase funding via the maximum award, the minimum ability threshold, or the rate at which the award increases in ability above the minimum threshold. Raising the maximum award increases the amount of merit aid received only for those who were above the maximum. Increasing the rate at which the award is increasing in ability does not change the number of eligible students but increases the amount received by each eligible student who was below the maximum. Lowering the minimum ability threshold increases the amount received by all eligible students not already above the maximum award and increases the number of eligible students. However, let us assume state government does not consider lowering $\underline{a}$ since doing so redefines the subset of students deserving of merit aid. Incorporating these conditions into the top equation of (17) results in the following equation for w

$$
w = \begin{cases}
\frac{\partial \overline{m}}{\partial t} t \ \ if \ \ \underline{a} + \frac{\left(\overline{m} + \frac{\partial \overline{m}}{\partial t} t\right)}{\left(c_m + \frac{\partial c_m}{\partial t} t\right)} < a \\
(a - \underline{a}) \left(\frac{\partial c_m}{\partial t} t\right) \ \ if \ \ \underline{a} < a < \underline{a} + \frac{\left(\overline{m} + \frac{\partial \overline{m}}{\partial t} t\right)}{\left(c_m + \frac{\partial c_m}{\partial t} t\right)} \\
0 \ \ if \ \ a < \underline{a}
\end{cases} \tag{21}
$$

which reflects the increase in merit aid equal to the increase in the maximum award if student ability remains above the new maximum award, the increase in merit aid equal to the product of ability above the minimum and change in the rate of increase if student ability remains between the minimum ability and maximum award, and no increase in merit aid if student ability remains below the minimum ability threshold. Equation (21) makes clear that in order for w to equal t for all S_m then $\frac{\partial c_m}{\partial t}$ and $\frac{\partial \overline{m}}{\partial t}$ must equal 1 as long as there are students with ability that earns above the maximum award. Also, it is important to note that based on (21) S_m does not increase.

The only way a state can modify its need-based grant directly according to (11) is through the maximum award. As a result of raising the maximum award, it is possible for eligible students to receive more funding. However, HTHA policy potentially affects the amount of aid received as well as the number of eligible students through changes in p_c. It is also worth noting that EFC remains constant as income is unaffected by the policy. Therefore, the final value of v depends on the interaction between the maximum award and any change in p_c external of need-based aid. Incorporating these conditions into the second equation in (17) results in the following equation for v

$$v = \begin{cases} \frac{\partial \overline{n}}{\partial t} t \ \ if \ \ EFC + \overline{n} + \frac{\partial \overline{n}}{\partial t} t < P^U + \frac{\partial P^U}{\partial t} t \\ t - w \ \ if \ \ EFC < P^U + \frac{\partial P^U}{\partial t} t < EFC + \overline{n} + \frac{\partial \overline{n}}{\partial t} t \ and \ w < t \\ 0 \ \ if \ \ P^U + \frac{\partial P^U}{\partial t} t < EFC \end{cases} \qquad (22)$$

where $\frac{\partial P^U}{\partial t} > 0$ if $w < t$ and vice versa.[16] Equation (22) reflects the increase in need aid equal to the increase in the maximum award if total expenditure remains above the sum of EFC and the maximum award, the increase in need aid equal to the change in price if expenditures remain between EFC and EFC plus the new maximum award, or no aid if expenditures remain below EFC.

For those with expenditures between EFC and the sum of EFC and the maximum award, need-based grant aid operates in a way such that p_c does not change; $v = t - w$, thus P^U does not change. For those with expenditures above the maximum award, need-based aid does not have this same automatic feature. In order for v to equal t for this subset it must be the case that $\frac{\partial \overline{n}}{\partial t} = 1$.[17]

The bottom condition in (22) pertains to changes in S_n. Since any reduction in state spending through t is partially offset by an amount equal to the product of $\frac{\partial P^U}{\partial t}$ and

---

[16] $\frac{\partial P^U}{\partial t} = \frac{\partial p_c}{\partial t} t(e^* + b^*)$ and $\frac{\partial p_c}{\partial t} = 1 - \frac{\partial m}{\partial t}$. Unless $\frac{\partial m}{\partial t} = 1 \equiv w = t$ from (30), $\frac{\partial p_c}{\partial t} > 0$, thus $\frac{\partial P^U}{\partial t} > 0$. If $w = t$, then $\frac{\partial P^U}{\partial t} = 0$.

[17] Technically $\frac{\partial \overline{n}}{\partial t} = 1 - w$ but it is assumed states cannot target the maximum award to each individual based on what they receive via changes to merit-based grants. If merit-based grants were factored into COA, changes in merit aid would be internalized into the amount of need aid awarded.

S_n, the change in S_n is important in determining whether condition (20) is met.[18] To reiterate, a student is ineligible for a need-based grant if $P^U < EFC$. Since expenditures increase as a result of t, this inequality will reverse for a subset of students with expenditures near their EFC. Specifically, the increase in S_n is equal to

$$\sum_{i=1}^{S} \frac{\partial P_i^U}{\partial t} > EFC_i - P_i^U \qquad (23)$$

or the sum of students whose change in expenditures is greater than the amount to which their EFC exceeded their original expenditure.

IMPACT OF HTHA ACROSS STUDENTS SUBSETS

Having examined how values of *v* and *w* vary with respect to *t* depending on the grant program mechanisms a state may or may not modify, all potential subsets of students from the population *S* can now be described in terms of the impact HTHA has on the price of college as well as how prices compare across subsets post-policy. For each type of grant a student belongs to one of three groups: ineligible, which is denoted with superscript *c* in accordance with standard set theory notation, eligible, and eligible but at the maximum award amount. Thus, there are nine subsets potentially affected by a compositional change in state subsidies.

Table 3.1 presents each student subset and the impact of HTHA on the per-unit price p_c leaving implicit the subsidy values for *l*, *m*, and *n* that were already in effect prior to the policy. The first two subsets represent the least variable and arguably the most probable of HTHA outcomes in terms of price changes. There is a subset comprised of students who are ineligible for both types of grants—$S_m^c \cap S_n^c$—and a subset comprised of students who are ineligible for merit-based aid and eligible for need-based aid below the maximum award—$S_m^c \cap S_n$. For $S_m^c \cap S_n^c$ the price increase of $p_c + t$ is greater than or equal to any other subset of students. Provided a state does not cap its total funding for need-based grants, there is no change in p_c for $S_m^c \cap S_n$.

The third and fourth rows include the only two subsets of students for whom the in-state public price cannot increase. If their merit-based aid is not sufficient to offset the

---

[18] A state reduces the extent to which savings are offset if total funding for need-based grants is capped, providing no grant for students who apply once funding has been exhausted. As mentioned in Chapter 2, only 24 percent of need-based grant programs funded all eligible students in 2016.

increase of t ($\frac{\partial c_m}{\partial t}$ or $\frac{\partial \overline{m}}{\partial t} < 1$), need-based aid offsets the remaining amount. If the increase in merit-based aid is greater than t, the price decreases. The direction of the price change for the remaining subsets is indeterminate and depends on the value of the relevant components of w and v relative to t. Among these remaining groups a few relational conclusions can be made regarding their post-HTHA prices. The price faced by $S_{\overline{m}} \cap S_{\overline{n}}$ is necessarily less than or equal to the price faced by $S_{\overline{m}} \cap S_n^c$ due to the common merit subsidy and the former's additional need-based subsidy. Similarly, the price change for $S_m \cap S_{\overline{n}}$ must be less than or equal to the price change experienced by $S_m \cap S_n^c$.

The third column of table 3.1 compares the in-state private price change for each subset. Prices cannot increase for any subset and can potentially decrease for all but three subsets ineligible for merit-based aid. The private price change is invariably less than the

Table 3.1 - Impact of HTHA on Prices Across Student Subsets

Subset		Price Change	
		In-state Public	**In-state Private**
1	$S_m^c \cap S_n^c$	$p_c + t$	p_c
2	$S_m^c \cap S_n$	$p_c + t - \frac{\partial n}{\partial t}t$	p_c
3	$S_m \cap S_n$	$p_c + \left(t - \frac{\partial c_m}{\partial t}t\right) - \frac{\partial n}{\partial t}t$	$p_c - \frac{\partial c_m}{\partial t}t$
4	$S_{\overline{m}} \cap S_n$	$p_c + \left(t - \frac{\partial \overline{m}}{\partial t}t\right) - \frac{\partial n}{\partial t}t$	$p_c - \frac{\partial \overline{m}}{\partial t}t$
5	$S_{\overline{m}} \cap S_{\overline{n}}$	$p_c + t - \frac{\partial \overline{m}}{\partial t}t - \frac{\partial \overline{n}}{\partial t}t$	$p_c - \frac{\partial \overline{m}}{\partial t}t$
6	$S_m \cap S_n^c$	$p_c + t - \frac{\partial c_m}{\partial t}t$	$p_c - \frac{\partial c_m}{\partial t}t$
7	$S_{\overline{m}} \cap S_n^c$	$p_c + t - \frac{\partial \overline{m}}{\partial t}t$	$p_c - \frac{\partial \overline{m}}{\partial t}t$
8	$S_m^c \cap S_{\overline{n}}$	$p_c + t - \frac{\partial \overline{n}}{\partial t}t$	p_c
9	$S_m \cap S_{\overline{n}}$	$p_c + t - \frac{\partial c_m}{\partial t}t - \frac{\partial \overline{n}}{\partial t}t$	$p_c - \frac{\partial c_m}{\partial t}t$

public price change for subsets 1, 6, and 7. It should be noted these results are contingent on the assumption that merit-based aid can be applied to in-state private schools. Also, comparing per-unit price changes across public and private institutions only relates to the change in price differential; public institutions still have a lower per-unit price due to remaining state appropriations and the amount of need-based aid that are not applicable to private institutions.

Combinations of student subsets and potential HTHA policy variations are numerous, but a few scenarios can be explored that highlight the boundaries of HTHA policy and its impact on the market. A realistic lower-bound might involve a case in which a state reduces appropriations and does nothing to increase funding through grants other than provide that which is needed for the automatic increase in need-based aid among those eligible and below the maximum award. An upper-bound might involve a case in which the state commits to providing every eligible student an increase in grant aid that is no less than the reduction in appropriations.[19] Assuming no subsets overlap perfectly, the upper-bound policy requires w and v to equal t through all grant program mechanisms.

For the lower-bound case in which appropriations are reduced and only additional need aid for those below the maximum is provided, the nine subsets in table 3.1 collapse to two in terms of those that experience a price change. The three subsets eligible for need-based aid and below the maximum award (2, 3, and 4) experience no price change. The remaining subsets experience a price increase equal to t. Though there are only two price changes, the quantities demanded of e and b still vary across different subsets based on the levels of ability and income that determine their particular subset.

Figure 3.4 shows the impact of this lower-bound HTHA policy on four hypothetical students within different subsets. Student A is ineligible for merit-based aid and is above the maximum need-based award. The budget constraint for this student reduces by t and optimal choice is now at point A′. The student at point B has equal ability as student A but is eligible for additional need-based aid due to her total expenditure toward college relative to her EFC. The budget constraint is unaffected and

---

[19] A precise upper-bound for r such as that stated in (27) is indeterminate thus far. It requires knowing the number of eligible students who actually receive aid based on institutional choice.

optimal choice remains at point B. Student C has equivalent income as student B but has higher ability that makes him eligible for merit-based aid. Therefore, student C's budget constraint is higher than B by the amount of his merit award and experiences no change in price. Lastly, Student D has higher ability and income than all other students such that she is eligible for merit-based aid (whether at the maximum or not is inconsequential) and ineligible for need-based aid. Like student A, the budget constraint for student D reduces by t and optimal choice is now at point D'.

This example illustrates that there are two groups in terms of pre- and post-HTHA prices—those for whom the per-unit price increased and those for whom it did not change—but also two student types within the group that experienced the increase in price—a lower-ability, lower-income student and a higher-ability, higher-income student. By virtue of their characteristics, the two students' demand for quantities of e and b respond differently to the same change in price. If preferences are homothetic (i.e. linear IEPs from the origin), then the decline in demand for b is greater for student A than D, and the decline in demand for e is greater for student D than A.

Figure 3.4 - Effect of a Lower-Bound HTHA Policy
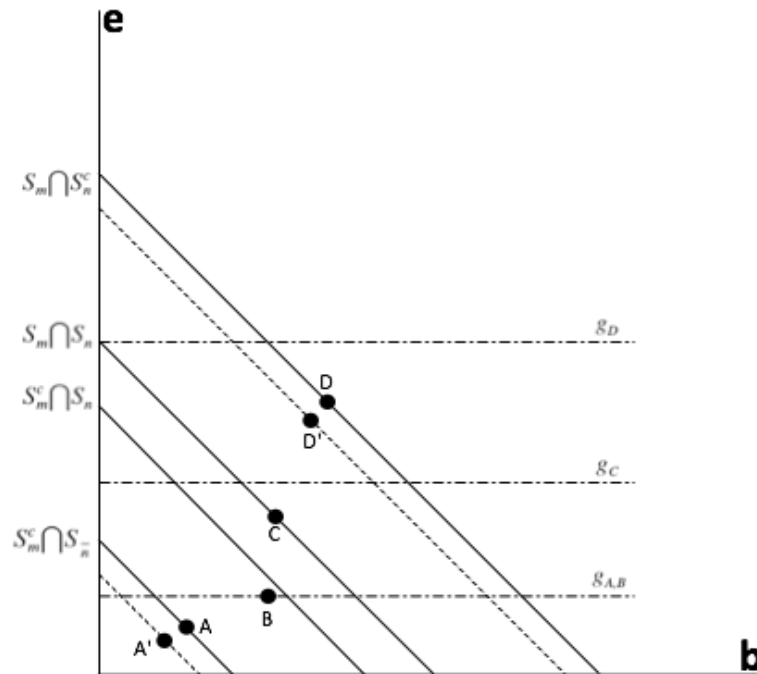
This lower-bound HTHA case reduces to increasing the price for some students and not for others on the basis of income or rather their ability to pay for the quantity of higher education they would optimally consume. Obviously, this results in a decrease in market demand provided there is some elasticity in demand, but does it result in a divergence in the quantity of educational resources demanded relative to amenities, as was stated at the beginning of the chapter? In this specific example it does because of student D's location on the graph relative to student A's, which was arbitrarily chosen except for the parameter that student D must have greater demand for e than student A. The extent to which demand differs between the two students depends on the values of $\frac{\partial^2 u}{\partial e \partial a}$ and $\frac{\partial^2 u}{\partial b \partial y}$, and whether an increase in the per-unit price equal to t results in a divergence in demand depends on $\frac{\partial e}{\partial t}$ for student D relative to $\frac{\partial b}{\partial t}$ for student A. Only in the event that the two are equal does the ratio of demand for e to b remain the same after the HTHA policy. Thus, it is likely that the lower-bound HTHA results in a divergence. However, whether demand for educational resources relative to amenities is higher or lower is indeterminant. Furthermore, the magnitude of this divergence in the state market depends on the sizes of the subsets involved (1 and 5-9).

In the upper-bound HTHA case where a state commits to providing an increase in grant aid for all eligible students by an amount no less than the reduction in appropriations, the nine subsets of students in table 3.1 collapse to three in terms of a change in price. Subset 1 which is ineligible for both types of aid experiences an increase in price equal to t. The two subsets eligible for both types of aid and above the maximum need award (subsets 5 and 9) actually experience a decrease in price equal to t. Again, this result follows from the assumption that merit-based aid does not displace need-based aid on the basis of ability to pay (i.e. EFC). Therefore, these students receive both the increase in merit-based aid via the maximum award or multiplier and the increase in the maximum need award. Unless a state can identify students in these specific financial situations, the higher-ability, lower- or higher-income students that comprise these two

49

subsets benefit from this particular HTHA policy.[20] The remaining subsets experience no price change.

  Figure 3.5 illustrates the impact of this upper-bound HTHA policy on three hypothetical students belonging to different subsets. The high-ability, low-income of student A places him in the subset of students beyond the maximum of merit- and need-based aid. The unit price for student A decreases by t and optimal choice is now at point A′. Student B belongs to the subset eligible for both types of aid below the maximum award, and thus experiences no price change. Lastly, the low-ability, high-income of student C places him in the subset of students who are ineligible for both types of aid. Therefore, the unit price increases by t and optimal choice shifts to point C′.

  Unlike the lower-bound case, the upper-bound case involves a price increase and decrease across fewer student subsets, resulting in a more determinable effect. The two subsets that experience a decrease in price have higher-ability and lower income than the subset that experiences an increase in price. This policy scenario results in a divergence

Figure 3.5 - Effect of Upper-Bound HTHA Policy

---
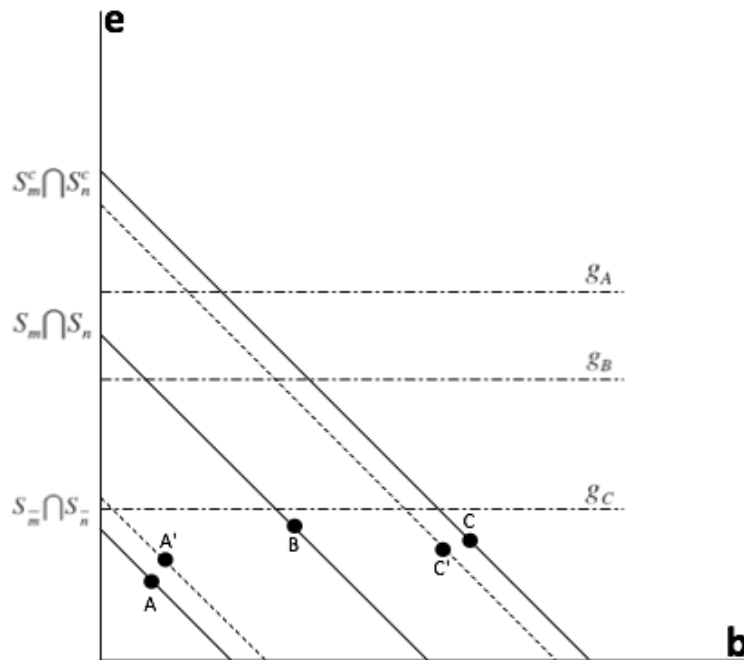
[20] Though it is likely that students above the maximum of need-based award primarily includes lower-income students, without a cap on the EFC eligible for need-based aid, a higher-income student could spend enough on college to exceed the maximum award.

in demand e and b among the subsets involved, specifically an increase in the ratio of educational resources-to-amenities. Again, the magnitude of this divergence in the state higher education market depends on the sizes of the student subsets.

For any subset in table 3.1 that experiences an increase in price, the price differential between in-state and out-of-state decreases. Shifting funds from appropriations to grants necessarily raises the in-state public price for students who are ineligible for grant aid. Describing this subset of students in terms of ability and income depends on the grant policy of a state. If a state has both need- and merit-based grants, these students are lower-ability and middle-to-higher-income compared to other students in the state. Consequently, these students have a higher demand for amenities and lower demand for educational resources than their peers. In other words, an HTHA compositional change decreases the financial incentive for this ineligible subset to remain in state. At the same time, public institutions in other states implementing HTHA policy have a financial incentive to attract more nonresident students in response to a decline in appropriations. Therefore, under certain circumstances HTHA policy can generate a positive feedback loop where states cross-haul their grant ineligible students who on average demand greater amenities. This suggests that the dominant trend in state financing of higher education may explain the disproportional increase in amenities among public postsecondary institutions.

INSTITUTIONAL OPTIONS AND DEMAND PRESSURE

Thus far, latent demand for college goods categorized by consumption amenity or educational resource has been the primary focus. Though these goods can be considered continuously distributed across the entire higher education market, the institutions that comprise the market supply these goods in somewhat discreet bundles.[21] A student cannot marginally increase or decrease e or b as demonstrated above unless there exists

---

[21] Even within discreet institutions amenities and educational resources can vary in a continuous fashion. In some cases, amenities are voluntary add-ons to attending college, such as dormitories and meal plans, both of which can offer variable pricing based on quantity. Though the quality of academic programs varies within institutions according to their educational resources, prices are mostly constant with the exception of mandatory fees that may be associated with a particular program. Variable educational resources are increasingly attached to variable pricing as institutions experiment with academic program-specific pricing.

an institution that supplies a marginally greater or lesser quantity of *e* or *b*. Inference regarding student demand for educational resources and amenities ultimately relies on observing college choice presented by equation (1). The array of institutions available for students choose determines many of the consequences of a compositional change in subsidies at the state level.

Holding the quantity of *e* and *b* supplied by an institution constant, the changes in price due to subsidies affect $(y_i - P_{ij})$ in (1). Table 3.1 summarizes how HTHA can impact the probability students choose to attend one of the three types of institutions. Any increase in price lowers the likelihood a student within the affected subset attends an in-state public or private institution and increases the likelihood of attending an out-of-state option or no college. The allocative decision a state makes across subsidies determines which subsets are affected, and in turn, determines whether demand for *e* relative to *b* is altered.

Intuitively, the probability that a student chooses to attend a particular institution is represented by its proximity to the student's optimal choice within the two-good space examined in the previous figures. One could imagine all postsecondary institutions placed in the figures above according to their quantities of *e* and *b*, providing a virtual continuum of options that make marginal changes in demand possible. A vast majority of these institutions are outside of students' home state, though, and are systematically more expensive per-unit due to various state subsidies, all else equal. Since a greater quantity of college goods can be consumed with in-state subsidies, it is likely that an in-state institution allows students to reach the greatest level of utility. Nevertheless, depending on the supply of in-state institutions, the number of feasible choices of *e* and *b* can be rather limited. This not only limits students' probability of maximizing utility with an in-state institution, but also limits the extent to which state subsidies can drive a divergence in demand within a state.[22] If a state had only one institution, any divergence in demand would operate entirely across state borders, with subsets of students being more or less likely to attend in-state, but with no sorting possible across institutions within the state.

---

[22] In a state like Wyoming where there is only one public 4-year institution, any effect on latent demand due to a compositional change in subsidies would be difficult to detect empirically through college choice. Coincidentally, states such as Wyoming, Montana, and Utah with limited institutional competition are among the states that allocate the greatest proportion of subsidies to appropriations.

Figure 3.6 illustrates this conceptualization of college choice within the context of the demand model presented thus far using the upper-bound HTHA policy among four students within the same state. The various budget constraints do not exhaust income and correspond with the per-unit price conditional on type of institution, grant eligibility, and consumption of other goods. The dashed constraints represent price changes from the HTHA policy. The no college option is represented by point 1 at the origin in which case only other goods are consumed. Public institutions are represented by points 2, 3, and 4, distributed in a way to reflect a state that has a low-educational, low-amenity option (point 2), a middle-educational, high-amenity option (point 3), and high-educational, middle-amenity option (point 4). In-state private options are represented by points 4 and 5, distributed in a way to reflect a state that has a middle-educational, low-amenity option (point 4) and an elite-educational, high-amenity option (point 5).

The top panel of figure 3.6 includes student A who belongs to the $S_m \cap S_{\bar{n}}$ subset and student B who belongs to the $S_m^c \cap S_n^c$ subset. For student A, the increase in both types of aid to offset the reduction in appropriations results in options 4 and 5 now being below the student's optimal share of income allocated toward college. Without the increase in aid, attending option 4 or 5 would require suboptimal consumption, particularly the substitution of other goods for e and b. The increase in aid allows greater numeraire consumption while attending the institution that was most proximate to optimal consumption prior to the policy change. Given the proximity of the out-of-state constraint to the origin it is unlikely that a better option exists outside of options 4 and 5. Option 4 is utility maximizing in terms of e and b, and thus would be assigned the highest probability of attendance. For student B, option 3 is now above the optimal share of income allocated toward college due to the reduction in appropriations. As a result, the probability of attending option 3 is reduced. The only other feasible in-state option is option 2. Surely there is an out-of-state option that would provide greater utility than option 2. In this scenario the reduction in appropriations has increased the likelihood that student B attends college out-of-state.

The bottom panel of figure 3.6 includes student C who belongs to subset $S_m \cap S_n^c$ and student D who belongs to the same subset as student B—$S_m^c \cap S_n^c$—but has a higher income. Student C experiences no price change but the in-state options do not match well

Figure 3.6 - Impact of HTHA on College Choice
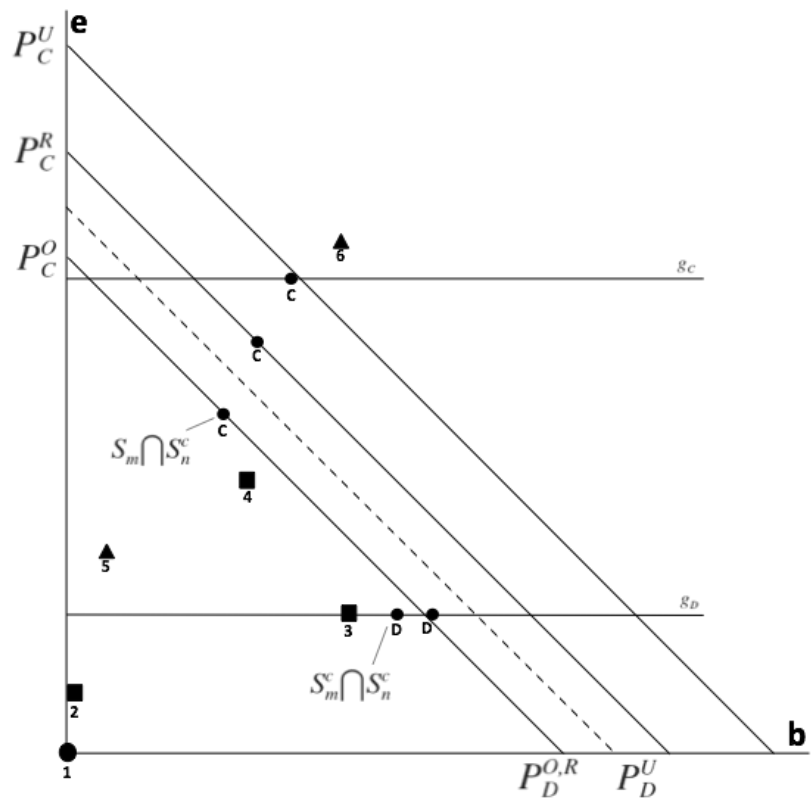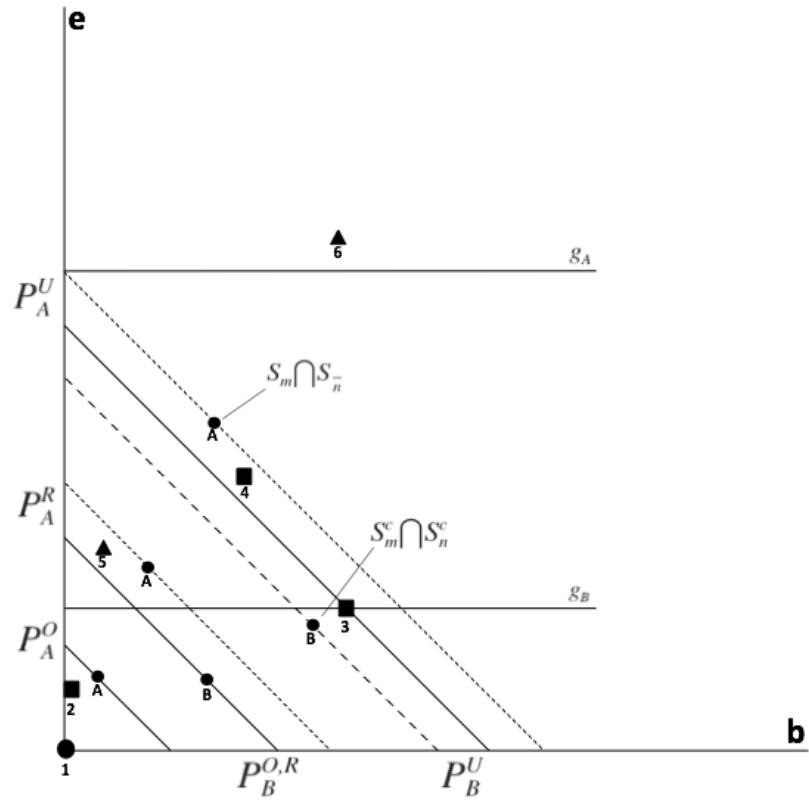
with her optimal choices. Option 6 is not academically feasible, leaving options 4 and 5 as providing the greatest utility among in-state options. It is likely an out-of-state option exists that would offer greater utility than the in-state options. This case highlights how merit-aid, despite reducing the per-unit price of in-state options, can be ineffective at retaining high-ability students within the state if there are not suitable institutions for eligible students. Student D experiences an increase in price for public options, reducing numeraire consumption if an in-state option is chosen but not significantly impacting his choice set. As is the case with higher-income students, there is likely an out-of-state option that best matches student D's optimal choice of *e* and *b*. The HTHA policy increases the probability student D chooses an out-of-state institution and lowers the probability of choosing option 3.

Generalizing from these examples, a few insights can be reached regarding the expected impact of state subsidy composition on college access and choice. In doing so, it is assumed that for any student whose unsubsidized optimal choice of *e* and *b* is positive, there is an out-of-state institution that most closely matches their optimal choice. Thus, the reason approximately 80 percent of students attend in-state institutions is largely due to state subsidies as well as the monetary and non-monetary costs associated with distance.

The effect of state subsidies on college access and choice can operate in two distinct ways depending on the relationship between student demand and available in-state options: 1) state subsidies make an in-state institution available that is otherwise unavailable, or 2) state subsidies lower the price of attending an available in-state institution but does not result in any new options. In the first case, state subsidies are expected to substantially increase the probability that an in-state institution is chosen. Furthermore, the likelihood that state subsidies have this effect is decreasing in student income and increasing in student ability, all else equal. In other words, the number of in-state public or private institutions already available to students is increasing in income, in turn, making it less likely that state subsidies result in a new option. State subsidies cannot result in new options if remaining institutions are not academically feasible.[23]

---

[23] On the supply-side, institutions may be incentivized to decrease admissions standards for such students.

In the second case, the effect of subsidies is expected to be less pronounced. Each additional dollar in subsidies increases numeraire consumption if the available in-state institution is chosen. Therefore, the effect of the subsidy on the probability that a student chooses the available institution is a function of his marginal rate of substitution of the sum of e and b supplied by the institution for income. Given a diminishing return to income, the marginal effect of state subsidies on college choice is decreasing in income if the subsidies do not result in new options. Moreover, the likelihood that state subsidies do not result in new options is increasing in income and decreasing in ability.

Overall, compositional subsidy changes that target lower-income, higher-ability students are expected to have the greatest marginal impact on in-state access and choice among public institutions as well as in-state private institutions if grant aid can be applied to them, all else equal. This would seem to be the motivation for states employing mixed grant programs. Given a positive correlation between income and ability (Strenze, 2007), merit-based grants seem to be poorly designed by comparison insofar as they provide subsidies to high-income, high-ability students whose institutional choices are least likely to be affected. Furthermore, if demand for amenities is increasing in income, and if it is deemed undesirable for public funds to contribute to the consumption of amenities rather than educational resources, then merit-based grants seem poorly designed in this respect as well.

Need-based grants are poorly designed by comparison insofar as they provide subsidies to low-ability students for whom new options are academically infeasible. However, as long as at least one institution is academically feasible, increasing the maximum need-based award increases the probability an eligible student attends college as opposed to no college until the award reaches the COA of the institution. If higher-income students are eligible for need-based grants due to no cap on EFC, then it is likely that such funds disproportionately contribute to the consumption of amenities, which may or may not be a desirable outcome.

Lastly, student demand for e and b is not only relevant in the context of college choice but throughout a student's time spent pursuing a college degree at an institution. As figure 3.6 illustrates, observing a student's choice of institution does not necessarily mean that institution supplies optimal quantities of e and b at the time of matriculation or

while the student is enrolled. Students spend several years at one or more institutions that match their optimal quantities of e and b to varying extents and have numerous opportunities to impose demand pressures on the institution they attend. Such pressure can include leaving an institution in the extreme case but also through daily usage of institutional resources, feedback on evaluation surveys, or advocacy and voting through shared governance mechanisms. Consideration of student demand in the manner presented above can help explain institutional supply beyond that which is aimed at competing for new students, namely their efforts to satisfy currently enrolled students.

CONCLUDING REMARKS

This chapter presented a theoretical model of student demand for college using a two-attribute conceptualization of college quality and heterogenous demand for those attributes along dimensions of student ability and income. State governments' allocative decisions across subsidy types fundamentally involve whether to target public funds based on these same student dimensions. Therefore, the mechanisms through which a state can modify its subsidies and alter prices for separate groups of students were also examined. The interaction between targeted price changes and heterogeneous demand for educational resources and amenities offers insights into the differential impacts of state subsidy composition in the higher education market that have not been thoroughly explored by scholars or considered by policymakers. The opportunity for research on the topics addressed in this chapter is substantial.

Fundamental questions remain regarding the multi-attribute conceptualization of postsecondary institutions. Estimating the relationship between every observable resource within institutions and students' enrollment choices is fairly straightforward but does little to advance our understanding of student or social welfare without properly characterizing these resources as an educational or consumption attribute. Evidence that students are more likely to attend an institution with high investment in a student center and state subsidy policy increases market demand for such resources is limited in its ability to provide policy recommendations unless we know what a student center actually represents economically. This categorization of college resources according to the economic investment they represent is itself a significant empirical task.

Moreover, it is unlikely that resources fall squarely into a single attribute or even that two attributes sufficiently characterize all institutional resources. Defining educational resources as anything that contributes to the value of a degree or increases labor market returns has sound economic footing within the human capital framework, but research is limited as to what underlying resources contribute to the value of a degree. Defining amenities as everything else that does not add value to a degree is exhaustive but possibly too rudimentary. At least some amenities presumably contribute toward student success even if success is narrowly defined as completing a degree. For instance, investment in student health services may not add value to a degree but may increase the likelihood a student realizes the value of said degree. Separating amenities further into those that increase the likelihood of degree completion may be necessary before policy recommendations can be made regarding public investment in higher education and student demand.

The role of the academic constraint in student demand for non-educational attributes could be the focus of further study. As was mentioned in the beginning of this chapter, it is not clear a priori why higher-income students would receive greater marginal return to amenities, all else equal. What empirical work exists suggests this is the case (Jacob et al., 2018). This finding could be due to the characterization of amenities just discussed. Perhaps demand for resources that increase the likelihood of success is increasing in income, which seems more intuitive than the claim that returns to a lazy river or climbing wall are increasing in income. Alternatively, research is fairly consistent in finding that low-income students are less likely to apply to institutions of academic quality that matches their ability (Bowen, Chingos, & McPherson, 2009; Hoxby & Avery, 2012; Hoxby & Turner, 2013). If higher-income students are more likely to reach a binding academic constraint, beyond which income can only be allocated toward amenities, then it would appear that demand for amenities is increasing in income. Which of these is the dominant explanation has implications for the investment incentives institutions face in a competitive market.

Regarding research on state subsidies in higher education, the above analysis highlights the need for detailed data at the student and state levels, first and foremost. One would need measures of student income and ability as well as comprehensive state

grant program information to adequately estimate effects of subsidy composition across the various student subsets according to their grant eligibility. Student-level income data is typically obtained by states once a student has completed the FAFSA, which introduces significant selection bias into inference pertaining to college-going behavior among a state's high school graduates. Nationally representative longitudinal surveys contain student-level data for cohorts of high school graduates but have relatively small sample sizes that are not appropriate to use for state-level analysis.[24] One would need to develop a procedure to normalize the various state subsidy features in order to generalize analysis to the national level. Furthermore, the detail necessary of state grant programs is not systematically collected or archived over time.

Available data does make state-level analysis of subsidy composition possible, much like the work done by Toutkoushian and Hillman (2012), but this masks specific effects on student subsets and can lead to fairly ambiguous policy implications. For example, in their 20-year panel of state subsidy and college enrollment, Toutkoushian and Hillman do not find evidence that the proportion of state subsidies allocated to need-based aid affects in-state or out-of-state enrollment. This could suggest need-based aid is ineffective due to targeting students who are least likely to enroll in college. Alternatively, such a result could indicate that need-based aid is effective at offsetting price changes from other subsidies among eligible students. Without information on the underlying mechanics of subsidy distribution, confidence regarding the effects of subsidy composition is limited.

Using the theory presented in this chapter and the empirical evidence provided by future research, a more informed state strategy with respect to subsidy composition in higher education can begin to materialize. State objectives concerning subsidies in higher education can vary, including the maximization of enrollment, educational attainment, tax revenues, or public benefits. This chapter represents an initial step toward a better understanding of the student subsets affected by state subsidy composition and their demand for broad categories of institutional goods and services that likely affect any objective a state may have.

---

[24] Inability to use NCES national surveys for state-level analysis is a primary motivation for the inaugural NPSAS 2018 survey which will be representative of all 50 states.

Finally, the potential effects of state subsidy composition demonstrated above has implications for at least two more aspects of the higher education market and are the focus of the next two chapters: institutional expenditures and college student migration. Assuming a competitive market in which institutional expenditures are responsive to student demand, the divergence in demand between educational resources and amenities driven by state subsidy composition should affect how institutions allocate revenues across budget categories related to these two attributes. Student migration, or the distance a student must travel to attend a particular institution, is another potentially important attribute not considered in this chapter. Given that state subsidies can alter college choice, they can alter the distances students migrate to attend college. The focus of Chapter 5 is to estimate the effect of distance on college-going behavior and degree completion as a way to link state subsidy policy to outcomes that are better understood in terms of their desirability compared to the uncertain desirability of student demand for educational resources versus amenities.

STATE SUBSIDY COMPOSITION AND INSTITUTIONAL EXPENDITURE DIVERGENCE

The composition of state funding between appropriations, need-based aid, and merit-based aid is an important policy lever states use to alter college prices for all or certain subsets of students. A multitude of studies examine student enrollment response to changes in the price of college (see Page & Scott-Clayton, 2016). Far fewer, by comparison, offer insight into how institutions respond to variation in government subsidies beyond changes to tuition levels. The previous chapter established the theoretical expectation that the composition of state subsidies alters the demand for educational resources relative to amenities. This chapter empirically examines whether state subsidy composition explains variation in institutional expenditures across budget categories in a manner that reflects expected changes in student demand.

BACKGROUND

State government is generally the primary source of institutional revenue and certainly the primary source of public funding. However, as Chapter 2 discussed at length, state support of higher education has waned over time. Average state funding as a percent of total educational revenue among postsecondary institutions has declined from about 70 percent in 1992 to almost 50 percent in 2017, and just this year student tuition provides a greater percent of revenue than appropriations in a majority of states. Like any other organization, postsecondary institutions must respond and adapt to changes in their revenue sources. Broadly, the response to declining state revenues must involve either increasing tuition, decreasing costs, or both to the extent that alternative revenue sources are insufficient.[25]

Most existing research on institutional response to public funding pertains to tuition. Somewhat unsurprisingly, state funding and in-state tuition exhibit an inverse relationship (Koshal & Koshal, 2000). There is also consistent evidence that institutions raise nonresident tuition or the proportion of nonresident students to recoup revenue lost from a decline in appropriations (Mixon& Hsing, 1994; Rizzo & Ehrenburg, 2004;

---

[25] Institutions may find alternative revenue sources to replace declining appropriations, such as research or philanthropy. Newfield (2016) provides strong arguments that institutions have pursued revenues via research and philanthropy, while neither are promising substitutions for appropriations.

Jaquette & Curs, 2015), resulting in crowding-out of low-income students (Jaquette, Curs, & Posselt, 2016) as well as resident students at selective research universities (Curs & Jaquette, 2017). Recent work finds that for every $1,000 reduction in state appropriations per student, the average student is predicted to pay an additional $257 per year using data from 1987 to 2014 and $318 since 2000 (Webber, 2017).

Regarding the relationship between tuition and grant aid, research has primarily focused on federal sources such as Pell Grants, which is strictly need-based. Evidence that institutions raise tuition in response to Pell Grants is mixed, ranging from no evidence of an increase, 17-50 cents per dollar among non-profit institutions, to as high as 78 cents on the dollar among for-profit institutions (McPherson & Shapiro, 1998; Singel & Stone, 2007; Cellini & Goldin, 2013; Turner, 2014). Long (2004a) examined tuition response to the broad state merit-based HOPE scholarship in Georgia and found evidence of tuition increases of 10 cents per dollar among public institutions and up to 30 cents per dollar among private institutions.[26]

Overall, it seems a substantial portion of institutional response to public funding occurs through expenditures for which there is a significant lack of research. Study of the relationship between state subsidies and institutional expenditures is seemingly exclusive to the policy context of performance-based budgeting, which is at best tangential to the topic of interest in this work. Rabovsky (2012) finds institutions alter budget allocations between instruction and research in response to a portion of appropriation revenue being made conditional on student success. This provides at least some evidence that institutions will respond in ways other than tuition to increase or protect revenues. In the event a state shifts a sizeable portion of its public funds from appropriations to grant aid, knowing how institutions might be expected to alter expenditures could be of value to policymakers.

Finally, one should be careful not to assign private or social value judgments to institutional expenditures toward broad attributes such as educational resources or amenities. It is not clear what amenities actually include beyond that which does not directly contribute to the production of human capital, and we do not have a good

---

[26] It is interesting to note that public institutions raised tuition through room and board fees. As mentioned in Chapter 3, governmental control over public tuition may incentivize institutions to increase the prices of opt-in services that are not financed directly by tuition in order to recover lost appropriations revenue.

understanding of what specific resources within an institution result in greater human capital. The national narrative surrounding amenities conjures posh dormitories and resort-like entertainment, but the conceptualization of amenities might also include services for physical and mental health, cultural enrichment, and extracurricular involvement. The measurement of institutional expenditures also limits our understanding of their return on investment, as expenditures are reported across only a few broad functional categories: instruction, research, academic support, student services, and auxiliary enterprises. Research has shown that expenditures on student services have a greater impact on student persistence and graduation than instruction (Webber & Ehrenburg, 2010; Webber, 2012). Investment in student services is also associated with self-reported gains in several academic and soft social skills (Toutkoushian & Smart, 2001).

STATE SUBSIDY COMPOSITION AND INSTITUTIONAL EXPENDITURES

From a broad state policy perspective, the considerations involved in higher education subsidy composition are not unlike those of vouchers at the K-12 level. Appropriations are distributed to institutions to subsidize the cost of college, while grants travel with the student and are received by the institution he or she attends. Arguments common in the voucher context, such as increased competition and limited mobility among disadvantaged students, also apply to the higher education context. Features unique to the higher education market require some unique considerations with respect to subsidy composition. Grants are awarded on the basis of need and/or merit, the latter of which disproportionately go to higher-income students. Competitive institutions (including public) can deny entry on the basis of ability or incorporate the receipt of grant aid into a student's tuition or admission.[27]

Though there is debate regarding the objective or mission of postsecondary institutions (e.g. profit, prestige, spending, educational attainment), it seems safe to assume any institutional objective involves the incentive to increase or preserve revenues, while the specific strategies employed to do so might vary according to institutional

---

[27] The author recognizes the case can be made that similar features are present at the K-12 level just not as overtly.

objective. Setting perverse incentives and strategies in response to the provision of grant aid aside, there is some degree of institutional competition over students that mirrors the traditional economic market. Research suggests that the higher education market is competitive overall, with most institutions possessing limited market power (Epple et al., 2006).

In theory, state subsidy composition alters the dynamic of institutional competition. Appropriations are tied to enrollment and so do not incentivize competition over any specific in-state students. If appropriations decline, public institutional revenues decline. These institutions can respond to the loss in revenue by decreasing expenditures, which does not preserve revenues, or increasing tuition. To the extent tuition is increased in-state enrollment will decline. In order to preserve revenues, institutions must increase enrollment of out-of-state students or students who receive tuition discounts from state grants. Therefore, grants incentivize competition over specific subsets of students who are eligible based on income and/or ability. If student demand for the various types of resources colleges can provide systematically differ along income or ability, then changes in state subsidy composition can be expected to affect institutional expenditures.

Chapter 3 demonstrated that as states allocate a greater proportion of their total subsidies toward merit-based aid, demand increases among students with greater preference for educational resources compared to those who are ineligible for merit-based aid whose demand potentially declines. Given a positive correlation between ability and income though, merit-based aid may also increase demand among those who have greater preference for amenities if demand for amenities is increasing in income. The effect of merit-based aid may also depend on the selectivity of the institution. Highly selective institutions already attract higher-ability students and are likely less financially constrained when increasing educational resources. Therefore, more selective institutions are expected to increase expenditures on educational resources. By contrast, if there is a relationship between demand for amenities and income, less selective institutions may have a greater incentive to increase expenditures on amenities in response to merit-based aid.

As states allocate a greater share of their total subsidies toward need-based aid, demand may increase among lower-income students who may have lower preference for

amenities than those who are ineligible. This depends on the nature of the increase in need-based share. If the increase is the result of offsetting the reduction in appropriations, demand should not change among those who do not reach the maximum award while demand decreases among those who do. If the increase in need-based share increases as a result of an increase in the maximum award, then demand among these lower-income students increases. The expenditure response to need-based aid would be largely indeterminant if not for the effect it has on those who are ineligible for need-based aid. Demand among these students declines. Again, given the positive correlation between income and ability, an increase in the share of need-based aid is expected to disproportionately decrease demand for educational resources and increase demand for amenities. The hypothesis follows that an increase in the share of need-based aid will increase expenditures toward amenities and decrease expenditures toward educational resources. This effect may also be sensitive to institutional selectivity. An increase in demand among lower-income students coupled with a decrease in demand among higher-income students may incentivize selective institutions to actually decrease expenditures toward instruction as well as amenities if their demand is increasing in income.[28] Similar to merit-based aid, an increase in the share of need-based aid is expected to increase expenditures toward amenities among less selective institutions given their constraint in raising educational resources.

In addition to selectivity, effects are expected to differ across the control of the institution for two primary reasons. First, the ability to apply state grant aid to the cost of attendance often differs between private and public institutions. A greater proportion of total subsidies allocated toward grants should have no effect on private expenditure shares if a state only allows its grant funds to be used at public institutions. Second, state appropriations are not a source of revenue for private institutions. The tradeoff at the state level between appropriations and grants does not represent the same tradeoff in revenue sources for private institutions as it does for public institutions. HTHA-like policies are likely to be state revenue positive for private institutions if states allow grants to be applied to them. As demonstrated in chapter 2, though the relationship between

---

[28] Provided there are budget categories related to attributes other than educational resources and amenities. Otherwise, an institution's share of expenditures cannot decrease in both of only two categories.

appropriations and grants is not a perfect zero-sum tradeoff, increases in grants are generally accompanied by larger declines in appropriations. This overall loss in revenue among public institutions may manifest in expenditure shares.

DATA

To study the impact of state subsidy composition on institutional expenditures a panel data set of the IPEDS universe between 1990 and 2015 prepared by The Delta Cost Project is used. These data were supplemented with additional institutional variables collected from IPEDS. Information regarding state grant aid and appropriations were collected from the National Association of State Student Grant & Aid Programs (NASSGAP) and State Higher Education Finance (SHEF), respectively. Additional state demographic data were collected from the U.S. Census. Institutional finance data were adjusted using FTE, state finance data were adjusted using age 18-24 state population estimates, and all financial data were adjusted for cross-time comparison using the 2015 Consumer Price Index.

Institutional selectivity is measured using Barron's Selectivity Index acquired through the Equality of Opportunity Project (Chetty, Friedman, Saez, Turner, & Yagan, 2017). Selectivity categories in descending order include the following: most competitive, highly competitive, very competitive, competitive, less competitive, noncompetitive. These were collapsed into two categories: more competitive consisting of the first three groups, and less competitive consisting of the latter three groups. Selectivity is available for only public institutions and is time invariant in the data though selectivity is assumed to be fairly stable over time.

Dependent variables include institutional expenditure toward select operational categories as a share of total expenditures. Total operational expenditures are measured as the sum of total educational and general expenditures—a variable consistently reported in the Delta Cost Project data—and auxiliary enterprise expenditures. Total educational and general expenditures is equal to the sum of expenditures toward the following operational categories: instruction, research, public service, academic support, student services, institutional support, plant operations and maintenance, and grants.[29]

---

[29] See Appendix for a description of each category.

Expenditures on grants was subtracted from total expenditures because IPEDS did not differentiate the source of grants until 2002, thus avoiding a mechanical relationship between state grants and institutional expenditures.

The expenditure shares of particular interest include those representing expenditures toward educational quality and amenities. Based on their examination of financial data and discussions with higher education finance practitioners, Jacob et al. (2018) conclude that expenditures in instruction and academic support represent educational quality, while expenditures in student services and auxiliary enterprises represent amenities. Therefore, the analysis that follows focuses on expenditure shares of these four categories. The authors present their analysis with these four categories collapsed into their two respective attributes. Instead, this study analyzes the categories separately. Though instruction and academic support may be broadly described as measures of educational quality, they still represent distinctly different goods and services for which an institution may alter its shares differently in response to changes in state subsidies. The same rational applies to student services and auxiliary enterprises. **Table 4.1** provides a brief description of the goods and services included in each of the four categories as well as how each category qualitatively represents spending on either educational quality or amenities.

The explanatory variables of interest include various measures of state expenditures on higher education subsidies, particularly the percentage of total subsidies allocated toward each subsidy type. The percentage of total subsidy allocated toward grant aid is a measure of the extent to which a state targets its subsidies by income and/or ability.[30] The data include state appropriations between 1990 and 2015, and two typologies for grant aid available during different time periods. The first is expenditures on need-based aid and non-need-based aid between 1990 and 2015. Non-need-based aid includes programs that are not exclusively based on need, meaning they include a merit component but may also include a need component. NASSGAP began including an exclusively merit-based indicator in its data in 1999, enabling one to distinguish between

---

[30] The grant aid percentage variables are not the same as those used in Chapter 3 to represent state subsidy composition. Percentages are used instead due to there being structural zeros in the data. There is not an agreed-upon method for dealing with zeros in compositional data that represent a structural absence of a component (Martin-Fernandez, Palarea-Albaladejo, and Olea, 2011).

Table 4.1 – Description of Expenditures on Education and Amenities

Category	Description	Attribute
Instruction	General academic instruction expenses such as salaries and wages for all instructional employees.	Education: directly tied to the aim of increasing human capital production
Academic Support	Activities and services that support instruction, research and public service such as libraries, academic administration (e.g. deans), and information technology.	Education: partially tied to human capital production
Student Services	Admissions, registrar, student records, student activities, cultural events, student newspapers, intramural athletics, and student organizations.	Amenities: primarily includes services that facilitate degree completion, enhance the college experience, or develop soft skills
Auxiliary Enterprises	Activities that are revenue generating, such as residence halls, food services, student health services, intercollegiate athletics, college unions, and college stores.	Amenities: primarily includes consumption goods and services largely available in the private sector

need-based, mixed, and merit-based aid. The imprecision of non-need aid and mixed aid as subsidies distributed on the basis of income versus ability presents challenges for interpreting their effects in relation to the theoretical expectations previously discussed. These will be addressed as they arise.

The sample of institutions included in the Delta Cost Project data was refined in a few ways to obtain the analytic sample. Only non-profit public and private four-year institutions classified as baccalaureate colleges or above are included. Special focus (e.g. theology, medical, teachers), for-profit, and two-year institutions are considered too heterogeneous in mission, student body, and interaction with state subsidies to include in the sample. Institutions that opened or closed between 1990 and 2015 as well as those missing data in any year for all expenditure categories of interest or total expenditures are excluded. Institutions for which state subsidy data were unavailable are excluded. Lastly, institutions in the bottom one percentile of panel-wide average undergraduate enrollment or those that were recorded as having zero undergraduates in any year are excluded. The analytic sample includes a total of 1,059 institutions across 47 states and 26 years.

Table 4.2 displays summary statistics including overall mean, minimum, and maximum as well as the within-institution or state standard deviation. The top panel

Table 4.2 - Summary Statistics

Variable	Mean	SD	Min	Max
Expenditure Shares				
Instruction	35.89	3.48	2.19	71.03
Academic Support	8.41	2.10	0.05	47.28
Student Services	10.78	2.50	0.17	61.43
Auxiliary	15.34	3.15	0.00	69.21
Grant Aid Percentages				
Need	4.35	1.63	0	26.8
Non-need	2.08	2.99	0	32.02
Mixed	0.92	1.71	0	16.64
Merit	1.35	2.53	0	22.36
Institution Controls				
FTE (1000s)	6.44	1.83	0.15	207.03
Undergrad	0.99	0.08	0.01	2.9
Public	0.38	0	0	1
Selective	0.32	0	0	1
State Controls				
Med. Inc (1000s)	55.27	3.64	33.48	81.02
Poverty Rate	12.74	1.86	4.5	26.4
Unemployment	5.62	1.55	2.3	13.78
Pct. White	83.29	1.71	24.04	98.82
Observations	27,534			
Institutions	1,059			
States	47			
Years	26			

includes institutional expenditure shares for the four categories of interest. On average instruction represents the largest expense among the four categories at 36 percent, while the others are between 8 and 15 percent. A minimum of zero spending on auxiliary enterprises seems possible, but the minimum values for the other categories are cause for some concern over the accuracy of the data. The sensitivity of the results to excluding extreme minimums in expenditure shares is examined in a later section. The second panel includes the percentage of total higher education subsidies allocated to various types of grant aid. Overall averages are rather low, but the maximum values indicate that some states allocate a considerable percentage of total subsidies to grants.

Institutional control variables include total FTE, the ratio of the total headcount of undergraduate students to total FTE (*Undergrad*), an indicator for whether an institution is public, and an indicator for whether an institution is in the top three categories of the Barron's selectivity index. *FTE* and *Undergrad* are included under the rationale that expenditure shares may vary with the size of the institution or as institutional revenues rely more heavily on undergraduate enrollment and the demand pressures they exert. *Public* and *Selectivity* are expected to moderate the effect of grant aid percentages on expenditure shares. State control variables include median household income, poverty rate, unemployment rate, and the percent of the population that is white. These are included as potential factors that affect grant aid and expenditure shares.

METHODS

Expenditures shares across operational categories are a function of institutional characteristics, some of which are observable and others that are not. It is likely that expenditure shares differ systematically across institutions based on unobservable characteristics. Therefore, an institution fixed effects identification strategy is used, which leverages the within-institution variation in expenditures. Since institutions belong to one state, this model also relies on within-state variation in state subsidies, as it is also likely that grant allocations vary systematically by unobserved state characteristics. The following reduced-form regressions are used to examine the effect of state subsidy composition on institutional expenditures:

$$Y_{ijst} = \beta_0 + (N_{st} \times I_{jst})\beta_1 + (NN_{st} \times I_{jst})\beta_2 + X_{jst}\beta_3 + Z_{st}\beta_4 + \theta_j + \tau_t + \epsilon_{jst} \quad (1)$$

$$Y_{ijst} = \beta_0 + (N_{st} \times I_{jst})\beta_1 + (Mx_{st} \times I_{jst})\beta_2 + (Mt_{st} \times I_{jst})\beta_3 + X_{jst}\beta_4 + Z_{st}\beta_5 + \theta_j +$$
$$\tau_t + \epsilon_{jst} \quad (2)$$

where *Y* is the percentage of total operational expenditures allocated to a particular category $i \in$ (instruction, academic support, student services, and auxiliary) for institution *j* in state *s* in year *t*. *N*, *NN*, *Mx*, and *Mt* represent the percent of total state subsidies allocated toward need, non-need, mixed, and merit, respectively. Each aid percentage is interacted with one of two time-invariant institutional controls: public and selective. β_1 and β_2 as well as β_3 in (2) are the parameters of interest, which are identified off of within-state variation in the percentage of grant aid captured by the institution fixed

effect θ_j and variation in type of institution conditional on the panel-wide time trend captured by τ_t. Standard errors are clustered at the state level to account for the fact that the explanatory variables of interest vary at the state level as well as serial correlation.[31]

Equations (1) and (2) account for bias from endogenous variation in expenditures across institutions, but two additional threats to validity warrant brief discussion. First, the percentages of grant aid must not be a function of institutional expenditures. This reverse causality is unlikely. To the extent states deliberately alter subsidies to achieve policy goals—the evidence for which is minimal (Hossler, 1997; SRI International, 2012)—there is little reason to suspect such decisions are based on how institutions allocate expenditures across operational categories. Second, variation in expenditures and grant aid percentages must not be a function of additional variables omitted from the model. Subsidies are likely affected by economic and demographic characteristics of the state, and it is possible that such factors also impact institutional expenditure shares. *Z* includes time-variant state household median income, unemployment rate, poverty rate, and percent of the population that is white in an attempt to mitigate this threat to validity. Lastly, *X* includes time-variant institutional controls FTE and undergraduate concentration. Institutional variables are not critical to validity but can improve the precision of the estimates.

RESULTS

Table 4.3 presents regression results for equation (1) for select variables.[32] Each column represents a separate regression for one of four expenditure share categories. Grant percentages are separated into need and non-need aid and interacted with the indicator for public institution. Recall that instruction and academic support are considered expenditures on educational resources. Student services and auxiliary enterprises are considered expenditures on amenities. It is also important to note that significant

---

[31] A compositional analysis model using log ratios of each expenditure category and grant type was not utilized for a few reasons. Compositional analysis transforms data in an attempt to obtain normally distributed variables, which is an appealing mathematical property with small sample sizes. Additionally, compositional analysis accounts for the negative correlation across dependent variables. In this case the sample size is not small and institutional expenditure shares of interest are not consistently negatively correlated. Therefore, simple linear regression was used for its ease in interpreting meaningful effect magnitudes. See Appendix for a sensitivity analysis.
[32] See Appendix for full results.

coefficients for the interaction terms indicate an effect among public institutions that is significantly different from the effect on private institutions along with the magnitude of the difference, not the effect of a one-unit change in the explanatory variable. The latter is reported in the lower panel with the marginal effects heading.

Point estimates in Column 1 indicate there is no statistically significant evidence that the percent of total subsidy allocated toward either type of grant aid affects the share of expenditures on instruction among private institutions. However, the linear combination of the non-need coefficient and non-need public coefficient indicates a 1 percentage point (1pp) increase in non-need relative to other subsidies leads to a decrease in instructional shares by 0.12pp among public institutions. With a mean instructional share of 35.89 percent this estimate corresponds to decline of 0.3 percent. Column 2

Table 4.3 - Effect of Need and Non-need Aid on Expenditure Shares by Control

	(1)	(2)	(3)	(4)
	Instruction	Academic Support	Student Services	Auxiliary
Grant Aid Estimates				
Pct. Need	0.0479	0.0416**	0.0582	-0.0327
	(0.0533)	(0.0125)	(0.0341)	(0.0291)
Pct. Non-need	0.0866	0.0192	0.0489	-0.0351
	(0.0431)	(0.0201)	(0.0277)	(0.0285)
Pct. Need x Public	-0.1488	-0.0464	-0.1500*	0.1739*
	(0.0739)	(0.0423)	(0.0562)	(0.0667)
Pct. Non-need x Public	-0.2070**	-0.0274	-0.0870*	0.0316
	(0.0755)	(0.0307)	(0.0330)	(0.0520)
Public Institution Marginal Effects				
Need	-0.1010	-0.0047	-0.0918	0.1412*
	(0.0558)	(0.0345)	(0.0494)	(0.0564)
Non-need	-0.1204*	-0.0082	-0.0380	-0.0036
	(0.0520)	(0.0228)	(0.0258)	(0.0417)
R-squared	0.191	0.104	0.381	0.039
Observations	27534	27534	27534	27534

Notes: Robust standard errors clustered at the state level in parentheses.
*p<0.05; **p<0.01; ***p<0.001

indicates that a 1pp increase in need aid increases the academic support share 0.04pp (0.5%) among privates, while the response among publics is not statistically significant. Based on the results in column 3, there is no evidence that private or public institutions alter student services shares in response to an increase in either type of grant relative to total subsidies. Lastly, the results in column 4 indicate that need aid affects the auxiliary share among public institutions. A 1pp increase in non-need aid leads to a 0.14pp (0.9%) increase.

Table 4.4 presents estimates for mixed and merit aid from equation (2) which distinguishes between mixed and merit grant aid within non-need aid from equation (1). To reiterate, these data span the years 1999 to 2015, thus some statistical power is lost compared to the above specification. The results in column 1 indicate a 1pp increase in mixed aid results in a 0.12pp (0.3%) increase in instruction shares among private institutions, while there is no evidence of a significant effect among publics. There is no evidence that either type of non-need aid impacts expenditure shares in the other three categories among private institutions. The results from equation (1) did not indicate an effect of non-need aid on student services, but in this specification, it appears there is an effect. Specifically, a 1pp increase in mixed aid relative to other subsidies leads to an increase of 0.5pp (0.5%) in the share of student services.

Overall, it is evident that the percentage of total subsidy allocated toward need or non-need aid affects expenditure shares of private and public institutions differently. In fact, both instances of a significant effect present among private institutions are positive and pertain to the two educational expenditure categories, while public institutions decrease shares pertaining to educational resources and increase shares toward amenity categories. An increase in the percentage of grant aid is the result of a higher allocation toward grant aid, a lower allocation toward appropriations, or both. Given that private institutions do not receive revenue via appropriations and as long as states allow some grant aid to be applied to private institutions, a higher grant percent allocation represents the potential to increase revenues by charging higher tuition to grant-eligible students. In order to increase enrollment among grant-eligible students, private institutions may shift expenditures toward functions that attract students. The results above suggest private institutions do this by increasing educational expenditure shares.

Table 4.4 - Effect of Mixed and Merit Aid on Expenditures Shares by Control

	(1) Instruction	(2) Academic Support	(3) Student Services	(4) Auxiliary
Grant Aid Estimates				
Pct. Mixed	0.1247***	0.0058	-0.0546	-0.0258
	(0.0341)	(0.0164)	(0.0423)	(0.0575)
Pct. Merit	0.0394	0.0292	-0.0279	-0.0189
	(0.0684)	(0.0171)	(0.0301)	(0.0185)
Pct. Mixed x Public	-0.0156	0.0028	0.1095*	-0.0660
	(0.0438)	(0.0403)	(0.0479)	(0.1369)
Pct. Merit x Public	-0.0758	-0.0694***	-0.0164	0.0736
	(0.0684)	(0.0154)	(0.0367)	(0.0583)
Public Institution Marginal Effects				
Mixed	0.1091	0.0086	0.0549**	-0.0918
	(0.0589)	(0.0282)	(0.0206)	(0.0886)
Merit	-0.0365	-0.0403	-0.0443	0.0547
	(0.0462)	(0.0262)	(0.0267)	(0.0601)
R-squared	0.020	0.009	0.181	0.019
Observations	18003	18003	18003	18003

Notes: Robust standard errors clustered at the state level in parentheses.
*p<0.05; **p<0.01; ***p<0.001

Conversely, to the extent appropriations decline more than grants increase (about 2:1 on average during this time period), an increase in grant percentages represents a decline in revenue among public institutions. Public institutions can recover lost state revenue by competing over grant-eligible students. The results above suggest they do so by shifting expenditures away from educational categories and toward amenities. Interpreting the specific types of grants involved will be discussed in more detail in the next section.

Table 4.5 presents the results from equation (1) using the selectivity indicator as the interaction term. These estimations include only public institutions. Selectivity is used as a measure of institutional market power. Expenditure shares among selective institutions are presumably less influenced by changes in student demand for goods in

74

Table 4.5 - Effect of Need and Non-Need Aid on Expenditure Shares by Selectivity

	(1) Instruction	(2) Academic Support	(3) Student Services	(4) Auxiliary
Grant Aid Estimates				
Pct. Need	-0.0609	-0.0073	0.0795	0.0927
	(0.0595)	(0.0474)	(0.0513)	(0.0712)
Pct. Non-need	-0.1065*	0.0194	0.0877*	-0.0792
	(0.0424)	(0.0241)	(0.0347)	(0.0598)
Pct. Need x Selective	0.1511	-0.0093	-0.0638	-0.1389
	(0.1359)	(0.0611)	(0.0559)	(0.1173)
Pct. Non-need x Selective	0.0960*	-0.0721	-0.0504	0.1400*
	(0.0427)	(0.0431)	(0.0339)	(0.0623)
Selective Institution Marginal Effects				
Need	0.0902	-0.0165	0.0157	-0.0462
	(0.1188)	(0.0346)	(0.0362)	(0.1043)
Non-need	-0.0105	-0.0527	0.0373	0.0607
	(0.0255)	(0.0342)	(0.0210)	(0.0375)
R-squared	0.100	0.058	0.230	0.083
Observations	10348	10348	10348	10348

Notes: Robust standard errors clustered at the state level in parentheses.
 *p<0.05; **p<0.01; ***p<0.001

services across the four operational categories because they have a greater abundance of applicants. The results suggest a 1pp increase in non-need aid leads to a 0.11pp (0.3%) decrease in instructional shares and a 0.09pp (0.9%) increase in student services shares among less selective public institutions. Though it is not definitively conclusive without analyzing every operational category, this result is indicative of a tradeoff between educational resources and amenities as the percentage of total subsidy allocated to non-need grants increases. By contrast, there is no evidence that expenditure shares among selective public institutions are affected by changes in subsidy composition.

Table 4.6 presents results from equation (2) using the selectivity interaction among public institutions. It appears the decline in instructional shares from an increase in non-need aid in table 4.6 is driven by merit-based aid. A 1pp increase in the total

Table 4.6 - Effect of Mixed and Merit Aid on Expenditure Shares by Selectivity

	(1) Instruction	(2) Academic Support	(3) Student Services	(4) Auxiliary
Grant Aid Estimates				
Pct. Mixed	0.1330*	0.0185	0.1047*	-0.1942**
	(0.0611)	(0.0315)	(0.0460)	(0.0605)
Pct. Merit	-0.0962*	-0.0395	0.0295	-0.0072
	(0.0469)	(0.0304)	(0.0252)	(0.0766)
Pct. Mixed x Selective	-0.1090**	-0.0474	-0.0928*	0.1959**
	(0.0329)	(0.0375)	(0.0403)	(0.0631)
Pct. Merit x Selective	0.1137*	0.0155	0.0118	0.0190
	(0.0517)	(0.0289)	(0.0350)	(0.0946)
Selective Institution Marginal Effects				
Mixed	0.0240	-0.0289	0.0119	0.0018
	(0.0618)	(0.0270)	(0.0125)	(0.0798)
Merit	0.0175	-0.0240	0.0413	0.0117
	(0.0439)	(0.0324)	(0.0428)	(0.0616)
R-squared	0.094	0.029	0.183	0.106
Observations	6766	6766	6766	6766

Notes: Robust standard errors clustered at the state level in parentheses. Sample includes only public institutions 1999-2015.
*$p<0.05$; **$p<0.01$; ***$p<0.001$

subsidy allocated to merit-based aid results in a 0.10pp (0.3%) decline in instructional shares among less selective public institutions. Interestingly, a 1pp increase in mixed aid leads to a 0.13pp (0.4%) increase in instructional shares. Regarding the increase in student services present in the above estimation, it appears that mixed aid is driving this result. A 1pp increase in mixed aid leads to a 0.10pp (1%) increase in student services shares as well as a 0.19pp (1.4%) decline in auxiliary shares. As in the previous estimation, there is no evidence that mixed or merit aid percentages impact expenditure shares among more selective public institutions. It appears that more selective institutions are generally insulated from any changes in demand pressure state subsidy allocations may generate.

SENSITIVITY ANALYSES

The timing of effects in equations (1) and (2) are difficult to model precisely. Specifically, whether institutional expenditures in year t are a function of state subsidies in the same year may be a source of some misspecification. On one hand, state funding for higher education can involve negotiations between state officials and institutions, so institutions may have an accurate expectation of state subsidies for year t and can develop their own budget in year t accordingly. On the other hand, the extent to which institutional expenditures can react to state budgets the same year is likely constrained and may instead be a function of state budgets in previous years. Only within-state variation in subsidies is used to explain within-institution variation in expenditures, so differences across state budget processes, such as annual versus biennial budget cycles, is not so much a concern.

The sensitivity of results to using lagged explanatory variables was examined. Regressions generating results in tables 4.4-4.7 were run using state subsidies lagged one year and again with two-year lags. The point estimates for one-year lags are qualitatively similar to those already reported but statistical significance is lost in many cases. Virtually all statistical significance is lost using two-year lags. Together, this is interpreted as evidence that institutional expenditures in year t primarily reflect state subsidies in year t, rather than state subsidies in previous years.

Compositional analysis is an alternative estimation strategy when variables of interest are proportions (Aitchison, 1986). Compositional analysis involves in this case the institutional expenditure shares being transformed. There are three compositional transformations, each with strengths and weaknesses, but it seems researchers in the field of budget and finance typically choose the additive log-ratio transformation. This involves dividing each share by a common base category, such as instruction, then using the natural log of each ratio as the dependent variable. State subsidies could also be modeled as a composition, but there are many cases where the proportion of a particular grant allocation is equal to zero. There is not an agreed-upon method for dealing with zeros in compositional data that represent a structural absence of a component (Martin-Fernandez, Palarea-Albaladejo, and Olea, 2011).

Nevertheless, the fixed effects estimation reported in tables 4.4-4.7 was repeated using additive log transformed dependent variables. The signs of estimates are the same and statistical significance is generally consistent with the results already reported. Statistical significance varies some in cases with marginally significant estimates in the tables above. The only notable difference between estimations pertains to the tradeoff between instruction and auxiliary reported in table 4.3. Using compositional dependent variables, an increase in non-need aid still leads to a decline in instruction, while the positive effect of need aid on auxiliary is no longer significant. Instead, an increase in non-need aid increases the share of student services. Therefore, as states shift subsidy allocations toward grants, evidence of a tradeoff between educational resources and amenities remains but the type of grants involved in the tradeoff differ using compositional dependent variables.[33]

As reported in table 4.2, the minimum expenditure shares for instruction, academic support, and student services are extremely low. This causes concern over data accuracy and the sensitivity of the results to the inclusion of institutions with such low expenditure shares in the categories of interest. These cases are particularly problematic if low shares are systematically subject to extreme increases that could lead to upwardly biased estimates. The analysis reported in tables 4.4-4.7 was repeated using the sample truncated at the first percentile of expenditure shares. The results were similar in sign, significance, and magnitude as those previously reported. Then, institutions with missing observations due to the truncation were excluded from the panel entirely. The results were again similar to those already reported.

DISCUSSION

Table 4.7 summarizes the directional effects of grant proportions on expenditure shares from the above analysis to aid interpretation. The hypotheses made at the beginning of this chapter were predicated on the relationship between state subsidies, student demand, and institutional response to demand pressures. As states shift funds away from institutions and toward subsets of students, student demand for various goods and services should more strongly reflect the demand of grant recipients. Since need-based

---

[33] See Appendix for estimates.

grants target lower-income students who generally have lower academic achievement and given that increases in need-based grants primarily operate to offset increases in cost, it was unclear how institutional expenditure shares might respond to greater demand among need grant recipients if their demand increases at all.

Instead, the effect of an increase in the proportion of need-based aid was predicted to be driven primarily by those who are ineligible for need-based aid. The higher-income students ineligible for need-based aid have greater demand for amenities than their lower-income peers who do not experience as much of an increase in price. To compete for these higher-income students, it was predicted that institutions would increase expenditure shares toward amenities and decrease expenditure shares in educational resources. This is precisely the outcome reflected in the results of the analysis, particularly among less selective public institutions that have the least market power. The distinction between student services and auxiliary enterprises is also important here. While shares in student services increase, so too do auxiliary shares. Goods and services in the latter category are far more related to the traditional consumption goods included in discussions regarding amenities in higher education.

Given the imprecision of non-need aid as it relates to the types of students who are eligible since it can contain both mixed and merit programs, it is not surprising that the results are largely insignificant across categories with the exception of a decline in

Table 4.7 - Directional Effects of State Grant Proportions on Expenditure Shares

Private \ Public	Instruction	Academic Support	Student Services	Auxiliary
Need Grants	Public: −	Private: +	Public: +	Public: +
Non-need Grants	Public: −			
Mixed	Private: +, Public: +		Public: +	Public: −
Merit	Public: −			

instructional shares among public institutions. Merit-based aid targets higher-ability students who generally have higher income as well, thus the predicted effect of a greater proportion of total subsidies allocated to merit-based aid on expenditure shares was also somewhat unclear. On one hand, greater demand among higher-ability students should lead to an increase in expenditure shares related to educational resources. On the other hand, recipients of merit-based grants are disproportionately higher-income, so the result may also be an increase in shares related to amenities.

The existence of mixed grant programs offers valuable insight into this ambiguity. Recipients of mixed grants are higher-ability and lower-income, thus eliminating the overlap in demand present with merit-based aid. Therefore, an increase in the proportion of total subsidies allocated to mixed aid should result in greater expenditure shares related to educational resources and lower shares related to amenities. Again, the results reflect this, especially among less selective public institutions. The distinction between student services and auxiliary enterprises is important here as well. Greater proportions of mixed aid lead to institutions increasing expenditure shares toward student services related to college access and completion, such admissions, advising, and extracurricular activities—the types of services perhaps preferred among lower-income, higher-ability students—and decreasing shares related to consumption goods preferred by higher-income students. Conversely, greater proportional allocation in merit-based aid results in public institutions decreasing instruction. Coupled with the mixed aid effect on instruction, this suggests the change in demand generated by merit-based aid is primarily driven by higher-income students wither greater preference for amenities. However, the increase in amenity shares that should accompany the decline in instruction is no statistically significant.

CONCLUDING REMARKS

Over the last three decades total state support for higher education has declined but support in the form of grant aid has increased. For public colleges and universities, the decline in state revenues requires them to increase revenues via other sources, such as tuition, or decrease expenditures. Based on responses in tuition levels to variation in state support, it seems public institutions do both (Webber, 2017). Coupled with a rise in grant

aid, the higher education market becomes increasingly competitive, placing state funds in the hands of subsets of student for whom institutions are financially incentivized to attract to their campus. Rather than examine tuition, this chapter asked whether trends in state subsidies affect how institutions allocate their financial resources across operational categories that interact most with students. Specifically, given the divergent demands for educational resources versus amenities with respect to student ability and income that the HTHA model may amplify, it was predicted institutions would systematically alter expenditure shares in ways that reflect this divergence.

The broad conclusion of the analysis is that targeting state subsidies on the basis of student income and/or ability rather than appropriations leads less selective public institutions to diverge their expenditure shares between educational resources and amenities. Targeting subsidies on the basis of income only results in a decrease in instruction and an increase in student services and auxiliary enterprises. Targeting subsidies on the basis of income *and* ability results in an increase in instruction and student services but a decrease in auxiliary enterprises. Targeting subsidies on the basis of only ability results in a decline in instruction but the tradeoff with amenities is inconclusive. Together, these results reflect a divergence in institutional expenditures with respect to educational quality and amenities, the cause of which is claimed to be an underlying compositional change in student demand driven by HTHA trends in state subsidies.

This analysis does not make claims regarding the consequences to private or social welfare from a tradeoff in expenditure shares between educational quality and amenities. There is not sufficient knowledge of the impacts of institutional spending across operational categories on the returns to a degree and degree completion to conduct a cost-benefit analysis on a dollar taken from instruction to add to student services or auxiliary enterprises. Readers may be inclined to assume shifting expenditures away from instruction and toward student services is a negative outcome, but existing research has found investment in student services to have a more positive impact on degree completion than investment in instruction, especially among students at less selective institutions (Webber & Ehrenburg 2010; Webber, 2012). However, perhaps the degrees students are more likely to complete have less value as a result of disinvestment in

instruction. Also, to the author's knowledge there has been no systematic analysis of the effects of auxiliary enterprises on student outcomes. These are important topics for future research.

This analysis also contributes to the large literature concerning the effects of state financial aid on college student outcomes. Evidence is mixed as to whether broad merit-based aid increases college completion (Dynarski, 2008; Henry, Rubenstein, & Burglar 2004; Bruce & Carruthers, 2011; Scott-Clayton, 2011; Sjoquist & Winters, 2012). Though there is mixed evidence that need-based aid increases student access (Perna & Titus, 2004; Goldrick-Rab, Harris, & Trostel, 2009), there is fairly consistent evidence of increased persistence (Bettinger, 2004; Goldrick-Rab, Harris, Kelchen, & Benson, 2012), while gains in college completion appear to be concentrated among higher-ability students who receive need-based aid (Castleman & Long, 2013). The explanations for these results are numerous and nuanced, but this analysis is the first to offer evidence that grant aid's impact on institutional expenditure shares may be an important mediating or moderating factor.

[5]
STUDENT MIGRATION, SUCCESS, AND THE ROLE OF STATE SUBSIDIES

The focus in previous chapters has been to theoretically or empirically examine policy pertaining to state subsidy composition and its impact on the higher education market. In brief, the argument has been made that the dominant trend of reallocating appropriations to grant aid drives a divergence in demand between educational resources and amenities across students of various incomes and abilities. Empirical evidence has been presented that supports this causal claim in the form of college-going patterns among students and institutional expenditures in response to changes in subsidy composition.

Student migration is a critical aspect of the higher education market that has yet to be incorporated into this discussion. Though student migration can be defined in a few different ways, it fundamentally involves the travelling of some distance between the student's point of origin and the institution of her choice. Virtually every study to include the distance between students' location and postsecondary institution has found it to impose a cost that deters access and choice. When public policy such as state subsidy composition affects college access and choice the distances students migrate to attend college are altered. The effect of distance on college student success is therefore a relevant line of inquiry when considering potential unintended consequences of state subsidy composition.

The purpose of this chapter is to conduct a more thorough analysis of the relationship between distance and college-going between initial enrollment and completion of a degree than what currently exists in the literature. Building off of Chapter 3, a theoretical framework incorporating distance into the processes of choice and persistence is developed, demonstrating how distance might be expected to affect the likelihood that a student completes a degree at her institution of choice. The effect of distance on persistence and completion is estimated separately for students seeking an associate's versus a bachelor's degree. College transfer behavior is also examined as it relates to distance.

There are two lines of research that commonly incorporate the distance between students' location and a set of postsecondary institutions. First, various measures of distance have been used as a source of exogenous variation in educational attainment to estimate its monetary and social returns. These studies find distance to be a significant predictor of attainment but do not examine the underlying mechanisms. Second, scholars include distance in studies of student migration or college access and choice. These studies consistently find distance to impose a cost that deters the enrollment outcome of interest but do not examine whether student success is impacted.

Moreover, the effect of distance on college-going behavior has changed over time. Studying college choice among student cohorts in 1972, 1982, and 1992, Long (2004) finds the deterrence of distance has decreased each period. Hoxby (1997) finds a similar decline from 1949 to 1994 and proposes several explanatory factors, one of which is policy that expands students' feasible set of institutions, such as interstate tuition reciprocity agreements. In turn, the role of distance in college access and choice diminishes. As policy alters the distance students migrate to attend college, policymakers should be concerned whether distance subsequently imposes a cost on students while attempting to complete a degree.

If distance to an institution has become less of a deterrent to college choice over time, how does this change manifest when observing the actual distances students migrate to attend college? Intuitively, one would expect more students to migrate greater distances as a result. Each year, the Higher Education Research Institute (HERI) surveys a nationally representative sample of incoming freshmen. Survey participants are asked, "How many miles away is your institution from your permanent home?" and given a set of ranges for answers: less than 10, 11-50, 51-100, 101-500, over 500. Results from the past 40 years of this survey item were collected in order to examine trends in distances.

Panels A and B of **Figure 5.1** show 5-year moving averages of the distances migrated between 1975 and 2015 as a percentage of all freshman attending public universities and 4-year colleges, respectively. For public universities, the most steadily changing range is over 500 miles, which has risen from approximately 5 to 15 percent of freshmen. The other ranges have remained relatively the same with mild fluctuations

Figure 5.1 - Distances Migrated to College, 1975-2015

Panel A
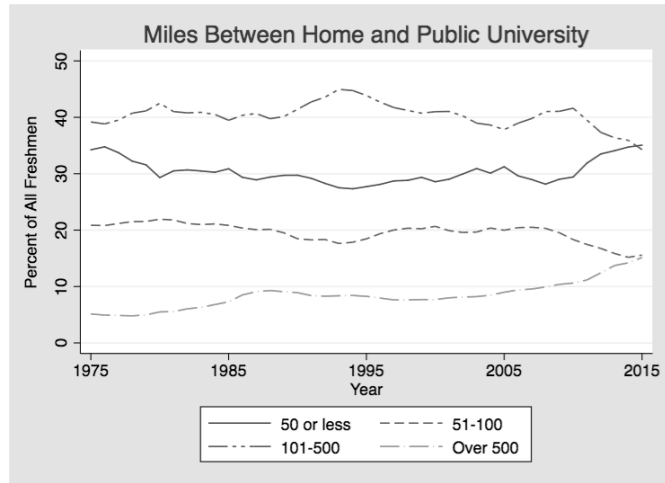
Panel B
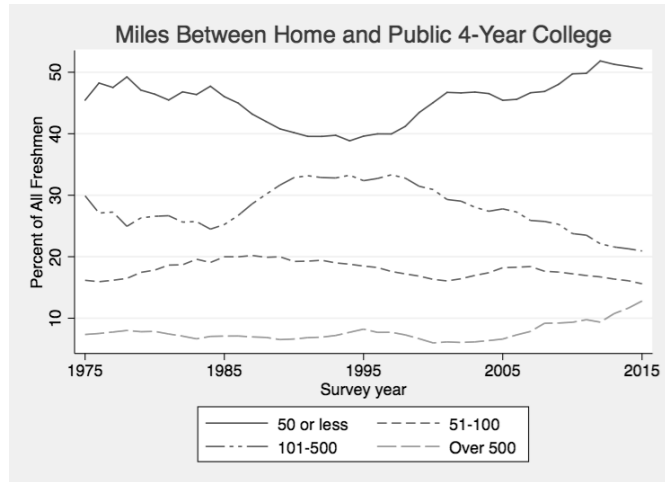
Panel C
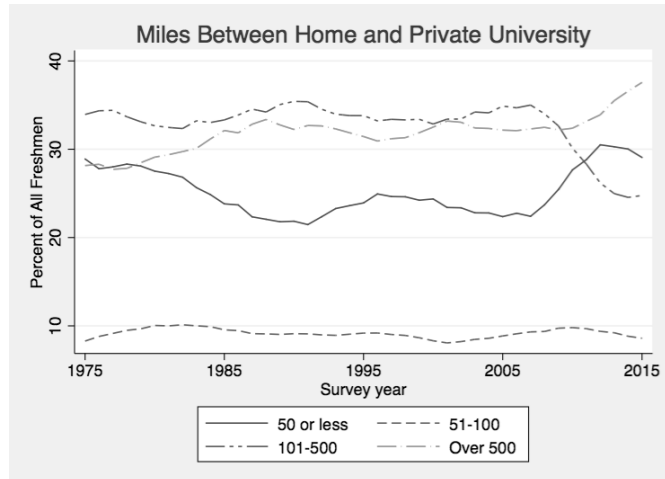
until around 2008, at which point all ranges of distance change more noticeably. During this time, the percentage of freshman traveling less than 50 and over 500 increased, while the proportion traveling between those extremes decreased. Distances migrated by students attending public 4-year colleges exhibit similar trends.

Panel C shows 5-year moving averages of the distances migrated by all freshmen attending private universities. Given that states do not subsidize the cost of private institutions for their residents, the private sector of higher education is more competitive on a national scale compared to the public sector. This is evidenced by the much higher percentage of freshmen migrating over 500 miles. Still, as is the case with public institutions, the percentage of freshmen migrating over 500 miles has risen fairly consistently from approximately 29 to 38 percent. The percentage of freshmen migrating 100 miles or less was about the same in 2015 as 1975. The percentage of freshmen migrating between 100 and 500 miles dropped precipitously from 2007 to 2015 at which point the percentage of freshmen migrating 50 or less and over 500 show noticeable increases.

Although conclusions should be drawn with caution from these data, it does appear more students are migrating greater distances over time. In both public and private sectors, the percentage of students migrating over 500 miles exhibits a clear upward trend. Another pattern emerging from these trends is the possible impact the Great Recession had on distances migrated. Among public and private universities especially, the trends exhibit distinct changes around 2008 in which the percentages of freshmen migrating distances of each extreme -- 50 or less and over 500 miles -- increase. Overall, the above figures demonstrate that the distances students migrate to attend college in the U.S. are subject to fluctuations. Based on the literature, these fluctuations are likely due to a combination of changes in student preferences and exogenous changes in the higher education market.

DISTANCE AND COLLEGE ENROLLMENT

College enrollment can involve several different outcomes. Access typically concerns enrollment opportunity and policy's ability to promote equality. College choice

concerns the determinants or consequences of enrolling in one institution over others. Student migration, though also about choice, is primarily concerned with students crossing borders in making their choice.

Virtually every study to incorporate distance into college enrollment has found it to be a deterrent. A dearth of proximate institutions hinders access (Hillman & Weichman, 2016), particularly among the socioeconomically disadvantaged (Turley, 2009). Analyzing enrollment of nationally representative samples, the probability a student chooses to enroll at an institution is decreasing in distance (Long, 2004). Distance also deters interstate migration (Gossman, 1967; McHugh & Morgan, 1984; Kyung, 1996; Hoxby, 1997; Cooke & Boyle, 2011) and is a significant determinant of intrastate migration flows between high schools and colleges; even more so than tuition in some cases (McConnell, 1965; Kariel, 1968; Ullis & Knowles, 1975; Leppel, 1993; Ordovensky, 1995; Ali, 2003; Alm & Winters, 2009).

It is clear distance imposes a substantial cost on students that impacts the decision-making process of initial enrollment. The cost of distance is easily conceived as financial in nature but its potential to impose a psychological or social cost should also be considered (Tinto, 1987; Ovink & Kalogrides, 2015). In either case, it is unlikely such costs disappear after enrollment, but rather persist for as long as a student attends a particular institution. Whether or the extent to which distance subsequently impacts student persistence, transfers, or degree completion are not addressed in the above literature.

DISTANCE AND COLLEGE COMPLETION

Since Card (1993), distance has been used as an instrumental variable (IV) to address the endogeneity of educational attainment in estimating wages or other returns (Kane & Rouse, 1995; Kling, 2001; Currie & Moretti, 2003; Carneiro & Taber, 2004; Dee, 2004; Doyle & Skinner, 2016). Unlike K-12, the prevailing thought is families do not locate based on the quality of proximate postsecondary institutions.[34] If it can be demonstrated that distance affects attainment, then distance provides a source of exogenous variation in

---

[34] Rouse (1995) and Careiro and Heckman (2002) find some evidence that distance to postsecondary institutions is correlated with family characteristics and academic ability. Caution should be used in claiming strict exogeneity of distance.

attainment. Though studies that use this method are primarily interested in a second-stage outcome, they must first estimate the effect of distance on attainment.

Additionally, the measurement of distance and attainment among the IV studies varies. For instance, Card (1993) uses the presence of a four-year institution within a county and finds this proximity increases the years of school 0.32 to 0.38 years. In contrast, Dee (2004) finds that living within 100 miles of a community college does not affect the attainment of an associate's degree but does increase the attainment of a bachelor's degree by 3.2 percent. Indeed, Doyle and Skinner (2016) demonstrate that attainment estimates are sensitive to the type of distance measurement used.

A small set of literature has examined the relationship between distance and degree completion more directly. Rouse (1995) uses miles to the nearest institution by type and finds that an increase of 10 miles to a four-year college decreases years of schooling by a miniscule amount, while distance to a community college has no effect on years of education when family background is included. Leigh and Gill (2003) argue that it is important to control for a student's desired amount of schooling. In doing so, they find proximity to a community college increases educational attainment by 0.4 to 1.0 years among individuals desiring a bachelor's degree.

Overall, it is apparent distance affects attainment but how? Is the effect driven entirely by the local average treatment effect on attendance? That would suggest once a student is induced into college by a change in distance, any remaining distance would have no effect on subsequent success. The relationship between distance and success is mostly a black box in the existing literature. Little is known as to whether the distance a student ultimately migrates to attend college impacts elements of success, such as persistence, transfers, and degree completion.

POLICY CONTEXT

Public policy can alter the distances student migrate to attend college, and thus the effect of distance on success is a policy issue. For example, federal programs like the College Scorecard aim to broaden students' college search beyond nearby institutions, drawing criticism for ignoring student mobility (Turley, 2009; Hillman & Weichman, 2016). State government is also interested in altering student migration. An explicit goal

achieved by broad state merit aid programs is to prevent high-achieving students from migrating out of state (Toutkoushian, 2012). Additionally, a decrease in appropriations increases the likelihood that students enroll out of state (Perna & Titus, 2004) and leads state institutions to increase the proportion of nonresident enrollees (Jaquette & Curs, 2015) or raise admissions standards for resident students (Epple et al., 2013), thus reducing more proximate seats for students.

Perhaps the most direct case of policy affecting distance is the placement of institutions. Although the spatial distribution of postsecondary institutions—especially public and nonprofit—is quite static, Long and Kennedy (2012) find that an average of 0.77 college credits could be gained if all states located institutions optimally. This generally involves moving four-year institutions to densely populated areas and two-year institutions away from those areas, which runs somewhat counter to the literature on community college proximity.

A less direct but relevant policy lever affecting distance is the delivery of state subsidies shifting increasingly toward financial aid rather than appropriations. Much like tuition reciprocity agreements, this change in subsidy composition degrades the tuition differentials between state borders. However, instead of intentionally expanding the market for all students, students who are ineligible for state financial aid—lower-ability and/or higher-income—are most affected. If the distances students migrate to attend college negatively impact success, then large scale policies involving state subsidies may reduce success among specific subsets of students along income and ability.

DISTANCE, COLLEGE CHOICE, AND SUCCESS

Given that a student has decided to pursue a degree and a particular institution to attend, how might distance be involved in the process of persisting at that institution until completing a degree? The impact of distance can be conceptualized in at least three ways. First, there is the financial cost of traveling a distance. Second, there is the cost to available time. Lastly, there is the cognitive effect of being a certain distance from home.

As with enrollment and choice of institution, persistence is a discrete choice problem. Each college j among all feasible colleges J offers a package of goods consisting of academic quality q and amenities b. Academic quality represents the

characteristics of an institution that generate returns to education or add value to a degree. Amenities include all other characteristics of an institution that provide utility to a student through consumption. Student i persists at college k in period t so long as the utility he receives is greater than the utility of attending any other college or entering the workforce, represented by the equation,

$$S_{ikt} = \begin{cases} 1 \; if \; U_{ikt}(R_{kt}(e_{kt}), b_{kt}) \geq U_{ijt} \; \forall \; k \neq j \; and \; P_{ikt} \leq I_{it} \\ 0 \; otherwise \end{cases},$$

(1)

where s is the indicator for persistence, R is the return to a degree from the institution, and P is the price of college k that must remain within the student's budget constraint I.

There must be at least one factor involved in persistence that is not involved in the process of choice. Otherwise, there would be no reason to separately consider persistence. The price of attendance is obviously such a factor, as price can change after choice such that s equals zero in a later period. Price is not the only reason students fail to persist though. Academic performance can be so low that the institution does not allow the student to persist. Less extreme than forced exit is that a student's academic performance lowers the value of the degree being pursued such that persistence is no longer utility maximizing. In both cases, GPA is a useful measure of academic performance.

Incorporating GPA motivates a modification to equation (1). The return to a degree is an increasing function of academic quality and GPA. Let us assume the difference in academic quality between institutions does not change so much as to meaningfully affect persistence after choice. Therefore, while attending an institution, the return to a degree depends solely on a student's GPA g, while overall utility also involves leisure l, resulting in the utility function

$$U_{ikt} = (g_{ikt}, l_{ikt}).$$

(2)

In a given time period T, a student allocates time between academic work w, leisure l, and commuting c between his residence and campus, or formally,

$$T = w_i + l_i + c_{ik}.$$

(3)

GPA is a function of the quantity of time allocated to academic work, academic ability, and a random component signifying the uncertain relationship between time

allocated to academic work and GPA. Academic ability a is the marginal productivity of academic work $\frac{\partial g_{ik}}{\partial w_{ik}}$. The following equation formally defines GPA,

$$g_{it} = a_i w_{it} + \epsilon_i, \tag{4}$$

where the random component ϵ is assumed to be additive and normally distributed $N(0, \sigma^2)$. Distance from home d, academic quality, and time allocated to leisure impact marginal academic productivity. For instance, one hour of work at a community college increases GPA more than one hour of work at an elite university. Regarding leisure, at the very least a student must allocate some time toward sleep in order for academic work to be productive. The effect of distance is not as clear since some students benefit from distance, while others have difficulty coping with it. These factors enter into equation (4) like a tax, and by substituting w with equation (3), GPA can be represented by the following equation:

$$g_{ikt} = a_i\big(1 - \tau(d_{ik}, q_k, l_{ikt})\big)(T - l_{ikt} - c_{ikt}) + \epsilon_{ik}, \tag{4}$$

where $0 \le \tau \le 1$, $\frac{d\tau}{dd} \gtrless 0$, $\frac{d\tau}{dq} > 0$, and $\frac{d\tau}{dl} < 0$. Finally, defining the GPA below which exit from the institution is either forced or voluntary as $e_{ikt} = \max\{U_{ijt} \; \forall \, j \ne k, g_0\}$, then persistence becomes the conditional equation,

$$s_{ikt} = \begin{cases} 1 \; if \; g_{ikt} \ge e_{ikt} \; with \; P_{ikt} \le I_{it} \\ 0 \; otherwise \end{cases}. \tag{5}$$

Figure 5.2 displays a hypothetical allocation under these assumptions. GPA is on the vertical axis, and leisure is on the horizontal axis. The constraint is fixed at total time T along the horizontal axis. The point at which a student's GPA causes the utility of a degree to no longer be greater than any alternative, leading the student to exit the institution is represented by line e. The figure displays a scenario in which a student maximizes utility at points (g^*, l^*).

Unless a student relocates on or near campus in a later time period, both distance and academic quality were determined in the choice process. A brief outline of the choice process completes the framework relevant in this study. At this stage, distance is an input for academic quality and amenities. At zero distance, a student acquires zero quality and amenities. Provided the utility maximizing institution is neither most proximate nor most distant to the student, quality and amenities are increasing in distance at a decreasing rate.

Increasing distance allows a student to attend institutions of increasing quality or amenities, and there is a distance at which the institution of highest quality and amenities is available. Distances beyond this point do not increase the quality or amenities attainable.

Put simply, a student will choose an institution with quantities of academic quality and amenities that provides greater utility than all other institutions provided he can persist there academically and financially. More formally, the discrete choice follows the equation,

$$Choose \ U_{ik}\big(R_{ik}(q_{ik}(d_i)), g_{ik}(a_i, q_k, l_{ik}, d_{ik}, c_{ik})), b_{ik}(d_i)\big) > U_{ij} \ \forall \ k \neq j$$

$$and \ g_{ik}^* \geq e_{ik} \ and \ P_{ik} \leq I_i \quad . \tag{6}$$

Equation (6) aligns with the college-going behavior observed in the market. Proximity increases the likelihood that students will enroll and choose a particular institution. Some institutions, if feasible, provide sufficiently high utility to be chosen at any distance. Furthermore, the phenomenon of under matching is not only due to financial constraints but also preferences for amenities and leisure, or the uncertainty of academic performance and risk aversion.

Figure 5.2 also shows how institutional choice affects the probability of persistence. Attending a college of farther distance away or higher quality rotates the constraint downward, resulting in a new allocation (g', l^*).[35] Now there are fewer feasible allocations of work and leisure that lie above e. As the constraint approaches e, the probability of persistence decreases at any allocation of g and l.

Recall that the return to a degree is increasing in quality. This is represented by the new exit line e' where a degree from the higher quality institution remains the best option at lower GPA values. The return to a degree from an institution relative to all other options is represented by the vertical distance between g and e. So long as the cost of distance or quality to GPA $(g^* - g')$ is less than the benefit gained $(e - e')$, then distance and quality increase the probability of persistence. Due to the diminishing return to

Figure 5.2 - Academic Labor-Leisure Model

---

[35] The figure illustrates quasi-linear utility such that distance does not affect time allocated to leisure, but as long as there is not perfect substitutability between academic effort and leisure, g is decreasing in d.
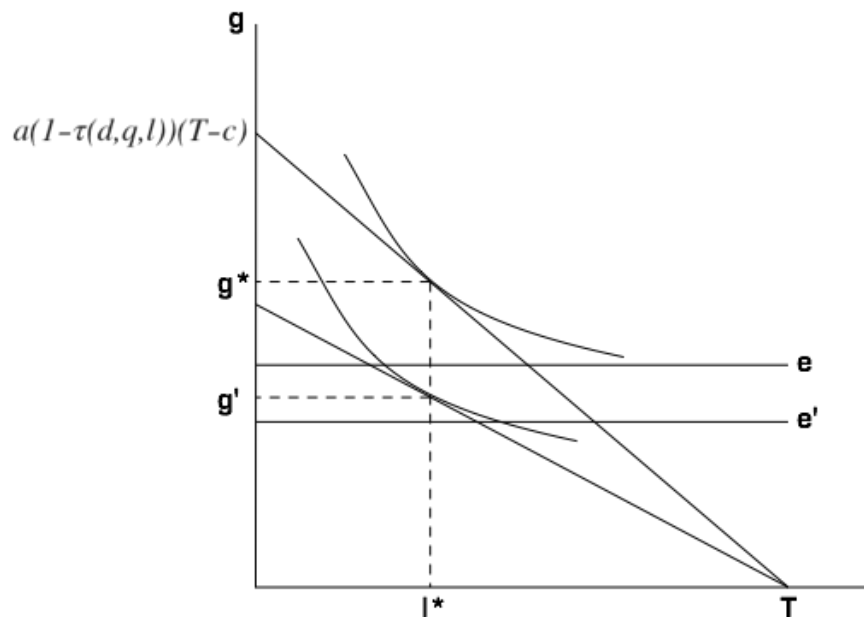
distance on quality—and academic productivity if positive at all—the cost eventually exceeds the benefit and decreases the likelihood of persistence.

If assumptions are made regarding students' academic ambition prior to choice as well as the quality of institutions across type, then additional propositions can be made with respect to distance and college-going behavior. Suppose students decide to pursue an associate's or bachelor's prior to choice of institution. Let us also assume that academic quality does not vary with respect to associate's degrees. That is to say the return to an associate's degree is equal across all institutions. Conversely, there is a strict ranking in academic quality with respect to bachelor's degrees among four-year institutions.

Under these assumptions, a student seeking an associate's degree maximizes its return by attending the most proximate institution unless the cost of migrating to a more distant two-year institution is less than the difference in tuition compared to the most proximate four-year institution. Otherwise, migrating any farther than the minimum distance is due solely to a student's marginal rate of substitution of quality for amenities. Therefore, the effect of distance on persistence or degree completion is expected to be non-positive on average. The cost of distance to time is attributable to the act of commuting. Given that most associate's degree seekers attend community colleges that do not have residence halls, the effect of distance is due to cost to time rather than

academic ability since such students presumably live at home. In general, distance is expected to have a larger impact on persistence among these students.

For students seeking a bachelor's degree, a student migrates the minimum distance that attains a utility-maximizing quantity of academic quality and amenities. The relationship between distance and choice of institution is expected to be weaker compared to those seeking an associate's degree. If a student relocates to campus, thus eliminating the cost of commuting, any effect of distance is primarily through academic ability. Such a distinction would be possible to estimate if data included residential choices of students. Given the relationship between distance and quality, the effect of distance on persistence is expected to be negative quadratic.

In sum, estimating the effect of distance—or any factor—on student success at an institution involves a two-stage decision process resulting in the student being observed at that institution: degree type enrollment and institutional choice. How these sources of selection bias are empirically modeled has important implications for external validity. This will be discussed in more detail following the next section.

DATA AND SUMMARY STATISTICS

Data for this study were obtained from the Kentucky Center for Education and Workforce Statistics (KCEWS), which administers the state's P-20 database. The analytic sample contains four cohorts of all graduates from Kentucky public high schools between 2008-09 and 2011-12 academic years. The first cohort aligns with the first year in which comprehensive data is available. Data contain the 2015-2016 academic year, enabling four years of in-state college-going behavior to be observed for the most recent cohort.[36]

The data contain time-invariant demographics of sex and race as well as time-variant information on limited-English-proficiency (LEP), special education (SPED), gifted, and free and reduced-price lunch (FRPL), all of which reflect a student's status in their senior year. High school academic achievement is available via ACT scores, final high school GPA, the number of Advanced Placement classes taken, and college credits

---

[36] A notable limitation of the data is out-of-state college matriculates are not observed unless they applied for financial aid in Kentucky. Approximately 8 percent of all Kentucky college matriculates go out of state. The data capture about 1 percent. The missing students are presumed to be an atypical subgroup that whose absence in the data should not impact results or policy implications.

earned in high school. The geographic coordinates of students' high school and all Kentucky public and private nonprofit two-year and four-year institutions available through IPEDS were used to calculate the geodesic distance based on the Vincenty computational formula. Observations missing one or more of these variables were dropped, resulting in a 6 percent reduction and a total of 149,183 high school graduates in the full sample.

Table 5.1 provides sample means of demographic and high school variables for the full sample of graduates in Column 1 and college matriculates in Column 2. Between 2009 and 2012, 66 percent of public high school graduates (93,617) enrolled in college within two years. The group of matriculates is less male, more affluent, took more AP classes, and had higher ACT and GPA achievement. Matriculates do not differ much along racial composition, and actually earned slightly more college credits while in high school. Lastly, proximity to the nearest two-year and four-year institution is roughly equivalent between the groups at 16 and 14 miles, respectively.

Several postsecondary variables are of interest. Among those who enrolled in Kentucky, 95 percent are identified as seeking an associate's, bachelor's, or are undeclared. The college student sample was reduced to include only these students. Relevant outcomes include college persistence to the second year of college as well as completion of a degree within four years for all cohorts and six years for the first two cohorts (2009-10).

Table 5.2 reports sample means of postsecondary variables for all students in all four cohorts in Column 1, only those seeking an associate's (Group A) or bachelor's degree (Group B) in Columns 2 and 3, respectively. Columns 4-6 report means for the same groups but only for the first two cohorts for which six years of data are available. Since these are all recent high school graduates, very few students attend part-time, which is highest among Group A at 20 percent. No one in Group B attended two-year institutions, which suggests one cannot declare as seeking a bachelor's degree. Students who attend a two-year school with intentions to attain a bachelor's are either in Group A or in the full sample that includes undeclared students.

Table 5.1 - Sample Means of High School Variables

	Graduates	Matriculates
	(1)	(2)
Male	49.33	44.25
White	85.35	85.16
Black	9.36	9.24
Hispanic	2.12	1.93
FRPL	41.67	34.52
SPED	1.59	0.66
LEP	0.50	0.29
Gifted	23.36	29.68
ACT	18.89	20.14
GPA	2.90	3.11
AP Classes	1.37	1.73
College Credits	1.51	1.66
Enrolled	66.18	100.00
Nearest 2-year	16.64	16.19
Nearest 4-year	14.63	14.31
Unemployment	9.84	9.79
Students	149,183	93,601

Notes: Sample for Column 1 includes all Kentucky public high school graduates between academic years 2008-09 and 2011-12, and Column 2 includes all graduates who enrolled at an in-state postsecondary institution within two years and sought an associate's, bachelor's or were undeclared.

Approximately 80 percent of all students persisted to the second year. This rate falls to 67 percent for Group A and rises to 87 percent for Group B. About 36 percent attained either an associate's or bachelor's degree during the time period, which is deflated due to limited number of years the two most recent cohorts are observed. The four-year graduation rate was 31 percent among all students, while the six-year rate was 43 percent among the first two cohorts. Six-year graduation rates were 31 and 53 percent

for Group A and B, respectively. Not all students attain the degree they initially sought. About 9 percent of Group A attain a bachelor's, while 4 percent of Group B attained an associate's instead. Lastly, all students travelled an average of 40 miles to attend college, but migration differs between degree seeking groups. Group A travelled 26 miles, roughly half the distance travelled by students in Group B at 53 miles.

Table 5.3 takes a closer look at sample means related to distance and college-going behavior. Approximately 29 percent of all students attended the institution nearest to them. As expected, substantially more students in Group A attend the nearest school (40 percent) than those in Group B (22 percent). This disparity is even greater when the type of institution is considered. Almost 70 percent of students in Group A attended the nearest two-year school, while 9 percent attended the nearest

Table 5.2 - Sample Means of Postsecondary Variables

	All Cohorts (2009-12)			First Two Cohorts (2009-10)		
	All	Group A	Group B	All	Group A	Group B
	(1)	(2)	(3)	(4)	(5)	(6)
Part-time	10.07	19.61	1.23	9.77	18.31	1.13
Full-time	89.93	80.40	98.78	90.23	81.71	98.87
Two-year	37.51	85.43	0.00	37.98	84.57	0.01
Four-year	62.49	14.57	100.00	62.02	15.44	100.00
Persisted	78.59	67.11	87.41	80.05	69.57	88.57
Associate's	8.58	15.91	3.38	9.20	16.82	3.92
Bachelor's	27.72	6.55	42.82	31.86	8.82	49.24
Graduated	27.74	24.09	30.61	42.80	30.67	52.74
Distance	39.96	24.15	52.89	39.62	24.51	52.75
Nearest 2-year	16.19	16.52	16.28	16.19	16.73	16.35
Nearest 4-year	14.31	16.79	12.70	14.29	16.94	12.63
Students	93,601	29,983	50,023	47,826	14,602	24,849

Notes: Sample includes all graduates of Kentucky public high schools who enrolled into an in-state postsecondary institution and sought an associate's (Group A), bachelor's (Group B), or were undeclared. Graduated for all cohorts includes 4-year rates, and 6-year rates for the last two cohorts.

Table 5.3 - Means related to distance and success

	All Cohorts (2009-12)		
	All	Group A	Group B
Attended nearest	29.34	39.99	21.65
Attended nearest 2-year	35.62	69.61	0.00
Attended nearest 4-year	18.28	9.33	25.59
Persisted and transferred	14.37	11.43	15.69
Transferred closer	59.91	41.21	68.86
Upward transfer	13.96	43.43	0.00
Graduated at same school	88.11	91.98	85.92
Graduated at closer school	26.21	16.76	30.67
Observations	93,601	29,983	50,023

Notes: Sample includes all graduates of Kentucky public high schools who enrolled into an in-state postsecondary institution and sought an associate's, bachelor's, or were undeclared. Percentages of indented variables are relative to the main variable above.

four-year school. By contrast, only 26 percent of Group B attended the nearest four-year school. Among the 80 percent of students who persisted to the second year, 14 percent transferred to a difference school and transfers were more prevalent among students in Group B than Group A. Among those who transferred, 60 percent transferred to a more proximate institution. This rate rises to nearly 70 percent for Group B compared to 41 percent of Group A. Transfers are defined as upward if done from a two-year to a four-year school, which among Group A students who transferred 43 percent did so. Lastly, among those who graduate, most do so at the school they initially matriculated, though 14 percent of Group B students graduated at a difference school and 31 percent of them did so at a more proximate school.

Kentucky is somewhat smaller than the median of states, ranking 37th in land area that spans approximately 420 miles east-to-west and 182 miles north-to-south. Also, Kentucky ranks 28th in public institutions per capita. Though the data include only in-state college students, 80 percent of all college students in the nation enrolled in state as of 2012. Therefore, the sample represents a large majority of college-going behavior

among the population. Furthermore, an important advantage of these data compared to a national survey is the statistical power gained from the higher number of observations. For instance, the three national surveys administered decades apart used by Long (2004) have about 1,000 four-year college observations each and even fewer at the two-year level. Alm and Winters (2009) stress the importance of intra-state migration but use school level data in Georgia.

Figure 5.3 provides some visual context to the study showing the approximate location of Kentucky public colleges and universities and the percentage of county population above age 25 with an associate's degree or higher by quintile. Perusal of the shading and locations suggests there is a positive correlation between proximity and attainment, just as existing literature suggests. In order to make conclusions concerning the causal relationship between distance and success, more rigorous analysis is required.

Figure 5.3 – Kentucky County Population 25+ with Associate's or Higher
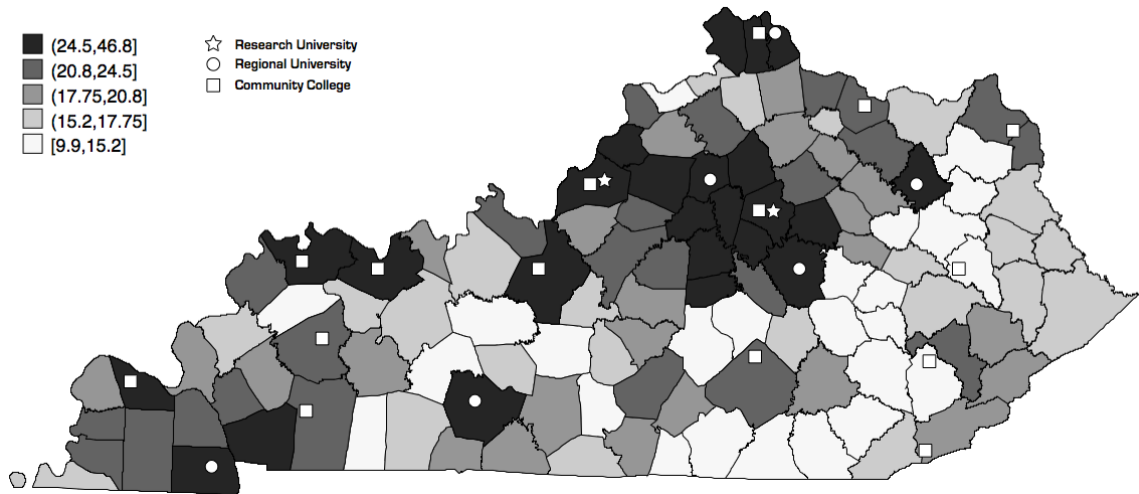
METHODS

Assuming linearity in parameters, the effect of distance on college outcome *y* for student *i* at college *j* can be estimated by the reduced-form equation

$$y_{ij} = \gamma d_{hj} + \beta X_{ij} + \epsilon_{ij} \tag{7}$$

where *d* is distance between the student's high school *h* and chosen institution, *X* is a vector of student demographics and high school achievement variables reported in Table

1 and ϵ is idiosyncratic error. Because we cannot observe marginal academic productivity nor students' residential choices in the data, the effect of distance in (7) captures financial, cognitive, and temporal mechanisms. Though the effect of distance is expected to be negative on average, the contribution of particular mechanisms is unclear.

Based on theory in the previous section, insight into mechanisms can be gained if additional assumptions are made. If we assume students choose what level of degree to pursue before choosing a college, rather than the proximity affecting the level pursued, then the type of degree sought can be included as a valid explanatory variable. If we assume further that students seeking an associate's degree commute, while student's seeking a bachelor's degree relocate, then a difference in the effect of distance between the two groups reflects the difference between temporal and cognitive mechanisms. Making this distinction also requires the assumption that the marginal financial cost of distance is the same between both groups, which seems reasonable. Separate estimations are conducted by type of degree sought that include a quadratic distance term to examine nonlinearities between the two groups. This approach requires the sample be reduced by 14 percent to include only degree-seeking students.[37]

Since distance is specific to the chosen institution the outcomes in y require careful defining that deviates from how college success is typically reported. For instance, graduation rates are reported regardless of transfers. Using a binary outcome for degree completion at any institution would inaccurately estimate the effect of distance. Therefore, the primary outcome of interest for y is referred to as success, which is defined as completing a degree at the institution in which a student initially matriculated. Almost 25 percent of all degree-seeking matriculates met this definition of success in four years, and 35 percent of those in the first two cohorts were successful within six years. Another outcome of interest is persistence to the second year. Unlike degree completion, all cohorts can be included in the analysis without requiring a time constraint. As with four- and six-year success, a student is coded as having persisted if he attends the same institution in the second year that he initially chose to attend in the first year.

---

[37] Almost all students in the sample not identified as seeking one of the two degrees are labeled undeclared. It is not clear what the educational ambitions of these students include, as attendance at two-year versus four-year institutions is not significantly different.

The potential issue with estimating equation (7) is students select into the institution, jointly determining the value of *d* that is observed. Depending on the variables included in *X*, the claim that distance migrated is uncorrelated with the error term may be dubious. A potential solution to omitted variable bias in (7) is

$$y_{igj} = \gamma_1 d_{igj} + \gamma_2 d_{igj}^2 + \beta X_{igj} + \alpha_{gj} + \epsilon_{igj} \tag{8}$$

where index *g* is incorporated to distinguish type of degree and α is the institution fixed effect. The inclusion of institution fixed effects estimates γ using within-institution variation in distance across students and controls for endogenous variation in the outcome of interest across institutions. In other words, (8) estimates the effect of distance using students who pursued the same degree, chose to attend the same institution, and whose success is impacted by the same unobservable characteristics of the institution.

Again, depending on controls, distance even within institution may be endogenous. A student who migrates a long distance may have an unobservable affinity for that particular institution. Such a case seems more likely among four-year institutions. Additionally, perhaps greater distance is associated with higher motivation, which could apply to students attending four- or two-year institutions. In either instance, assuming affinity or motivation is positively associated with success, the direction of the omitted variable bias is positive. However, this is not a concern so long as one is willing to assume unobservable characteristics associated with distances migrated to an institution are time-invariant, as the fixed effect averages such factors out in the error term. Therefore, (8) is used as the base model to estimate the effect of distance on success and to compare with results of the dual-lambda selection correction method described below.

A variation of the dual-lambda method developed by Vijverberg (1995) is used that corrects for selection bias resulting from a two-stage choice with multiple alternatives. Vivjerberg (1995) shows that Lee's (1983) method for correcting selection bias due to a prior choice with multiple alternatives is poorly suited if there is more than one choice involved in the process. For example, scholars estimate wage equations correcting for labor force participation, while others correct for migration choices. Both participation and migration are likely interrelated; Vivjerberg models labor participation as conditional on location. Critically, if the biases work in opposite directions, then bias may not be detected at all. The dual-lambda method accounts for selection over multiple

interrelated choices with any number of alternatives and allows one to estimate the two selectivity effects separately.

Estimating student success at a particular institution is quite similar to the above example. College students are observed at an institution as a result of two choices: 1) they chose to pursue either an associate's or bachelor's degree, and 2) they chose to attend that institution among numerous alternatives. It is highly likely steps 1 and 2 are interrelated, which is supported by patterns in the data described in the previous section. A large majority of student's seeking an associate's degree attend a community college, while those seeking a bachelor's degree almost exclusively attend a public or private four-year school. Furthermore, less than 0.5 percent of students seeking an associate's attended a private four-year school. Therefore, estimation proceeds under the assumption that probabilities of college choice are conditional on the type of degree pursued.

Using the dual-lambda method, estimating the effect of distance on success involves a linear probability model for the following equation

$$y_{igj} = d_{igj} + d_{igj}^2 + \beta X_{igj} + \sigma_{1ju}\lambda_{j|g} + \sigma_{2gu}\lambda_g + u_{igj} \tag{9}$$

where $\lambda_{j|g}$ is an extension of the Inverse Mills Ratio (Heckman, 1978) that corrects for selection of college j conditional on degree type g, λ_g corrects for selection of degree type, and σ is the estimated parameter for each selection term. Rejection of the null for σ indicates the presence of selection bias, while negative values indicate positive bias and vice versa. If $\sigma_{1ju} < 0$, then students pursuing that type of degree who choose institution j are more likely to succeed than the population of college students, and if $\sigma_{2gu} < 0$, then students who choose to pursue that type of degree are more likely to succeed than the population of college students.

Given the discrete nature of college-going behavior outlined in the previous section, a multinomial logit is used to estimate the probability of seeking an associate's or bachelor's degree as well as a Kentucky postsecondary institution conditional on type of degree. The probability student i pursuing degree g chooses to attend institution $j=1$ among all alternatives J is estimated via the functional form

$$\Pr(y_{ig} = 1) = \exp(\beta_1 X_{ig1}) / (\exp(\beta_1 X_{ig1}) + \cdots + \exp(\beta_J X_{igJ})). \tag{10}$$

The estimated probabilities are used to calculate the values for λ in (9). [38]

Identification of each λ relies on including variables in the first-stage multinomial logit that predict either type of degree or institution and can be excluded from the second-stage. Variables used to predict type of degree include the county unemployment rate and the percent of the county adult population with a bachelor's degree or higher. Given the evidence that individuals do not sort based on proximity to postsecondary institutions, the distance between students and each institution is considered to be exogenous. Therefore, a gravity model measure commonly found in migration research is used as an IV for choice of institution that quantifies the pull each institution exerts on each student based on its size and proximity, or

$$pull_{ij} = \frac{E_j}{d_{ij}^2},$$ (11)

where E is the enrollment at institution j.

BASE MODEL RESULTS

Table 5.4 shows the estimated effect of distance on four- and six-year success (i.e. completed a degree from initially chosen institution) as well as two-year persistence at the same school for those seeking an associate's degree in Columns 1-2 (Group A) and bachelor's degree in Columns 3-4 (Group B). Distance is modeled as a quadratic or logarithmic function for both groups. The sample mean for each outcome is displayed at the top of each set of estimates.

According to the results in Column 1, there is no evidence that distance affects four-year success among those in Group A if modeled as a quadratic. However, Column 2 suggests the effect of distance on four-year success is statistically significant if modeled logarithmically. On average, a one-percent increase in distance decreases the likelihood of four-year success 0.007 percentage point among students seeking an associate's degree at the same institution. Based on a sample mean of 22 percent, this represents a 0.03 percent decrease. Average distance among these students is 23 miles with a standard deviation of 27 miles. Therefore, the results suggest that a student seeking an associate's degree at a particular institution who travels one standard deviation greater distance has a

---

[38] See Appendix for the formulas used to construct the values of lambda

Table 5.4 - Effect of Distance on Success

	Group A Quadratic (1)	Group A Log (2)	Group B Quadratic (3)	Group B Log (4)
Four-year Success	*[0.2213]*		*[0.2538]*	
Distance	-0.0045	-0.0067*	0.0065***	0.0078**
(10 miles or 1%)	(0.0027)	(0.0030)	(0.0018)	(0.0026)
Distance^2	0.0002		-0.0002*	
	(0.0002)		(0.0001)	
Mean Distance	23.11		54.20	
Students	28,111	28,111	40,685	40,685
Six-Year Success	*[0.2581]*		*[0.4518]*	
Distance	-0.0058	-0.0068	-0.0023	-0.0067
(10 miles or 1%)	(0.0039)	(0.0039)	(0.0025)	(0.0037)
Distance^2	0.0003		0.0001	
	(0.0003)		(0.0001)	
Mean Distance	24.16		54.07	
Students	13,605	13,605	20,263	20,263
Two-Year Persistence	[0.5956]		[0.7546]	
Distance	-0.0126***	-0.0153***	-0.0102***	-0.0184***
(10 miles or 1%)	(0.0034)	(0.0035)	(0.0017)	(0.0024)
Distance^2	0.0004		0.0004***	
	(0.0002)		(0.0001)	
Mean Distance	23.11		54.20	
Students	28,111	28,111	40,685	40,685
Student Controls	Y	Y	Y	Y
Institution FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Notes: Sample includes all graduates of Kentucky public high schools who enrolled into an in-state postsecondary institution and sought an associate's (Group A), or bachelor's (Group B) degree. Success is defined as completing a degree at the institution initially chosen. Persistence excludes those who transferred. A one-unit change for quadratic models is 10 miles. The unit change for log models is one percent. For example, Column 2 indicates a one-percent increase in distance decreases the likelihood of four-year success by 0.007 percentage point. The sample mean for each outcome and group is displayed in italicized brackets. Standard errors are clustered at the high school-institution pair level.
*p<0.05; **p<0.01; ***p<0.001

3-percentage point (14 percent) lower probability of completing a degree at that institution within four years.

Among those seeking a bachelor's degree, both quadratic and log models of distance are statistically significant, though the quadratic model in Column 3 has slightly higher explanatory power. Furthermore, theory suggests the effect of distance is not monotonically positive as Column 4 indicates. At the average distance of 54 miles among students seeking a bachelor's degree, an increase of 10 miles raises the probability of completing a degree at the initially chosen institution within four years by 0.4 points (1.5 percent). Due to the significant negative quadratic, the effect of distance becomes negative at approximately 160 miles.

The top panel of **Figure 5.4** plots the predicted probabilities of four-year success among those in Group B as a function of distance holding other covariates constant at the mean. The point estimates display a quadratic effect, rising until 150 miles and slightly lower at 250 miles. However, the estimates are imprecise at these more extreme distances, making the negative effect of distance inconclusive. The bottom panel contrasts the point estimates between the 50-mile increments in Panel A. The contrasts for 200 and 250 miles are statistically insignificant. Therefore, while the effect of distance on four-year success is nonlinear, it cannot be concluded with sufficient statistical confidence that the likelihood of success eventually declines.

The bottom-third of estimates in table 4.4 represent the effect of distance on persistence to the second year at the same institution. There is no evidence that distance has a quadratic effect on persistence among those seeking an associate's degree. As theory predicts, the effect is strictly negative. The models in Columns 1 and 2 are virtually equivalent in explanatory power, and so the linear estimate is used to interpret results. According to Column 1, an increase of 10 miles decreases the probability that a student seeking an associate's persists at the same institution by 1.3 percentage points (2 percent). Furthermore, a student seeking an associate's degree at a particular institution who travels one standard deviation greater distance has a 3.2 percentage point (5.4 percent) lower probability of persistence.

Figure 5.4 - Marginal Effects of Distance on Four-year Success, Bachelors
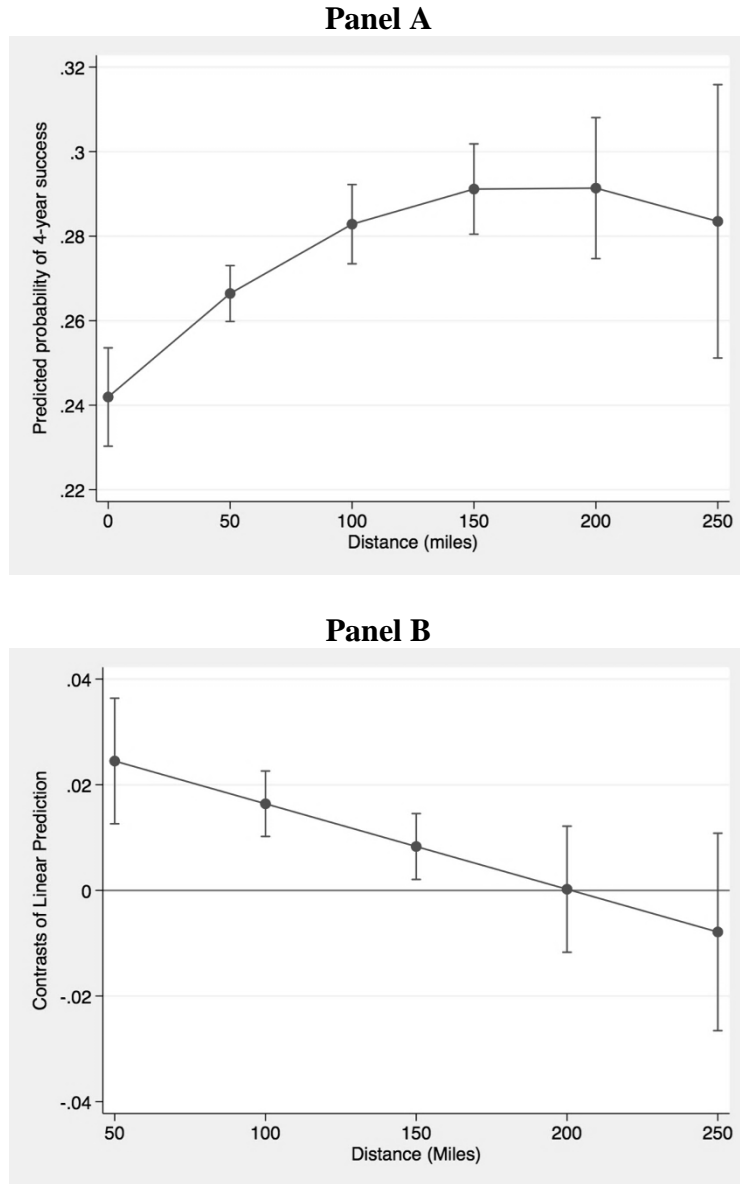
Panel A

Panel B

Notes: Figures illustrate the effects of distance estimated in Table 4, Column 3. Panel A provides predicted probabilities of four-year success at various distances holding covariates constant at their mean. Panel B contrasts the point estimates in Panel A, showing the marginal effect and significance at each distance.

According to the preferred model in Column 3 migrating 10 miles in addition to the average 54 miles decreases the probability of persistence among students seeking a bachelor's degree at the same institution by 0.6 points (0.8 percent). The effect of distance on two-year persistence becomes positive at approximately 130 miles. **Figure 5.5** displays the predicted probabilities of persistence by distance migrated in the top panel along with contrasts in the bottom panel. Unlike four-year success, there is significant evidence that distance has a quadratic effect on persistence. At 50 and 100 miles, distance lowers persistence among students at the same institution seeking a bachelor's. At 200 and 250 miles, distance increases persistence.

The probability that a student transferred in the second year and the difference in distance between transferred institutions were estimated using the quadratic model. **Table 5.5** reports the results separately between Groups A and B. Column 1 indicates at the mean distance of 24 miles, an additional 10 miles increases the likelihood of transfer by 1.4 percentage points (18 percent) among those seeking an associate's degree. As before, there is no evidence of a quadratic effect among this group. For those seeking a bachelor's degree in Column 2, an additional 10 miles at the mean distance increases the probability of transfer by 1 point (7 percent), and there is significant evidence of a negative quadratic effect.

Among those students who transferred in their second year, does the distance they initially migrate affect whether they transfer to a more proximate or distance institution? The bottom half of table 5.5 reports estimates for this question. For Group A students who attended the same institution and transferred in their second year, migrating 10 miles farther than average decreased the distance to the transferred school by 12 miles. For Group B, students transferred 10 miles more proximate to their high school. In other words, short-to-intermediate distances increase the probability that students transfer in their second year, and those students are more likely to transfer closer to home.[39]

---

[39] The point estimates should be interpreted with caution because part of the effect is likely mechanical. Since only in-state students are observed, the farther a student migrates, there are necessarily fewer options that are more distant.

Figure 5.5 - Marginal Effects of Distance on Persistence, Bachelors
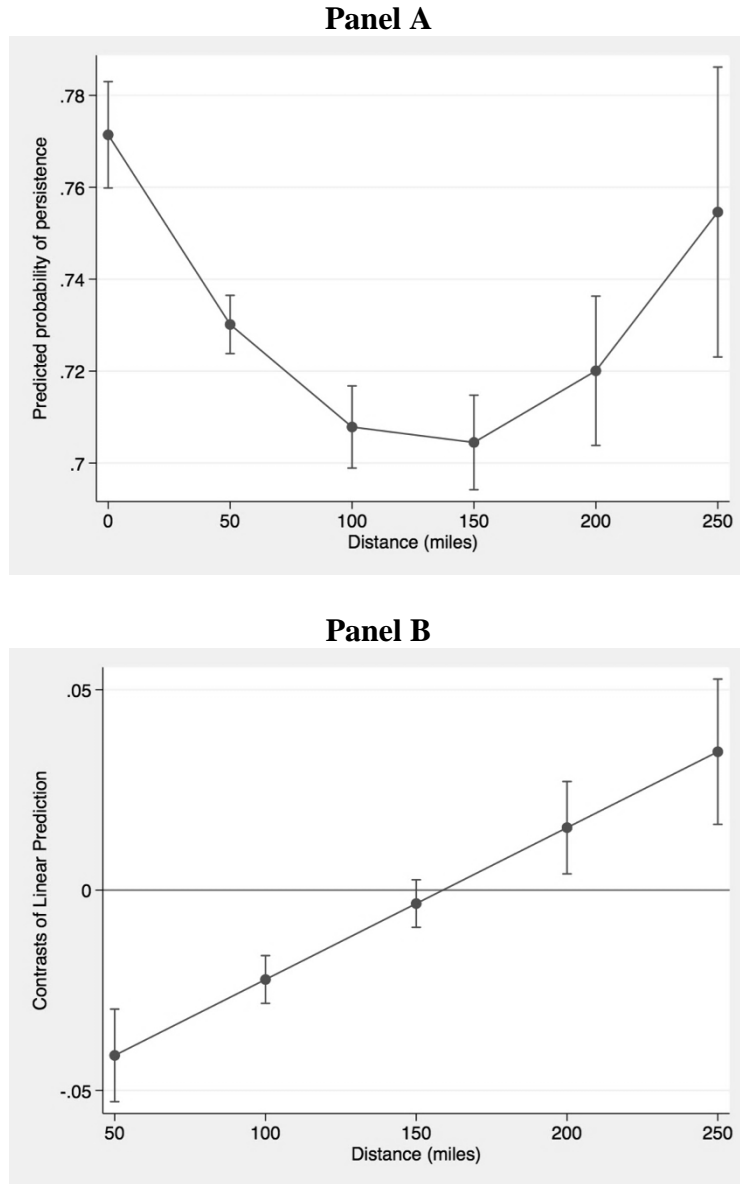
Panel A

Panel B

Notes: Figures illustrate the effects of distance estimated in Table 4, Column 3. Panel A provides predicted probabilities of persistence at various distances holding covariates constant at their mean. Panel B contrasts the point estimates in Panel A, showing the marginal effect and significance at each distance.

Table 5.5 - Effect of Distance on Transfers

	Group A Quadratic (1)	Group B Quadratic (2)
Transferred	*[0.1114]*	*[0.1400]*
Distance (10 miles)	0.0196***	0.0165***
	(0.0029)	(0.0012)
$Distance^2$	-0.0005*	-0.0006***
	(0.0002)	(0.0001)
Mean Distance		
Students	18,854	35,699
Distance Transferred	[12.15]	[-35.17]
Distance (10 miles)	-14.6309***	-11.4999***
	(1.2372)	(0.5513)
$Distance^2$	0.3167***	0.0966***
	(0.0903)	(0.0289)
Mean Distance	35.61	64.80
Students	2,055	4,792
Student Controls	Y	Y
Institution FE	Y	Y
Year FE	Y	Y

Sample for transferred includes all graduates of Kentucky public high schools who enrolled into an in-state postsecondary institution and sought an associate's (Group A), or bachelor's (Group B) degree. Transferred is defined as attending a different institution in the second year. Sample for distance transferred includes only those who did transfer in their second year. Distance transferred is calculated as distance to second-year school minus the distance to the initially chosen school. The sample mean for each outcome and group is displayed in italicized brackets. Standard errors are clustered at the high school-institution pair level.
**p<0.01; ***p<0.001

DUAL-LAMBDA SELECTION CORRECTION RESULTS

Results of the first-stage analysis indicate that both the unemployment rate and the percent of adult-age population with a bachelor's degree or higher at the county level are significant predictors of which degree a student pursues. Also, for each degree group, the

constructed pull variable is a significant predictor of which institution a student attends.[40] **Table 5.6** reports the estimated effect of distance on four- and six-year success as well as persistence for Groups A and B. Also included are the estimates for group and institution selection corrections.[41] The estimates for Group A are substantially different under this specification compared to the base model. Among those seeking an associate's degree, a 10-mile increase in distance decreases the probability of four-year success by 1 percentage point, six-year success by 1.6 percentage points, and persistence by 1.7 percentage points. There is a small, positive quadratic effect on persistence, but as was the case in Figure 3, the linear prediction is imprecise at extreme distances. Therefore, it cannot be concluded that the probability to persist actually becomes positive at 170 miles and greater.

The only outcome for which there is significant evidence of bias among Group A is persistence. Based on the group selection estimate, those who choose to pursue an associate's are less likely to persist than if a random draw of college matriculates were assigned to pursue an associate's. Based on the institution selection estimate, conditional on choosing to pursue an associate's, there is evidence of positive selectivity, meaning there are institutions in the group for which the students choosing them are more likely to persist than a random draw of those seeking an associate's degree. A separate estimation on the subsample of community colleges revealed that students seeking an associate's and choose to attend a community college are more likely to persist than a random draw of students seeking an associate's degree. There is no such evidence for students in Group A who attend four-year universities.

For those seeking a bachelor's degree in Column 2, the estimates are fairly similar for four-year success, though the quadratic term is no longer significant. Notably, the six-year success estimates are significant when correcting for selection bias. The effect of

---

[40] See Appendix for first-stage results.

[41] For brevity, results for each institution conditional on each degree, which would include 32 separate estimations, are not reported. Instead, separate estimations are run for each type of degree as was done in the previous section but pooled across institutions. This enables a more direct comparison between the two specifications. Interpretation of the group selection correction term is straightforward, indicating whether those who choose a particular type of degree are more or less likely to achieve the outcome than a random draw of the population. However, the institution selection correction term is not a direct comparison between those who choose an institution conditional on type of degree and a random draw of the population, but rather a group-wide average of institution selection bias.

Table 5.6 - Effect of Distance on Success with Selection Correction

	Group A (1)	Group B (2)
Four-year Success		
Distance (10 miles)	-0.0101**	0.0053*
	(0.0036)	(0.0024)
Distance^2	0.0004	-0.0002
	(0.0002)	(0.0001)
Group Selection	0.1874	-0.1724***
	(0.1215)	(0.0283)
Inst. Selection	-0.1102	0.2596***
	(0.1422)	(0.0396)
Students	28,111	40,685
Six-Year Success		
Distance (10 miles)	-0.0163**	-0.0138***
	(0.0052)	(0.0031)
Distance^2	0.0005	0.0005***
	(0.0003)	(0.0001)
Group Selection	0.3021	-0.1746***
	(0.1751)	(0.0407)
Inst. Selection	-0.1368	0.0415
	(0.1843)	(0.0603)
Students	13,605	20,263
Persistence		
Distance (10 miles)	-0.0173***	-0.0175***
	(0.0049)	(0.0019)
Distance^2	0.0005*	0.0006***
	(0.0003)	(0.0001)
Group Selection	0.6342***	-0.1011***
	(0.1452)	(0.0207)
Inst. Selection	-0.6523***	0.0093
	(0.1526)	(0.0276)
Students	28,111	40,685
Student Controls	Y	Y
Institution FE	Y	Y
Year FE	Y	Y

Notes: Sample is the same as in Table 4. Bootstrapped standard errors in parentheses are clustered by high school-institution dyad.

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

distance is in the opposite direction compared to four-year success, as was the case with persistence in the base specification as well as this specification. A student who travels an additional 10 miles than the average is less likely to succeed within six years by almost 1 percentage point. Similarly, traveling 10 miles greater than average lowers persistence by slightly over 1 percentage point. Across all outcomes in Table 6 for Group B, there is significant evidence of group selection bias. Those who choose to pursue a bachelor's degree are more likely to succeed within four and six years, as well as persist, than the population of college matriculates. The only evidence of institution selection bias pertains to four-year success. This means there are institutions in the group (i.e. four-year universities) for which the students choosing them are significantly less likely to succeed within four years than a random draw of those seeking a bachelor's degree.

The top panel of **Figure 5.6** plots the predicted probabilities of six-year success among those in Group B as a function of distance holding other covariates constant at the mean. The point estimates display a quadratic effect, decreasing until 150 miles and then increasing at 200 and 250 miles. The bottom panel contrasts the point estimates between the 50-mile increments in Panel A. The contrasts 50 and 100 miles indicate that the marginal effect of distance is significantly negative. At 150 and 200 miles, the marginal effect is not statistically different than zero. However, at 250 miles the marginal effect of distance is significant and positive. Therefore, it can be concluded with sufficient statistical confidence that the likelihood of six-year success eventually increases as a function of distance.

Lastly, **Table 5.7** reports the effects of distance on transfers correcting for selection bias and are similar to those reported in Table 5. Those in Group A who travel greater distances are more likely to transfer their second year and attend a more proximate institution. Those in Group B who travel greater distances are also more likely to transfer until 130 miles, at which point the probability of transferring begins to decrease. Among those who do transfer, greater distance to the initially chosen school results in transferring to a more proximate school. Once again, there is only evidence of selection bias among those in Group B relative to transfers.

Figure 5.6 - Marginal Effects of Distance on Six-year Success, Bachelors
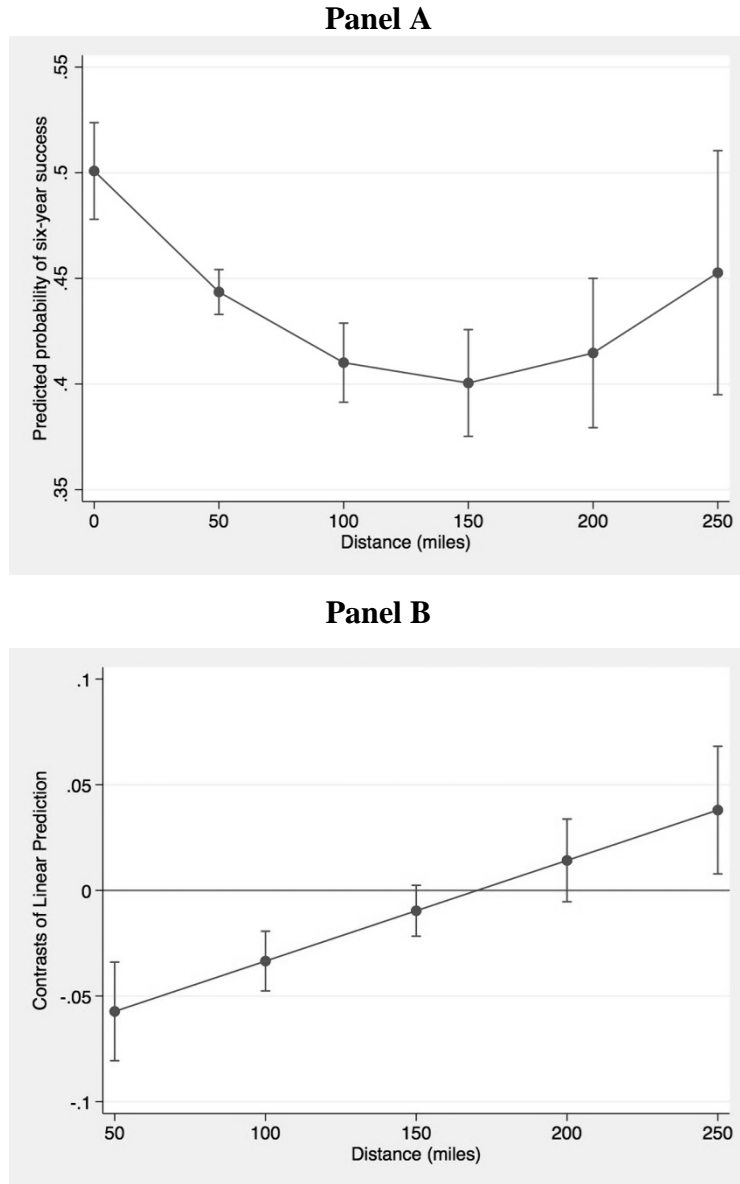
Panel A

Panel B

Notes: Figures illustrate the effects of distance estimated in Table 6, Column 2. Panel A provides predicted probabilities of 4-year success at various distances holding covariates constant at their mean. Panel B contrasts the point estimates in Panel A, showing the marginal effect and significance at each distance.

Table 5.7 - Effect of Distance on Transfers with Selection Correction

	Group A (1)	Group B (2)
Transferred		
Distance (10 miles)	0.0173***	0.0156***
	(0.0036)	(0.0014)
Distance^2	-0.0004	-0.0006***
	(0.0002)	(0.0001)
Group Selection	0.0196	0.0542**
	(0.1449)	(0.0187)
Inst. Selection	0.0229	-0.1124***
	(0.1608)	(0.0267)
Students	18,855	35,699
Distance Transferred		
Distance (10 miles)	-14.3529***	-9.7714***
	(1.6255)	(0.8113)
Distance^2	0.3115***	0.0474
	(0.0813)	(0.0332)
Group Selection	29.7594	14.9426
	(37.7131)	(12.2438)
Inst. Selection	-39.6310	9.3355
	(43.7760)	(14.2132)
Students	2,055	4,792
Student Controls	Y	Y
Institution FE	Y	Y
Year FE	Y	Y

Notes: Sample is the same as Table 5. Bootstrapped standard errors are clustered by high school-institution dyad.
**p<0.01; ***p<0.001

CONCLUDING REMARKS

Among the results, interpreting the effect of distance among those seeking an associate's degree is the most straightforward. For this group of college-going students distance imposes a cost that lowers the likelihood they persist or complete a degree at the institution in which they initially matriculated, especially when controlling for their choice to pursue an associate's degree. These findings are consistent with the theory

outlined in the prior section. Limitations in the data do not enable us to identify the mechanisms driving the cost, but some speculations can be made.

Given that 75 percent of those in Group A attended a college within 31 miles of their high school, it seems reasonable to assume any effect distance may have on marginal academic productivity does not play a significant role in the examined outcomes. Additionally, the financial situation for most students is likely stable while in school, and the financial costs associated with distance are presumably the same as when considering attending a particular college. Thus, the financial cost of distance may not play a significant role either.[42] Therefore, it may be reasonable to suggest the negative effect of distance on students in Group A is driven primarily by the cost to time from commuting. The fact that an additional 10 miles can reduce persistence by nearly 2 percentage points suggests commuting is a substantial factor.

The quadratic effect of distance on success among those seeking a bachelor's degree makes interpretation somewhat more nuanced, but overall the results for this group are congruent with the theory as well. At distances that are representative of most of the sample—between 90 and 95 percent—distance imposes a cost that lowers the likelihood of persistence and completing a degree within six years and increases the probability they transfer. Again, the effects are especially detectable when controlling for their choice to pursue a bachelor's degree. However, the negative effect of distance is diminishing and for the small proportion of students who migrate relatively extreme distances to attend their college of choice, they are just as likely to succeed as those who migrated very little distance to attend the same college.

This positive quadratic relationship suggests distance is an input that allows students to access higher quality institutions. On average, students who migrate great distances have selected into an institution that provides greater utility compared to those students who migrate moderate distances. As a result, the costs associated with distance are offset. For those in Group A, no such relationship is evident, suggesting that quality of institutions when pursuing an associate's degree does not differ or sufficiently so to ever offset the costs.

---

[42] In a limited attempt to examine the financial cost of distance, an interaction between distance and FRPL was included in an alternative specification. The estimate was not significant and did not change the results.

Figures 3-5 also provide some insight into the cost of distance as it relates to time commuting versus either cognitive or financially. The negative effect of distance is greatest at short distances. Again, this suggests that commuting is a substantial factor of success. Though to a lesser magnitude, the effect of distance remains negative at distances where most students presumably relocate to live on or near campus. Of course, relocation does not eliminate the need to commute for those who do not live on campus, so it may still be a factor. Nevertheless, those who migrate 100 miles are 1 point less likely to persist than those who migrate 50 miles. Relocation is likely necessary at both distances, so something in addition to commuting is contributing to the negative effect of distance.

The most perplexing result is the reversed relationship between distance and four-year success among those seeking a bachelor's degree, which is present in both the base and selection bias correction specifications. If distance reduces two-year persistence and completing a degree within six years, what explains distance increasing the likelihood of completing a degree within four years? It is worth noting that only 29 percent of students seeking a bachelor's complete any degree within four years regardless of transferring to a different institution. In fact, completing a degree at the same institution is only slightly lower at 25 percent.

One explanation then is students in Group B who complete a degree at the same institution within four years made an optimal choice. These students knew which institution was best for them. In this case, distance is primarily an input that enables them to attend their optimal institution. This would also explain why there is weak evidence of a negative quadratic that is no longer significant when correcting for selection. The costs associated with distance do not offset the benefit of attending a students' optimal college.

As is the case with any human behavior, describing college-going is complex. Based on a rich literature, we can be fairly certain that proximity to institutions of higher education increases educational attainment on average. It is also clear that the relationship between distance and attainment is at least partially attributable to the fact that the likelihood of enrolling in college at all increases with proximity to a college. But how might distance affect attainment after a student has decided to enroll and attend a

particular institution? What are the implications for policy that alter the distances students migrate to attend college?

Controlling for selection bias resulting from choosing type of degree and institution, within-institution variation in distance has a significant effect on whether students remain at the institution in the second year and complete a degree within six years. For what describes a majority of college-going in the U.S.—recent graduates who attend an in-state institution—distance has a negative effect on success at short-to-intermediate distances. This effect is linear for those seeking an associate's degree, but for bachelor's degree-seekers, distance enables them to access institutions of higher quality that offset the costs associated with distance.

With policy aimed at increasing college enrollment and success, and in light of the evidence in this study, it is worth noting that 65 percent of individuals in the U.S. live within 51 miles of a public college and less than 20 percent live within 51 miles of a public four-year institution (Akers & Soliz, 2015). More students living farther away will need to attend college, or colleges will need to be placed more proximate to them. The former is clearly more feasible. In doing so, policy needs to consider that students who migrate greater distances to attend college may be less likely to succeed there.

[6]
CONCLUSION

The goal of this work was to examine the policy and impacts of state higher education subsidies across different modes of delivery in ways that contribute to existing research. The primary means of achieving this goal was to extend the discussion surrounding state subsidies from their effects on college access, choice, and success to their effects on demand for the underlying goods and services provided by institutions that mediate such outcomes. Specifically, focus was directed at the interaction between two phenomena: 1) on average, the delivery of state subsidies has become increasingly on the basis of student income and/or ability over the last 25 years, and 2) student demand for educational resources and amenities differs across dimensions of ability and income. The impact of this trend in state subsidy composition in relation to heterogeneous demand across students has not been thoroughly examined.

Chapter 3 theoretically examined the response in student demand to changes in state subsidy composition, focusing on the various mechanisms through which a state can alter its provision of subsidies and the corresponding student subsets affected. The general conclusion from this analysis is that HTHA policy drives a divergence in demand between educational resources and amenities, especially in states with merit-based grant programs, but crucially depends on three factors: 1) the specific program mechanisms a state uses to increase grant funding, 2) the relative sizes of each student subset determined by a state's grant program eligibility criteria, and 3) the state's array of institutional choices with respect to educational resources and amenities from which affected student subsets can choose. The chapter provides theoretical motivation for several avenues of empirical research in the future, which are discussed in the chapter's conclusion.

Chapter 3 also has implications for normative theory and represents an initial step toward a better understanding of optimal state subsidy composition. No matter a state's objective in subsidizing higher education—maximizing public benefits, tax revenue, political party support, educational attainment—the allocation of subsidies across the different modes of delivery is an important policy lever to achieve its objective. It seems reasonable to assume student subsets do not contribute to a state's objective identically,

thus linking state subsidy composition to the various subsets affected can help inform state policy how to more effectively and efficiently achieve its objective. Of course, such steps cannot be taken until there is a better understanding of what institutional goods and services should be considered an educational resource, an amenity, or some other category that is relevant to student outcomes.

Chapter 4 empirically examined the effect the percentage of total state subsidies allocated to grants has on institutional expenditure shares. The expectation was that institutions will allocate resources across operational categories in ways that reflect the divergence in demand discussed in Chapter 3. The results support this hypothesis, primarily among less-selective public institutions, which are most sensitive to student demand pressure. An important task for future research on this front is to strengthen causal inference by identifying the beginning and/or end of substantial state grant programs and analyzing their effect on institutional expenditure shares.

In addition to providing empirical support for the theory presented in Chapter 3, Chapter 4 contributes to research concerning the effect of state financial aid on college student outcomes, particularly completion of a degree. It is of considerable interest to scholars and policymakers whether state subsidies impact college completion. Whether state subsidies simultaneously affect institutional expenditure shares, which in turn impact college completion, has not been considered previously. A more comprehensive analysis of institutional expenditures and their impact on student outcomes is needed in order to make recommendations concerning state subsidy composition on this basis.

Lastly, Chapter 5 is somewhat peripheral to the subject of state subsidies but nevertheless examines an important aspect of college-going behavior that state subsidies can alter—the distance students migrate to attend college. This chapter contributes to existing research in three ways: 1) establishing a theoretical basis upon which to expect distance to affect college student success after choosing to attend an institution, 2) estimating the effect of distance on the likelihood a student completes a degree at the institution he or she initially matriculated into, and 3) explores the dual-lambda selection correction method as a way to account for the multiple processes involved in college choice. The results suggest distance has a negative, linear effect on the success of those seeking an associate's degree, which may reflect the impact of commuting. The effect of

distance on success among those seeking a bachelor's degree according to the results is more nuanced and somewhat open to interpretation. At a minimum, there is a clear distinction between the effects of short, intermediate, and long distances on success. Again, this is arguably due to differences between commuting and relocating to college, which is a valuable topic for future research.

As state budgets become increasingly strained, most state governments have restructured their financing of higher education in a way that lowers appropriations in exchange for subsidies targeted on the basis of student income or ability. Moreover, there is little evidence such decisions are made in a strategic manner. Though the topic of public benefits from higher education is still debated, the fact that these subsidies exist suggests state governments expect a return on this investment. As long as provision of higher education remains neither fully private or public, which types of students receive subsidies and how much they receive will continue to be critical questions for issues of college access, choice, and success that no doubt impact states' returns on investment. While much public attention is paid toward levels of subsidies, this work attempted to show that the extent to which states target subsidies on the basis of income or ability relative to appropriations is an important part of these question.

APPENDIX A: DESCRIPTION OF COLLEGE EXPENDITURE CATEGORIES

Instruction

A functional expense category that includes expenses of the colleges, schools, departments, and other instructional divisions of the institution and expenses for departmental research and public service that are not separately budgeted. Includes general academic instruction, occupational and vocational instruction, community education, preparatory and adult basic education, and regular, special, and extension sessions. Also includes expenses for both credit and non-credit activities. Excludes expenses for academic administration where the primary function is administration (e.g., academic deans). Information technology expenses related to instructional activities are included if the institution separately budgets and expenses information technology resources (otherwise these expenses are included in academic support).

Research

A functional expense category that includes expenses for activities specifically organized to produce research outcomes and commissioned by an agency either external to the institution or separately budgeted by an organizational unit within the institution. The category includes institutes and research centers, and individual and project research. This function does not include nonresearch sponsored programs (e.g., training programs). Also included are information technology expenses related to research activities if the institution separately budgets and expenses information technology resources (otherwise these expenses are included in academic support.)

Academic support

A functional expense category that includes expenses of activities and services that support the institution's primary missions of instruction, research, and public service. It includes the retention, preservation, and display of educational materials (for example, libraries, museums, and galleries); organized activities that provide support services to the academic functions of the institution (such as a demonstration school associated with a college of education or veterinary and dental clinics if their primary purpose is to support the instructional program); media such as audiovisual services; academic administration (including academic deans but not department chairpersons); and formally organized and separately budgeted academic personnel development and

course and curriculum development expenses. Also included are information technology expenses related to academic support activities; if an institution does not separately budget and expense information technology resources, the costs associated with the three primary programs will be applied to this function and the remainder to institutional support.

Student services

A functional expense category that includes expenses for admissions, registrar activities, and activities whose primary purpose is to contribute to students emotional and physical well-being and to their intellectual, cultural, and social development outside the context of the formal instructional program. Examples include student activities, cultural events, student newspapers, intramural athletics, student organizations, supplemental instruction outside the normal administration, and student records. Intercollegiate athletics and student health services may also be included except when operated as self - supporting auxiliary enterprises. Also may include information technology expenses related to student service activities if the institution separately budgets and expenses information technology resources (otherwise these expenses are included in institutional support.)

Institutional support

A functional expense category that includes expenses for the day-to-day operational support of the institution. Includes expenses for general administrative services, central executive-level activities concerned with management and long-range planning, legal and fiscal operations, space management, employee personnel and records, logistical services such as purchasing and printing, and public relations and development. Also includes information technology expenses related to institutional support activities.

APPENDIX B: COMPOSITIONAL ANALYSIS OF INSTITUTIONAL EXPENDITURES

Chapter 4 examined the effect of state subsidies on institutional expenditure shares as proportions of total educational and general expenditures. The following analysis is aimed at checking the sensitivity of the results to compositional analysis. To do so, the expenditure shares s for the four operational categories i of interest at each institution j—instruction, academic support, student services, and auxiliary enterprises—were first transformed to a composition c using the additive logarithmic transformation (alr):

$$c_{ij} = ln\left(\frac{s_{ij}}{s_{kj}}\right) \forall\, i \neq k$$

where $s_{kj} = 1 - \sum s_{ij}$.

Analysis was repeated for equations (1) and (2) using the compositional dependent variables. Coefficients for select variables are reported in the figures below along with 95 percent confidence intervals. Coefficients are exponentiated so that the interpretation of the x-axis is the percent change in the ratio due to a 1-unit increase in the explanatory variable. It is important to reiterate that the significant coefficients corresponding to the interaction terms indicate a significant difference from the base term, not a significant effect of the explanatory variable itself. A test of the linear combination of the base term and the interaction must be conducted to determine a significant marginal effect. Notable differences were discussed in the Sensitivity Analysis section of Chapter 4.

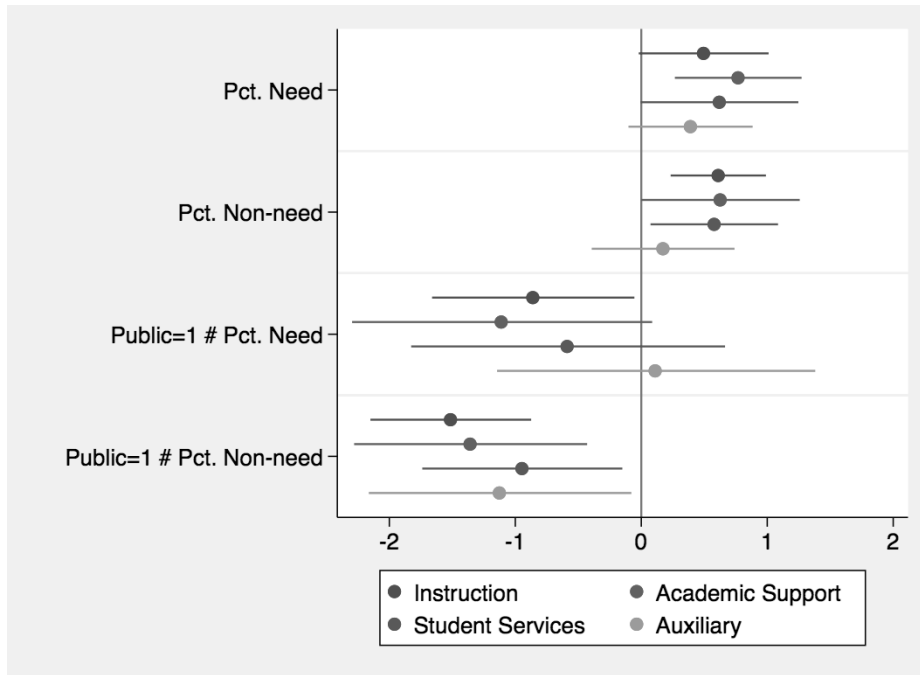Figure A.1 – Effect of Need and Non-need by Control

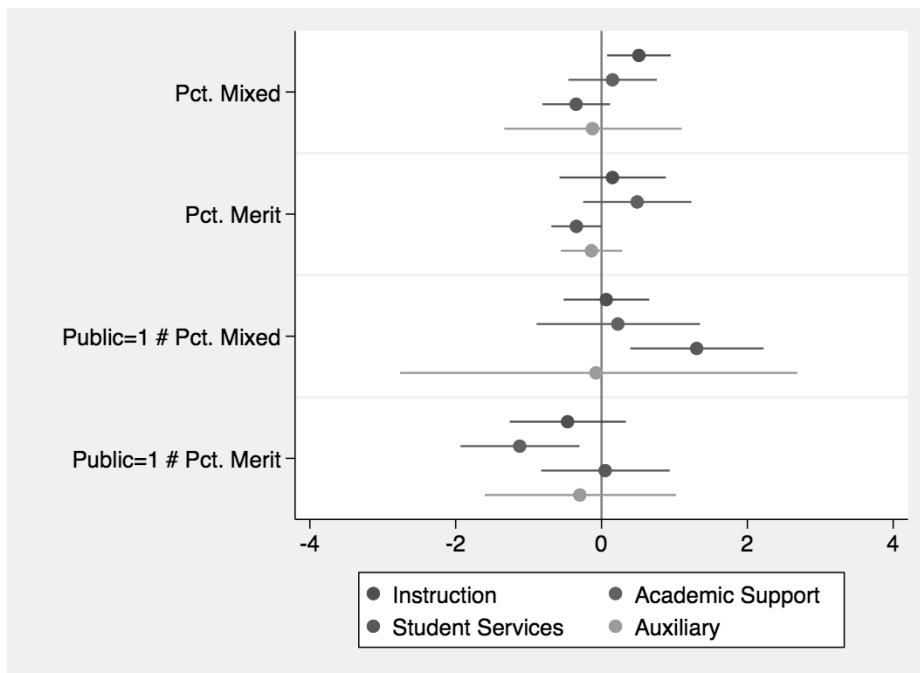Figure A.2 – Effect of Mixed and Merit by Control

124

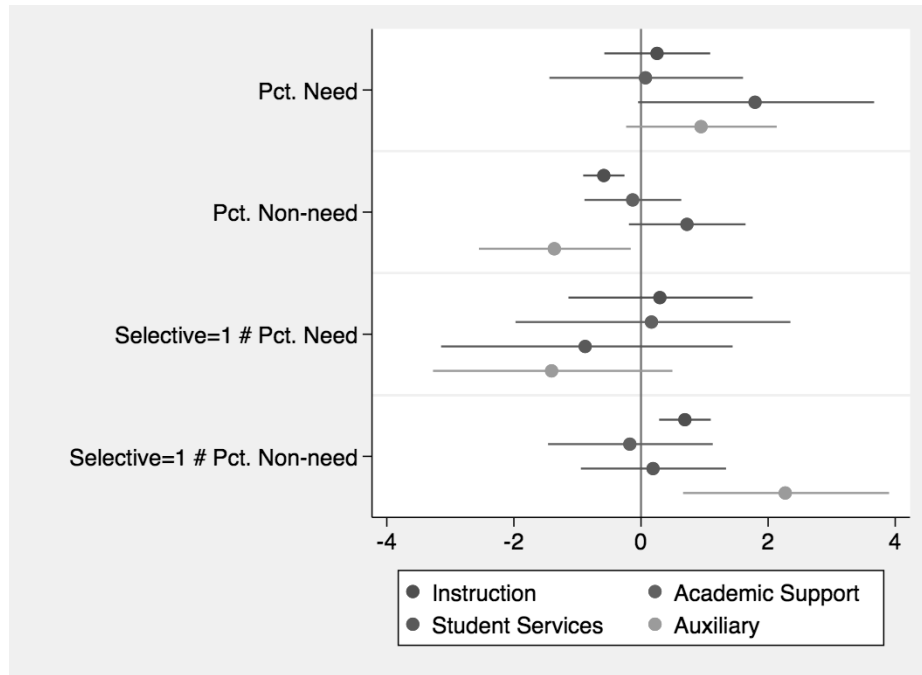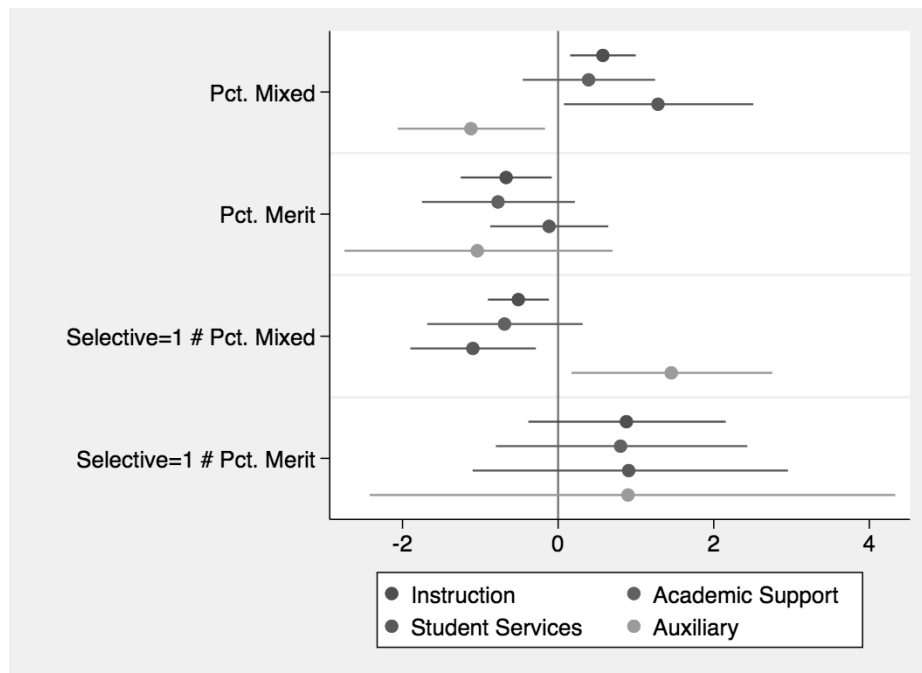Figure A.3 – Effect of Need and Non-need by Selectivity

Figure A.4 – Effect of Mixed and Merit by Selectivity

APPENDIX C: DERIVATION OF DUAL LAMBDAS

The following procedure was proposed by Vijverberg (1995) to derive dual lambdas that control for selection bias when the choice is the result of two interdependent processes. Vijverberg used dual lambda selection correction to estimate wage equations conditional on migration and employment participation. Chapter 5 adopts this procedure to estimate the likelihood of college student success conditional on degree choice and college choice. Notation is adapted to be consistent with Chapter 5.

$$\lambda_{j|g} = \frac{-\phi(A_{j|g}^n \Phi\left[(1-\rho^2)^{-0.5}\left(A_g^n - \rho A_{j|g}^n\right)\right]}{\rho_{gj}}$$

$$\lambda_g = \frac{-\phi(A_g^n \Phi\left[(1-\rho^2)^{-0.5}\left(A_{j|g}^n - \rho A_g^n\right)\right]}{\rho_{gj}}$$

where ρ is a correlation coefficient between the two selection biases

$$\rho = \iint \Phi^{-1}[F(\eta_{j|g})]\Phi^{-1}[F(\eta_g)]h(\eta_{j|g}, \eta_g) \, d\eta_{j|g} \, d\eta_g$$

and A^n is a normal distribution transformation of the estimated probabilities that a student chooses to pursue degree g or attends college j conditional on g

$$A_{j|g}^n = \Phi^{-1}[p_{j|g}]$$

$$A_g^n = \Phi^{-1}[p_g]$$

which are also used in the calculation of ρ by substitution of the η terms.

APPENDIX D – FIRST-STAGE DUAL LAMBDA ESTIMATES

	Degree Choice	Joint Test of Pull on Institutional Choice χ^2	
	Bachelor's	Associate's	Bachelor's
Unemployment	0.0740***		
	(0.0069)	1400.24***	207.68***
Bach or Higher	10.6323***		
	(0.1799)		
Distance	0.4537***		
	(0.0071)		
Distance^2	-0.0139***		
	(0.0004)		
Male Dummy	0.2829***		
	(0.0220)		
Black	0.0247		
	(0.0395)		
Hispanic	-0.0676		
	(0.0762)		
Asian	0.6176***		
	(0.1170)		
FRPL	-0.2623***		
	(0.0229)		
SPED	-0.5733***		
	(0.1623)		
LEP	-1.2449***		
	(0.2553)		
Gifted	0.0207		
	(0.0261)		
ACT	0.2246***		
	(0.0038)		
Final GPA	1.0533***		
	(0.0231)		
AP Classes	0.0826***		
	(0.0056)		
Credits	-0.0351***		
	(0.0036)		
Observations	68797		

Notes: ***$p<0.001$

REFERENCES

Abel, J. & Deitz, R. (2014). Do the benefits of college still outweigh the costs? Delaney, J. A. & Doyle, W. R. (2011). State spending on higher education: Testing the balance wheel over time. *Journal of Education Finance*, 36(4), 343–368.

Aitchison, J. (1982). The statistical analysis of compositional data. *Journal of the Royal Statistical Society. Series B (Methodological)*, 139-177.

Akers, B. & Soliz, A. (2015). Mapping the market for higher education. *Brookings Institute.*

Ali, M. K. (2003). Analysis of enrollment: A spatial-interaction model. *The Journal of Economics*, 29(2), 67–86.

Alm, J. & Winters, J. V. (2009). Distance and intrastate college student migration. *Economics of Education Review*, 28(6), 728–738.

Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education*. University of Chicago Press.

Bennett, W. J. (1987). Our greedy colleges. *New York Times*, 18(A27).

Bettinger, E. (2004). How financial aid affects persistence. In *College choices: The economics of where to go, when to go, and how to pay for it* (pp. 207-238). University of Chicago Press.

Bowen, W. G., Chingos, M. M., & McPherson, M. S. (2009). *Crossing the finish line: Completing college at America's public universities* (Vol. 52). Princeton University Press.

Braxton, J. M. (2000). *Reworking the student departure puzzle*. Vanderbilt University Press.

Breneman, D. (1981). Strategies for the 1980s. In Mingle, J. (Ed.), *Challenges of Retrenchment*. Jossey-Bass, San Francisco.

Canton, E. & Vossensteyn, H. (2001). Deregulation of higher education: tuition fee differentiation and selectivity in the us.

Card, D. (1993). Using geographic variation in college proximity to estimate the return to schooling. Technical report, National Bureau of Economic Research.

Cellini, S. R., & Goldin, C. (2013). Does Federal Student Aid Raise Tuition? New Evidence on For-Profit Colleges. *NBER Working Paper*, *17827*.

Cheslock, J. J. & Hughes, R. P. (2011). Differences across states in higher education finance policy. *journal of education finance*, 36(4), 369–393.

Chetty, R., Friedman, J., Saez, E., Turner, N., & Yagan, D. (2017). *Equality of Opportunity Project*. Data Table 10. Retrieved from http://www.equality-of-opportunity.org/data/

Chingos, M.M., & Baum, S. (2017). The federal-state higher education partnership. *Urban Institute*. Washington D.C.

Cooke, T. J. & Boyle, P. (2011). The migration of high school graduates to college. *Educational Evaluation and Policy Analysis*, 33(2), 202–213.

Cooper, P. (2016). Federal Student Loans Will Cost Taxpayers $170 Billion. *Forbes*. Retrieved from https://www.forbes.com/sites/prestoncooper2/2016/04/10/federal-student-loans-will-cost-taxpayers-170-billion/#148413ef62a9 .

Corazzini, A. J., Dugan, D. J., & Grabowski, H. G. (1972). Determinants and distributional aspects of enrollment in us higher education. *Journal of Human Resources*, 39–59.

Curs, B. R., & Jaquette, O. (2017). Crowded Out? The Effect of Nonresident Enrollment on Resident Access to Public Research Universities. *Educational Evaluation and Policy Analysis*, *39*(4), 644-669.

Dee, T. S. (2004). Are there civic returns to education? *Journal of Public Economics*, 88(9), 1697– 1720.

Delaney, J. A. & Doyle, W. R. (2011). State spending on higher education: Testing the balance wheel over time. *Journal of Education Finance*, 36(4), 343–368.

DesJardins, S. L., Dundar, H., & Hendel, D. D. (1999). Modeling the college application decision process in a land-grant university. *Economics of Education Review*, 18(1), 117–132.

Dickler, J. (2017). Student loan interest rates edge higher and higher. *CNBC*. Retrieved from https://www.cnbc.com/2017/07/18/student-loan-interest-rates-edge-higher-and-higher.html.

Dill, D. D. (1997a). Accreditation, assessment, anarchy? *Standards and quality in higher education*, 37(15).

Dill, D. D. (1997b). Higher education markets and public policy. *Higher education policy*, 10(3-4), 167–185.

Doyle, W. R. (2006). Adoption of merit-based student grant programs: An event history analysis. *Educational evaluation and policy analysis*, 28(3), 259–285.

Doyle, W. R. (2010). Does merit-based aid "crowd out" need-based aid? *Research in Higher Education*, 51(5), 397–415.

Dynarski, S. (2002a). The behavioral and distributional implications of aid for college. *American Economic Review*, 92(2), 279–285.

Dynarski, S. (2002b). *The consequences of merit aid* (No. w9400). National Bureau of Economic Research.

Eagan, K., Stolzenberg, E., Bates, A., Aragon, M., Suchard, M., & Aguilar, C. (2015). The American freshman: National norms of 2015. Higher Education Research Institute.

Epple, D., Romano, R., Sarpca, S., & Sieg, H. (2013). The US market for higher education: A general equilibrium analysis of state and private colleges and public funding policies. Technical report, National Bureau of Economic Research.

Fitzpatrick, M. D. & Jones, D. (2012). Higher education, merit-based scholarships and post-baccalaureate migration. Technical report, National Bureau of Economic Research.

Goldrick-Rab, S., Harris, D. N., & Trostel, P. A. (2009). Why financial aid matters (or does not) for college success: Toward a new interdisciplinary perspective. In *Higher education: Handbook of theory and research* (pp. 1-45). Springer, Dordrecht.

Goldrick-Rab, S., Harris, D., Kelchen, R., & Benson, J. (2012). Need-based financial aid and college persistence experimental evidence from Wisconsin.

Gossman, C. S. (1967). Migration of college and university students in the united states.

Greene, K. V. (1994). The public choice of non-resident college tuition levels. *Public Choice*, 78(3-4), 231–240.

Groen, J. A. (2004). The effect of college location on migration of college-educated labor. *Journal of Econometrics*, 121(1), 125–142.

Gumport, P. J. & Pusser, B. (1995). A case of bureaucratic accretion: Context and consequences. *The Journal of Higher Education*, pages 493–520.

Hansen, W. L. & Weisbrod, B. A. (1969). The distribution of costs and direct benefits of public higher education: the case of California. *Journal of human resources*, pages 176–191.

Hansen, W. L. & Weisbrod, B. A. (1971). On the distribution of costs and benefits of public higher education: Reply. *The Journal of Human Resources*, 6(3), 363–374.

Hearn, J. C. & Longanecker, D. (1985). Enrollment effects of alternative postsecondary pricing policies. *The Journal of Higher Education*, pages 485–508.

Heller, D. E. (2002). The policy shift in state financial aid programs. In *Higher education: Handbook of theory and research*, pages 221–261. Springer.

Heller, D. E. & Marin, P. (2002). Who should we help? the negative social consequences of merit scholarships.

Heller, D. E. & Marin, P. (2004). State merit scholarship programs and racial inequality. *Civil Rights Project at Harvard University (The)*.

HERI (2016). *Data Archives*. Retrieved from https://heri.ucla.edu/heri-data-archive/

Hillman, N. & Weichman, T. (2016). Education deserts: The continued significance of "place" in the twenty-first century. Technical report, American Council on Education Center for Policy Research and Strategy.

Hoenack, S. A. (1971). The efficient allocation of subsidies to college students. *The American Economic Review*, pages 302–311.

Hossler, D., Lund, J. P., Ramin, J., Westfall, S., & Irish, S. (1997). State funding for higher education: The Sisyphean task. *Journal of Higher Education*, pages 160–190.

Hoxby, C. M. (1997). How the changing market structure of us higher education explains college tuition. Technical report, National Bureau of Economic Research.

Hoxby, C. M. (2000). The effects of geographic integration and increasing competition in the market for college education. *NBER Working Paper*, 6323.

Hoxby, C. M., & Avery, C. (2012). *The missing" one-offs": The hidden supply of high-achieving, low income students* (No. w18586). National Bureau of Economic Research.

Hoxby, C., & Turner, S. (2013). Expanding college opportunities for high-achieving, low income students. *Stanford Institute for Economic Policy Research Discussion Paper*, (12-014).

Hurlburt, S. & Kirshstein, R. J. (2012). Spending: Where does the money go? A Delta data update, 2000-2010. *Delta Cost Project at American Institutes for Research*.

Jacob, B., McCall, B., & Stange, K. M. (2013). *College as country club: Do colleges cater to students' preferences for consumption?* (No. w18745). National Bureau of Economic Research.

Jaquette, O. & Curs, B. R. (2015). Creating the out-of-state university: Do public universities in- crease nonresident freshman enrollment in response to declining state appropriations? *Research in Higher Education*, 56(6), 535–565.

Jaquette, O., Curs, B. R., & Posselt, J. R. (2016). Tuition rich, mission poor: Nonresident enrollment growth and the socioeconomic and racial composition of public research universities. *The Journal of Higher Education*, 87(5), 635-673.

Johnson, W. R. (2006). Are public subsidies to higher education regressive? *Education*, 1(3), 288– 315.

Kane, T. J. (1995). Rising public college tuition and college entry: How well do public subsidies promote access to college? Technical report, National Bureau of Economic Research.

Kane, T. J. (2006). Public intervention in post-secondary education. *Handbook of the Economics of Education*, 2:1369–1401.

Kane, T. J., Orzag, P. R., & Gunter, D. L. (2003). State fiscal constraints and higher education spending: The role of Medicaid and the business cycle. *Higher Education*, 12(11.1), 1–1.

Kariel, H. G. (1968). Student enrollment and spatial interaction. *The Annals of Regional Science*, 2(1), 114–127.

Koshal, R. K. & Koshal, M. (2000). State appropriation and higher education tuition: what is the relationship? *Education Economics*, 8(1), 81–89.

Kyung, W. (1996). In-migration of college students to the state of New York. *The Journal of Higher Education*, pages 349–358.

Larson, E. (1997). Why colleges cost too much. *Time Magazine*, 149(11).

Leigh, D. E. & Gill, A. M. (2003). Do community colleges really divert students from earning bachelor's degrees? *Economics of Education Review*, 22(1), 23–30.

Leppel, K. (1993). Logit estimation of a gravity model of the college enrollment decision. *Research in Higher Education*, 34(3), 387–398.

Long, B. T. (2004a). How do financial aid policies affect colleges? the institutional impact of the Georgia Hope scholarship. *Journal of Human Resources*, 39(4), 1045–1066.

Long, B. T. (2004b). How have college decisions changed over time? an application of the conditional logistic choice model. *Journal of Econometrics*, 121(1), 271–296.

Long, B. T. & Riley, E. (2007). Financial aid: A broken bridge to college access? *Harvard Educational Review*, 77(1), 39–63.

Mak, J. & Moncur, J. E. (2003). Interstate migration of college freshmen. *The Annals of Regional Science*, 37(4), 603–612.

Manski, C. F., Wise, D. A., & Wise, D. A. (1983). *College choice in America*. Harvard University Press.

McConnell, H. (1965). Spatial variability of college enrollment as a function of migration potential. *The Professional Geographer*, 17(6), 29–37.

McFadden, D. (1973). Conditional logit analysis of qualitative choice behavior.

McHugh, R. & Morgan, J. N. (1984). The determinants of interstate student migration: A place- to-place analysis. *Economics of Education Review*, 3(4), 269–278.

McMahon, W. W. (2009). *Higher learning, greater good: The private and social benefits of higher education*. JHU Press.

McPherson, M. S., & Schapiro, M. O. (1998). The student aid game.

McPherson, M. S., Schapiro, M. O., & Winston, G. C. (1993). *Paying the piper: Productivity, incentives, and financing in US higher education*. University of Michigan Press.

Medsker, L. L. & Tillery, D. (1971). *Breaking the Access Barriers: A Profile of Two-Year Colleges*. ERIC.

Melguizo, T. (2011). A review of the theories developed to describe the process of college persistence and attainment. In *Higher education: Handbook of theory and research*, pages 395–424. Springer.

Mixon, F. G. (1992a). Factors affecting college student migration across states. *International Journal of Manpower*, 13(1), 25–32.

Mixon, F. G. (1992b). A public choice note on college student migration. *International Journal of Manpower*, 13(3), 63–68.

Mixon, F. G. & Hsing, Y. (1994). The determinants of out-of-state enrollments in higher education: A tobit analysis. *Economics of Education Review*, 13(4), 329–335.

NASSGAP (2016). *Annual Survey Data*. Retrieved from https://www.nassgapsurvey.com

Newfield, C. (2016). *The great mistake: How we wrecked public universities and how we can fix them*. JHU Press.

Noorbakhsh, A. & Culp, D. (2002). The demand for higher education: Pennsylvania's nonresident tuition experience. *Economics of Education Review*, 21(3), 277–286.

Oliff, P., Robyn, M., & Thiess, R. (2017) Federal Support for Higher Education Comes from Spending Programs and the Tax Code. *The Pew Charitable Trusts*. Retrieved from http://www.pewtrusts.org/en/research-and-analysis/analysis/2017/03/07/federal-support-for-higher-education-comes-from-spending-programs-and-the-tax-code.

Ordovensky, J. F. (1995). Effects of institutional attributes on enrollment choice: Implications for postsecondary vocational education. *Economics of Education Review*, 14(4), 335–350.

Orsuwan, M. & Heck, R. H. (2009). Merit-based student aid and freshman interstate college migration: Testing a dynamic model of policy change. *Research in Higher Education*, 50(1), 24– 51.

Ovink, S. M. & Kalogrides, D. (2015). No place like home? familism and Latino/a–white differences in college pathways. *Social science research*, 52:219–235.

Page, L. C., & Scott-Clayton, J. (2016). Improving college access in the United States: Barriers and policy responses. *Economics of Education Review*, *51*, 4-22.

Paulsen, M. B. (2001). The economics of human capital and investment in higher education. *The finance of higher education: Theory, research, policy, and practice*, pages 55–94.

Martin-Fernandez, J.A., Palarea-Albaladejo, J., & Olea, R.A. (2011). Dealing with zeros. In Pawlowsky-Glahn, V., & Buccianti, A. (Eds.), *Compositional data analysis: Theory and applications*. John Wiley & Sons.

Pechman, J. A., Hansen, W. L., & Weisbrod, B. A. (1970). The distributional effects of public higher education in California: A review article.

Perna, L. W. & Titus, M. A. (2004). Understanding differences in the choice of college attended: The role of state public policies. *The Review of Higher Education*, 27(4), 501–525.

Rabovsky, T. M. (2012). Accountability in higher education: Exploring impacts on state budgets and institutional spending patterns. *Journal of Public Administration Research and Theory*, 22(4), 675–700.

Rizzo, M. & Ehrenberg, R. G. (2004). Resident and nonresident tuition and enrollment at flagship state universities. In C.M. Hoxby (Ed.), *College choices: The economics of where to go, when to go, and how to pay for it* (303–354). University of Chicago Press.

Rizzo, M. J. (2006). State preferences for higher education spending: A panel data analysis, 1977- 2001. *What's happening to public higher education*, pages 3–36.

Rouse, C. E. (1995). Democratization or diversion? the effect of community colleges on educational attainment. *Journal of Business & Economic Statistics*, 13(2), 217–224.

SHEEO (2016). *State Higher Education Finance*. Retrieved from http://www.sheeo.org/projects/shef-—-state-higher-education-finance

Singell Jr, L. D., & Stone, J. A. (2007). For whom the Pell tolls: The response of university tuition to federal grants-in-aid. *Economics of Education Review*, *26*(3), 285-295.

Sjoquist, D. L. & Winters, J. V. (2015). State merit-based financial aid programs and college attainment. *Journal of Regional Science*, 55(3), 364–390.

SRI International. (2012). States' Method of Funding Higher Education: Report for the Nevada Legislature's Committee to Study the Funding of Higher Education. Arlington, VA.

Strenze, T. (2007). Intelligence and socioeconomic success: A meta-analytic review of longitudinal research. *Intelligence*, *35*(5), 401-426.

Tinto, V. (1987). *Leaving college: Rethinking the causes and cures of student attrition.* ERIC.

Toutkoushian, R. K. & Smart, J. C. (2001). Do institutional characteristics affect student gains from college? *The Review of Higher Education*, 25(1), 39–61.

Toutkoushian, R. K. & Shafiq, M. N. (2010). A conceptual analysis of state support for higher education: Appropriations versus need-based financial aid. *Research in Higher Education*, 51(1), 40–64.

Tuckman, H. P. (1970). Determinants of college student migration. *Southern Economic Journal*, pages 184–189.

Turley, R. N. L. (2006). When parents want children to stay home for college. *Research in Higher Education*, 47(7), 823–846.

Turley, R. N. L. (2009). College proximity: Mapping access to opportunity. *Sociology of Education*, 82(2), 126–146.

Turner, S. (2004). Going to college and finishing college. explaining different educational out- comes. In *College choices: The economics of where to go, when to go, and how to pay for it*, pages 13–62. University of Chicago Press.

Turner, L. J. (2014). The road to Pell is paved with good intentions: The economic incidence of federal student grant aid. *College Park, MD: University of Maryland, Department of Economics. Retrieved April 15*, 2016.

Ullis, J. J. & Knowles, P. L. (1975). A study of the intrastate migration of Washington college freshmen: A further test of the gravity model. *The Annals of Regional Science*, 9(1), 112–121.

Webber, D. A. (2012). Expenditures and postsecondary graduation: An investigation using individual-level data from the state of Ohio. *Economics of Education Review*, 31(5), 615–618.

Webber, D. A. (2017). State divestment and tuition at public institutions. *Economics of Education Review*, *60*, 1-4.

Webber, D. A. & Ehrenberg, R. G. (2010). Do expenditures other than instructional expenditures affect graduation and persistence rates in American higher education? *Economics of Education Review*, 29(6), 947–958.

Williams, G. (1996). The many faces of privatisation. *Higher Education Management*, 8(3), 39–57. Windham, D. M. (1976). Social benefits and the subsidization of higher education: A critique. *Higher Education*, 5(3), 237–252.

Yu, H., & Mixon, F. G. (1996). A regional study of net migration rates of college students. *The Review of Regional Studies*, 26(2), 197.

Zhang, L. & Ness, E. C. (2010). Does state merit-based aid stem brain drain? *Educational Evaluation and Policy Analysis*, 32(2), 143–165.

Zimmerman, S. D. (2014). The returns to college admission for academically marginal students. *Journal of Labor Economics*, 32(4), 711–754.

Zinth, K. & Smith, M. (2012). Tuition-setting authority for public colleges and universities. Technical report, Education Commission of the States.

Zipf, G. K. (1946). The p 1 p 2/d hypothesis: on the intercity movement of persons. *American sociological review*, 11(6), 677–686.

Alex E. Combs

_____

EDUCATION

2014   Master of Public Administration (MPA)
        The Martin School of Public Policy and Administration
        University of Kentucky
2009   B.A., Political Science; Philosophy Minor; Honors Scholar
        Eastern Kentucky University

PROFESSIONAL EXPERIENCE

2018-2019   Temporary Professor & Research Analyst,
             University of Kentucky
2015-2018   Research Assistant,
             University of Kentucky
2013-2014   Research Fellow,
             Council of State Governments
2010-2013   Associate Director of Educational Leadership,
             Sigma Nu Fraternity, Inc.
2009-2010   Consultant,
             Sigma Nu Fraternity, Inc.

SCHOLASTIC AND PROFESSIONAL HONORS

Graduate School Academic Year Fellowship (2015, 2016)
Graduate School Travel Grant (2015, 2016, 2017)
Daniel Reedy Award for Outstanding MPA Paper (2014)
Second Place, Policy Solutions Challenge USA (2014)
Pi Alpha Alpha National Honor Society (2014)

PROFESSIONAL PUBLICATIONS

Combs, A.E., Foster, J., & Toma E.F. (Forthcoming) Local response to school finance
equalization: Wealth or place? _Journal of Public Finance and Management_