

Application Behavior as a Consequential Juncture in the
Take-Up of Postsecondary Education

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Abstract

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The submission of an application, while typically required to access a public program, has generally been taken for granted as an inconsequential step in the process through which an individual pursues a program or policy's benefits. The burden that submitting an application represents, however, is increasingly of interest to researchers who disentangle and expose the administrative and behavioral barriers that applications represent. Drawing from multiple disciplines, this dissertation explores application behavior as a consequential juncture in the take-up of postsecondary education. Each chapter assumes that an enhanced understanding of how individuals submit postsecondary applications can inform public programs and policies designed to improve postsecondary access through targeting this behavior.

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Chapter 1. APPLICATIONS AND THE LOGIC OF PUBLIC PROGRAM TAKE-UP DECISIONS: THE CASE OF SECONDARY-POSTSECONDARY CHOICE

Abstract

In this chapter I contend that the consequential nature of application behavior makes the act of submitting an application worthy of attention from scholars and policymakers alike. Drawing on scholarship from multiple disciplines, I present a typology to organize research on application behavior into four predominate types. I also inventory recent research on application behavior to examine trends in the particular realm of behavioral interventions to influence this behavior. Finally, I present a thought exercise (based on a hypothetical program called “Post-Medicare”) to challenge key conventions in the domain of education policy specific to the secondary-postsecondary choice. The discussion that follows, in turn, sets the stage for the subsequent chapters in which I focus on the nuances and complexities of postsecondary application behavior in the United States.

1.1 INTRODUCTION

A thorough examination of application behavior adds value to understanding and evaluating the logic of a program or policy's take-up. Drawing on research from multiple disciplines, I illustrate that application behavior is a significant juncture through which an individual gains access to a public program or policy. I use the word "juncture" purposefully because I consider application behavior to represent more than a step in a process; following its definition, the term "juncture" throughout this dissertation represents the fact that the submission of an application is a "point in time" that is "made critical by a concurrence of circumstances" (Merriam-Webster, 2016). The concurrence of circumstances, in this case, is that an individual's access a policy or program's benefits hinges first on the submission of the application. The consequential nature of application behavior makes the act of submitting an application worthy of attention, from scholars and policymakers alike, alongside more conventional evaluations of programs and policies' outcomes and effectiveness. To illustrate this conceptualization, I translate the general characteristics of application behavior and take-up to the specific case of individuals submitting postsecondary applications to attend college.

The intentional consideration of application behavior makes an important contribution to the evaluation of public programs and policies that has evolved over the past half-century. Questions about the management and effectiveness of public programs and policies emerged, and became increasingly pressing, in the 1960s with the pantheon of Great Society initiatives implemented under the Johnson administration. As a result of the substantial increase in federal funding for public programs, Congress developed a keen interest in the extent to which program funds "caused desirable results" (Shadish, Cook, & Leviton, 1991, p. 22). Much of this theoretical

and empirical work was carried out at universities and research organizations to determine if a program caused “desirable results” (Shadish, Cook, & Leviton’s term), which were defined by a program or policy’s outcomes *relative to its goals*. Historically, a workforce program to train the unemployed was evaluated by employment rates and wages of those who participated in the program (Reisch, 2009); a policy to take affirmative steps in the hiring of minority workers was evaluated by the number of African Americans holding federal jobs, for example (Parham, Quadagno, & Brown, 2009).

Over time, the evaluation of outcomes gave way to a subfield evaluation research on program take-up (Currie, 2006). Moffitt (1983) offered one of the first empirical evaluations of take-up in examining the extent to which families applied for the Aid to Families with Dependent Children (AFDC) program. In observing the curiosity that “many turn out to be eligible for a positive welfare benefit but do *not* in fact join the welfare rolls,” Moffitt hypothesized that this “seemingly irrational rejection of an increase in income” was the result of “welfare stigma” (Moffitt, 1983, p. 1023, emphasis his). Currie (2006) notes that later studies on take-up included other types of costs, such as the costs associated with learning about and applying for the programs, that became “more important than [Moffitt’s] stigma [hypothesis]” (p. 83) in understanding why take-up rates vary across programs and subpopulations of recipients.

I apply extant theoretical and empirical knowledge on program take-up to a specific policy domain, education, and topic, access to postsecondary education, and illustrate how a thorough evaluation of an application process enhances the understanding of a program’s ex-post logic of take-up and reveals where policies and interventions may intercede to improve take-up. I use the term “logic” here and throughout this chapter in a manner similar to the way the term is used in “logic model” or “program logic.” That is, the “chain” (as described by Head & Alford, 2015) or

“inner-components” of a program or policy (Astbury & Leeuw, 2010) that comprise inputs, processes, outputs, and outcomes.¹ This focus on the consequential nature of application behavior frames my analysis of postsecondary application behavior in this and subsequent chapters.

A caveat worth noting is that the submission of an application for a public program, such as Medicaid or food stamps, is not perfectly analogous to submitting an application for postsecondary education. Two important distinctions exist. First and foremost, whereas someone applying for a public program submits a single application at an agency office or through an online portal, the submission of an application for postsecondary education has no single destination given the more than 4,000 postsecondary institutions in the United States. This multitude of destinations (community colleges and four-year universities, close-to-home or far away, etc.) introduces a substantial amount of complexity to the mere act of “submitting an application.” Evaluating the costs and benefits of *where* to submit postsecondary applications is also inordinately more complicated than applying to a single agency for program enrollment.

Second, submitting an application and meeting the eligibility requirements for a conventional public program typically leads to enrollment; meeting the eligibility requirements at a postsecondary institution, on the other hand, only guarantees an individual is *considered* for admission. This interplay between students choosing to apply to colleges and colleges choosing to admit students means both parties must be in agreement (a student applies; a college admits the student) in order for the student to enroll.

These characteristics of how an individual applies to, and takes up, postsecondary education make the process akin to other policy-relevant processes that contain *open-ended*

¹ Astbury and Leeuw (2010) help to clarify what is meant by logic in noting that a program or policy’s logic identifies and describes how the parts of a program or policy fit together (p. 365). Hence, when I reference the logic of a program’s take-up, I am using a shorthand term (i.e. “logic”) to describe the many steps involved with the take-up process.

choices as part of the overall take-up process. In this context I define an “open-ended choice” as a choice without clear bounds or a predetermined set of options. Two examples of open-ended choices relevant to existing public programs help to illustrate this point. The U.S. Housing and Urban Development (HUD) housing choice voucher (typically known as a Section 8 voucher) is an example of a program that delivers a housing subsidy to a low-income family but then leaves the actual housing choice in the hands of the family; the family considers where to submit rental applications based on their criteria for choosing housing options (Shroder, 2002). Similarly, an unemployed individual enrolled in a public sector training program faces the prospect of submitting job applications to a list of potential employers in an effort to gain employment (LaLonde, 1995). With these examples I suggest that open-ended choices, such as where to apply for housing or where to apply for employment, are highly relevant to understanding and evaluating the take-up process.

Given these distinctions, I make a case in this chapter (and subsequent chapters) that fruitful theoretical and empirical opportunities exist to consider the postsecondary application process alongside other types of application processes within the take-up of public programs and policies. I also contend that the submission of an application, open-ended or otherwise, is a necessary condition to access postsecondary education in the United States just as the submission of an application is a necessary condition to access any other public program or policy that is not universal. The nature of this necessary condition, regardless of the policy domain (postsecondary education, retirement security and savings, healthcare, etc.), presents a unifying theme around which theoretical and empirical analysis can coalesce.

1.2 RESEARCH ON APPLICATION BEHAVIOR: A TYPOLOGY

Acknowledging the importance of application behavior in the logic of a public program or policy's take-up, a growing body of literature on application behavior has emerged across a range of disciplines and theoretical perspectives. To make sense of this empirical research I propose a typology of four conceptual categories into which application research can be assigned. The categories – descriptive, neoclassical, administrative, and behavioral – are not mutually exclusive. Rather, the categories provide a basic structure to analyze empirical research on application behavior such that the empirical and theoretical role of the application itself is identified within context study. These categories also provide a conceptual frame to organize the study of application behavior across disciplines.

The first category, *descriptive*, captures studies on application behavior that describe and analyze patterns of application behavior independent of any public policy intervention. These studies nonetheless typically seek to develop a baseline, often exploratory, understanding of application behavior in a particular policy domain. Studies of this type examine the characteristics of individuals submitting applications, the characteristics of application behavior in and of itself, or statistical relationships between an individual's characteristics and the probability or odds of application submission. Examples of this type include Meneff, Edwards, and Schieber's (1981) demographic analysis of those who submit applications for the Supplemental Security Income Program, Moffitt's (1983) earlier-mentioned study of the factors that predict the take-up of AFDC, and Mitchell and Phillips's (2002) study of older workers navigating the application process for disability insurance. Chapter 2 and Chapter 3 of this dissertation fall within this descriptive category of studies on application behavior.

Neoclassical studies of application behavior model the submission of an application (or a proxy representing an application) as the dependent variable with a focus on a policy or program's effects on the probability of application submission. As the term implies, neoclassical studies are generally based on an economic premise that a policy or program affects the benefits or costs associated with application submission. An experimental or quasi-experimental approach to identify a causal relationship between a change to a policy or program's benefits or costs and the probability of application submission is also common in these studies. Specific to the education policy domain, for example, Dickson (2006) and Long (2004) examine the extent to which changes in state-level affirmative action laws affect the application behavior of white and minority students. Studies beyond the realm of education include research by Card and Levin (2000) and Anderson and Meyer (2003) which analyze how increases in either the duration or magnitude of benefits, respectively, increase the probability of application submission for unemployment insurance.

Research on application behavior that falls within the *administrative* category takes a broader look at the organizations, institutions, and political forces that may shape the process through which the application is submitted. This type of research, one of two types of research I consider on the frontier of studying application behavior, examines the individual's experience in submitting the application, which Moynihan, Herd, and Harvey (2015) call the "citizen-state interaction." In their article "Administrative burden: Learning, psychological, and compliance costs in citizen-state interaction," Moynihan, Herd, and Harvey (2015) explain that submitting applications marks an early occasion where an individual interacts with the state. In other words, before an individual receives Medicaid services or a disability payment from Social Security, the individual engages in the "citizen-state interaction" of submitting an application and the associated processes. This area of research on application behavior draws from the public management

literature and, in particular, has been formalized with the advent of the administrative burden theoretical framework proposed by Moynihan and colleagues (2015). Moynihan, Herd, and Harvey (2015) suggest that in applying for public programs and policies, individuals face learning costs, psychological costs, and compliance costs in navigating application processes.² Political actors may intentionally increase administrative burdens to multiply the barriers individuals face in accessing public programs, or administrative burden may be “opaque” to policymakers and inadvertently accumulate over time as a function of bureaucratic processes (Moynihan, Herd, & Harvey, 2015). Examples that fall under the administrative category of application behavior include Heinrich and Brill’s (2015) study of administrative burden’s negative effects on the take-up of a cash transfer program, and work by Moynihan, Herd, and Harvey (2015) and Moynihan, Herd, and Ribgy (2016) on the administrative burden associated with submitting a Medicaid application. Chapter 4 of this dissertation, which further discusses the administrative burden theoretical framework in the specific context of applying to public postsecondary institutions, is also an example of the administrative approach to studying application behavior.

The fourth category, *behavioral*, represents the second innovative area of applied research on application behavior. Behavioral economics and the subfield of Judgement and Decision Making (JDM) in the field of psychology comprise this area of research that applies a behavioral intervention in order to spur a change in application behavior. This change in application behavior may contain benefits in and of itself, as with Hoxby and Turner’s (2013) suite of behavioral interventions to nudge high school students toward applying to more selective colleges than those

² Learning costs are the costs a citizen must bear in learning about a policy or program; compliance costs are the costs associated with completing an application, providing documentation, and responding to discretionary demands related to the application process; and psychological costs represent the stigma, loss of autonomy, and increases in stress that may accompany program processes and participation. I revisit these costs and discuss them at greater length in Chapter 4.

to which the students would have otherwise applied. Behavioral interventions focused on application behavior are also implemented to increase the take-up of programs or policies. Bettinger and colleagues (2012) used a simplified application process to increase the rates at which low-income families submitted the Free Application for Federal Student Aid (FAFSA), the U.S. Department of Education application that is required to access federal and state need-based financial aid.

I suggest that behavioral research represents a frontier of applied research on application behavior, similar to administrative research on administrative burden, because of recent initiatives in the United States and United Kingdom to formalize the use of this type of research in the policymaking process. In the United Kingdom the Behavioral Insights Team was created in 2010 as a part of Prime Minister David Cameron's administration while the Social and Behavioral Sciences Team was formally established as part of the White House Office of Science and Technology Policy in 2015 by President Barack Obama. The Social and Behavioral Sciences Team exists as part of the Executive Branch under the premise that "when behavioral insights—research findings from behavioral economics and psychology about how people make decisions and act on them—are brought into policy, the returns are significant" (Executive Office of the President, 2015, p. 2). In the United States, the use of behavioral research has led to changes in application processes for programs and policies in the Department of Education, Department of Health and Human Services, and the Veterans Administration (Executive Office of the President, 2015).

The focus and objective of each of these categories is distinct but as noted earlier, the categories are not mutually exclusive (Table 1-1). For example, Moynihan, Herd, and Harvey (2015) suggest that behavioral economics holds valuable promise in determining how unintentional application burdens may be reduced by the state (p. 64); this observation portends a

potential study applying the administrative burden framework to a behavioral intervention. Likewise, in discussing the important overlap between economic and behavioral research, Congdon (2013) observes that a promising “approach [to behavioral research] is to integrate behavioral economics more fully into the policy-relevant fields of economics” (p. 474). Sustained interest in application behavior from researchers, especially across disciplines, is likely to stimulate collaboration across these categories.

TABLE 1-1: CATEGORIES OF APPLICATION BEHAVIOR RESEARCH

Category	Focus	Objective	Example
Descriptive	Patterns in application behavior	Exploratory analysis, identify patterns of application behavior, hypothesis generation	Demographic factors predicting application submission (Moffit, 1983)
Neoclassical	Policy or program	Identify causal relationships between changes in a policy/program and application behavior	Effects of larger unemployment insurance payments on application rates (Anderson & Meyer, 2003)
Administrative	Structures of governance	Examine application behavior as “citizen-state” interactions	Evaluation of Medicaid applications across 50 states (Moynihan, Herd, & Ribgy, 2016)
Behavioral	Choice architecture, “nudge”	Demonstrate a behavioral intervention’s effectiveness at changing a particular behavior <i>per se</i> or increase a policy/program’s effectiveness through improved take-up	Easing the application submission process of applying for federal financial aid (Bettinger et al., 2012)

The chapters to follow represent two distinct categories of research on application behavior. Chapter 2, an exploratory analysis of types of postsecondary application behavior, and Chapter 3, an analysis of the extent to which these types of application behavior predict

postsecondary enrollment outcomes, fall within the descriptive category of application research. By providing a baseline analysis of the complexities and nuances of postsecondary application behavior, however, I intend for these chapters to also serve as the means to generate hypotheses for potential behavioral interventions such as those typically designed for a narrow category of application behavior (e.g. the Hoxby and Turner (2013) experiments targeting low-income high-achieving students). Chapter 4 is squarely in the category of administrative research. This chapter also moves this category of application behavior forward by connecting the emergent administrative burden's theoretical frame with the well-established public administration literature on street-level bureaucrats (Lipsky, 1980/2000).

1.3 PUBLIC POLICY, PUBLIC PROGRAMS, AND APPLICATION BEHAVIOR: WHAT DO WE KNOW?

Take-up, the act through which a citizen gains access to a public program or policy, has broad implications for public administration because low take-up rates jeopardize a program or policy's ability to serve its targeted recipients. Targeting was historically synonymous with the means-testing to "exclude individuals of means" from transfer programs but an updated definition suggested by Smolensky, Reilly, and Evenhouse (1995) defines targeting as any characteristic that can be used to direct the flow of public benefits to an intended group of people (p. 4). I consider the general mechanics of take-up to unfold as follows: for a given program or policy, political actors or managers identify a program or policy's targeted group (the parents of low-income children, small business owners from racial/ethnic minority backgrounds, pregnant women, etc.);

an application is proposed for this targeted group to facilitate their request for and access to the program's benefits; the application is created to collect information (at a bare minimum, an individual's name) that enables means-testing or other factors to determine eligibility; individuals from the targeted group submit applications to gain access to the program or policy; and program staff or policy administrators, who likely fit the definition of street-level bureaucrats (Lipsky, 1980/2010; Maynard-Moody & Portillo, 2010), review the application to verify or judge an individual's eligibility. The final step is either the rejection or approval of the application.

Approval is often synonymous with program enrollment but the two do not always coincide. Consider, for example, the take-up process for the previously discussed Section 8 housing voucher. A low-income individual submits an application which may be approved but, because of limited funding, access to the voucher itself then depends on a lottery and a years-long waitlist before the individual actually receives the benefit; in some cases, waitlisted individuals never receive a benefit because public funding runs out (Jacobs & Ludwig, 2012). This example illustrates why some scholars (e.g. Currie, 2006) draw a clear line between the application stage and the enrollment stage of a program's overarching logic of take-up.

The take-up of social programs and policies varies widely. In an extensive survey of the take-up rates for social programs and policies in the United States, Currie (2006) argues that the administrative barriers and stigma associated with means-testing likely account for the relatively low take-up of many programs, but there exist few explanations for variation in take-up across means-tested programs. To illustrate take-up variation in the United States, Currie (2006) contrasts the State Children's Health Insurance Program's (SCHIP) "very low" historic take-up rates of 8 to 14 percent of eligible citizens with the "extremely high" take-up rate of 35 to 40 percent of eligible pregnant women in Medicaid (pp. 86-87). Compare these means-tested take-up rates to the take-

up of an entitlement program based on near-universal enrollment, such as Social Security. Social Security, where eligibility is based primarily on age and applying for benefits can take as little as ten minutes at a local Social Security Administration office, boasts a nationwide take-up rate of nearly 100% (Moynihan & Herd, 2010).³ I return to this topic of “universal” enrollment and its implication for application behavior later in this chapter.

An increasing interest in the intersection of application processes and take-up have produced a subfield of research on the topic spanning the public policy, public administration, and economics literatures. Table 1-2 surveys these studies with a focus on the particular aspect of the application process affected by a given intervention and the observable ways in which application behavior changed. Note that because the focus here is on policy-related interventions and their effects on application behavior, I exclude studies that might focus on types of application behavior (e.g. Mitchell & Phillips, 2002; Moynihan, Herd, & Harvey, 2015) that fall outside the bounds of these parameters.

Three themes emerge from the studies outlined in Table 1 that help to illustrate general characteristics of application behavior and application submission rates. First, these studies demonstrate that either making an application easier to submit or providing application assistance generally increases the rates at which citizens apply for access across a wide range of public

³ Measuring the average number of minutes required to complete an application can be a compelling method to quantify administrative burden. In addition to Moynihan and Herd’s (2010) observation that an application for Social Security can take as few as ten minutes, postsecondary federal financial aid is another policy domain where administrative burden has been quantified in minutes. Responding to critics calling for a simplified application for federal financial aid, the U.S. Department of Education stated that an applicant submitting the Free Application for Federal Student Aid (FAFSA) spends an average of 52 minutes reading instructions and 23 minutes completing online forms; Dynarksi and Wiederspan (2012) find this statistic “particularly implausible” when one considers the IRS estimates completion of the ubiquitous Form 1040, which is only “slightly longer than the FAFSA,” takes an average of 23 *hours* (p. 9-10, emphasis added). Bettinger et al. (2012) note their behavioral simplification intervention reduced the FAFSA submission time to “generally less than 10 minutes” (p. 1206). Since the passage of the Paperwork Reduction Act of 1995, which defines burden as the “time, effort, or financial resources expended by persons to generate, maintain, or provide information to or for a Federal agency,” the Office of Management and Budget (OMB) collects from all federal agencies the “burden hours” associated with “each particular information collection” effort the agency undertakes (Spotila, 1999).

programs and policies. Second, I consider each of these studies an example of the behavioral type of application research (Row 4, Table 1) because the studies examine interventions that do not change the policy or program itself. For example, Bansak and Raphael (2006) do not study a change in the *benefit* level of the State Children's Health Insurance Program (SCHIP) but rather the extent to which a simplified application process increases application rates. Finally, the recent publication dates of these studies reflect researchers' growing interest in application behavior and sets the stage for the development of theory around application behavior, such as with Moynihan, Herd, and Harvey's (2015) administrative burden theoretical framework.

TABLE 1-2: REVIEW OF TAKE-UP LITERATURE SPECIFIC TO APPLICATION SUBMISSION

Program/ Policy	Application-Related Intervention	Impact on Application Behavior	Source
Medicaid	Community-based bilingual application assistants	Increased application rate among Hispanics by 4.6 percent; among Asians for their children by 6 percent (p. 238)	Aizer (2003)
SCHIP	Simplify application process; eliminate face-to-face eligibility interviews and asset tests	Simplification led to 5.7 to 7.6 percentage point increase in application rate; eliminating the asset test was associated with a 17 percentage point increase (p. 164)	Bansak & Raphael (2006)
SCHIP	Create a website with information about application process and a phone hotline to assist with application submission	Website increased probability of application submission by 2 percentage points; phone hotline increased application submission rate by 4.9 percentage points (p. 513)	Wolfe & Scrivner (2005)
Earned Income Tax Credit	Introduction of electronic state income tax filing program	0.7 percentage point increase in the share of state population applying for the EITC (p. 1363)	Kopczuk et al. (2007)
Food Stamps	Reduce the number of times income certification is required to qualify for assistance	Increased take-up by 1.0 to 1.8 percentage points (p. 618)	Hanratty (2006)
Food Stamps	Introduction of statewide online application	Per capita application rates increased 5 percent over a six-year period (p. 14)	Schwabish (2015)
Food Stamps	Application assistance provided by an H & R Block representative	18 percentage point increase in the likelihood of applying for benefits (p. 21)	Schanzenbach (2009)
Federal Financial Aid	Application assistance provided by an H & R Block representative	15.7 percentage points increase in the likelihood of application submission (p. 1225)	Bettinger et al. (2012)

1.4 THE NATURE OF THE SECONDARY-TO-POSTSECONDARY CHOICE: A THOUGHT EXPERIMENT

I now turn specifically to postsecondary application behavior with this overview of different types of application behavior research in mind. Application behavior is increasingly considered a key factor in the logic of how individuals pursue postsecondary education (Hoxby & Turner, 2013; Klasik, 2012). Research on postsecondary application behavior, however, has yet to intersect with the broader literature on application behavior and the take-up of public programs and policies (e.g. Currie, 2006). Public education in the United States presents a unique case study in how individuals experience a government-provided service. From kindergarten to the 12th grade the state provides for (and, in fact, compels) citizen participation in public education or a sanctioned nonpublic alternative. Yet beyond the 12th grade in the United States, the pursuit of any further education is a *choice*. Moreover, accompanying this conscious choice that must be made to pursue postsecondary education is the reality that one must typically incur at least some of the financial cost of such education, be it postsecondary education that is publicly or privately provided. This consequential juncture at the conclusion of the 12th grade, where enrollment moves from compulsory, universal, and free to voluntary and requiring payment to participate, thus leaves the act of participating in any type of education beyond the 12th grade hinging in part on the *submission of an application* which is not required at earlier stages.

The shift from universal-to-voluntary participation makes the secondary-to-postsecondary transition unique in this regard across public policy domains in the United States. Universal enrollment is, in fact, increasingly rare in and of itself. Especially since the 1980s and the dawning of the “New Governance” which simultaneously increased the prevalence of means-testing for

public programs⁴ (Smolensky, Siobhan, & Evenhouse, 1995; van Oorschot, 2002) and policy tools based on market principles (Salamon, 2002), universal enrollment in public programs and policies of any kind is the exception rather than the norm. The most salient exception is that most American taxpayers are statutorily required to contribute to Social Security and thus work most of their lives to reach a point when they “enroll” in Social Security to reap the program’s benefits for the remainder of their lives. Likewise, with Medicare A & B, which provides hospital and medical insurance, respectively, an application is moot since enrollment is automatic upon turning 65 years old. This automatic enrollment leads to nearly 100% participation rates in Social Security and Medicare (Moynihan & Herd, 2010; Levy & Weir, 2009) and, consequently, to public programs that are strikingly resilient to political pressure to change eligibility and enrollment criteria (Wildavsky & Caiden, 2004).

To reveal the policy implications of the universal-to-voluntary shift in how individuals participate in public of education in the United States, with its abrupt end to universal enrollment in the 12th grade, I introduce a hypothetical universal-to-voluntary enrollment program for Medicare. In this hypothetical scenario, suppose an individual is still automatically enrolled in Medicare A & B upon turning 65 years old but upon turning 90 years old, guaranteed Medicare enrollment ends.⁵ At this juncture, Medicare still exists but now the individual must apply for one

⁴ Synonymous with means-testing is the notion that programs and policies are “targeted” to specific groups. The trade-offs of such targeting, however, are contested i.e. targeting a program’s benefits through means-testing may be a more efficient way to deliver scarce public resources but also leads to a substantial proportion of eligible individuals not receiving the program’s benefits because they fail to apply (Bruckmeier & Weimers, 2012; Matsaganis, Levy, & Flevotomou, 2010; van Oorschot, 2002).

⁵ An important assumption here is that this hypothetical individual has retired at or before reaching the age of 65 years old. As noted on the sign-up page of Medicare’s main website, “Some people get Part A & Part B automatically if they are already getting Social Security” but “Some people need to sign up for Part A & Part B if they aren’t getting Social Security (for example, because you’re working)” (Centers for Medicare & Medicaid Services, 2016). Since fewer than one in five (19.7%) adults 65 years and older were projected to participate in the labor force in 2014 (Holder & Clark, 2008), I consider this a valid assumption for the purpose of this thought exercise, acknowledging that the individuals who work past their 65th birthday indeed face an application process for Medicare Part A & Part B.

of three types of “Post-Medicare” coverage, each requiring its own application.⁶ Further, imagine each of the three Post-Medicare options have varying combinations of benefits that the 90-year-old individual has to assess in making her choice. Finally, in this hypothetical situation, while each of the three Post-Medicare options carries a modest monthly premium, low-income and middle-class 90-year-olds can submit a separate application, the Free Application for Federal Medicare Aid (FAFMA), for federal assistance to cover these costs. The submission of the FAFMA entails submitted detailed information about the individual’s income, taken from her prior year’s IRS tax return, and assets, including investments and real estate. This form is required for any elderly individual to receive a means-tested grant which she can apply to the premium cost of the Post-Medicare option of her choice.

The politics and historical developments surrounding entitlement programs in the United States make this hypothetical “Post-Medicare” scenario unlikely to say the least. But as a thought experiment to disentangle our assumptions about application behavior and the status quo this example is useful to illustrate three important implications of the move from universal-to-voluntary enrollment, such as with the secondary-to-postsecondary education dynamic.⁷ First, in the example of Post-Medicare, enrollment begins at 65 years old and ends at 90 years old, so the “universal” nature of the program spans 25 years; notice that with public education, universal enrollment does not begin at birth but rather around five years old with kindergarten and continues until the 12th grade. The point here is that while the boundaries of when eligibility begins and ends

⁶ One could even imagine lawmakers arguing that this kind of “choice” is inherently better compared to the status quo because Post-Medicare gives each elderly person the power to choose which type of Medicare is best for them given their individual circumstances in the latter years of their lives. Choice, as Greenfield (2012) and Sunstein (2015a, 2015b) point out, is a politically powerful idea that is central to American policymaking and rarely cast in a negative light.

⁷ “Post-Medicare” does not contain an open-ended choice as is the case when pursuing postsecondary education. This thought exercise is not intended to ignore the open-ended nature of the postsecondary application process; rather, I use this thought exercise to challenge the status quo assumptions surrounding the process through which individuals take up postsecondary education in the United States.

for any given program are an important part of the status quo and may appear politically intractable, altering the ages (or milestones, as with high school graduation) at which universal enrollment begins and ends is always a tool at the disposal of policymakers. I return to this point shortly.

Second, a program that switches from universal enrollment to one that requires any type of application for enrollment introduces the potential for “non-take-up” (Blundell, Fry, & Walker, 1988). With our example of Post-Medicare, a 90-year-old enrolling in *none* of the three options is possible to imagine based on the steps involved with such enrollment, particularly if an impoverished 90-year old submits an application for Post-Medicaid but fails to submit her Free Application for Federal Medicare Aid. A logical question arising in this scenario is if the 90-year-old who does not enroll in Post-Medicare truly wishes to not enroll in such program or if application-related circumstances precluded her successful take-up of program. This question is also highly relevant relative to those who aspire to participate in postsecondary education but who do not submit postsecondary applications (Hoxby & Avery, 2013; Klasik, 2012).⁸

Third, it is easy to imagine in this hypothetical example the criticism levied against Post-Medicare: Why burden these 90-year-old individuals with such an onerous application process, requiring them to apply for one of three Post-Medicare options, not to mention subjecting them to the complexities of the Free Application for Federal Medicare Aid? Given the reciprocal relationship among the public policy process, participation in public programs, and political participation for senior citizens in particular (Campbell, 2003), lawmakers would burden these 90-year-olds at their own political peril.

⁸ Implicit in this observation is the fact that both adolescents (Reyna, Chapman, Dougherty, & Confrey, 2011) and the elderly (Hess & Blanchard-Fields, 1999; Peters, Hess, Vastfjall, & Auman, 2007) have cognitive limits that may preclude optimal decision making.

The fact that senior citizens experience the burden in this Post-Medicare example is important: Schnieder and Ingram (1993) and Soss (1999), among others, have argued that a targeted group's "social construction" is highly consequential in the extent to which policymakers allocate a policy or program's benefits or burdens. In other words, subjecting senior citizens to Post-Medicare's burdensome application process is intuitively untenable because senior citizens in the United States hold a relatively high level of political power and are generally perceived positively. Compare this social construction of senior citizens to that of college-bound students; while these students might also be perceived positively by policymakers, their lack of political power (especially low-income college-bound students who may be less positively viewed in general because of low incomes) leaves them more susceptible to the receiving end of a policy or program's burdens. Hence, these differences in a group's social construction help explain why the implementation of a burdensome application process for a positively-constructed group is unlikely while for a group with a neutral or negative social construction, a burdensome application as the status quo garners little attention from policymakers. In fact, the extent to which the Free Application for Federal Student Aid (FAFSA) burdens low-income families has, in recent years, become well documented (Dynarski & Scott-Clayton, 2006). Dynarski (2015) recently suggested that the FAFSA could be eliminated entirely and federal financial aid awards made solely using tax return data from the IRS, all in an effort to alleviate the burden low-income individuals face in accessing the requisite federal financial aid to enroll in postsecondary education.

Recalling the characteristic of education's universal-to-voluntary switch following the 12th grade, I offer two observations with the Post-Medicare example in mind. Returning to a point made earlier, my first observation is that the point at which an individual submits an application in the take-up process is the result of where policymakers place the boundaries of program eligibility.

Indeed, raising the minimum age for Medicare and Social Security enrollment up to 70 years old has been an often-discussed option to reduce entitlement expenditures and increase the availability of workforce labor (Waidmann, 1998; Wittenburg, Stapleton, & Scrivner, 2000) but such proposals have met fierce political opposition. Likewise, the fact that public education at present spans kindergarten to the 12th grade obscures the fact that historically speaking, at the turn of the 20th century neither kindergarten nor high school were part of what constituted a public education provided by the state (Bryant & Clifford, 1992; Goldin & Katz, 2011).

To this end, policy efforts focused on increased access across the educational spectrum increasingly examine the extent to which the status quo (i.e. kindergarten to the 12th grade) might be expanded with early childhood education and “universal preschool” (Heckman, 2000; Zigler, Gilliam, & Jones, 2006) at one end and at the other, proposals for “universal community college” (Wyner, 2015) and federal legislation to implement President Obama’s call for “free tuition” at all public community colleges (White House, 2015; H.R. 2962, 2015). In these circumstances, with either “universal preschool” or “universal community college,” current proposals are designed such that individuals would need to opt-in and *apply* for such programs. In other words, I draw a distinction here between expanding what constitutes universal and compulsory enrollment versus *offering* preschool or postsecondary education without charge. The implementation of compulsory schooling up to the 13th grade with an option to *opt-out* after completion of the 12th grade is distinct from, say, the potential to opt-in to universal community college.⁹ One requires an application

⁹ An emergence of “five-year” high schools in which the 13th grade is offered is akin to the “Early College” initiative in which college coursework is offered alongside high school coursework and students attend for up to five years to increase their college readiness (Barnett, Bucceri, Hindo, & Kim, 2013). In a less formal arrangement, a few Oregon school districts in recent years have created the “13th grade” by encouraging high school seniors to delay graduation for an additional year so those seniors can enroll in community college courses and earn college credit paid for by the public high school (Nesbitt, 2014).

process, the other does not; as I suggest throughout this dissertation, the consequences of such an application process can be far-reaching.

The second observation worth noting is that the hypothetical Post-Medicare example illustrates the potential burden of an application process on the 90-year-old applicant because the proposed Post-Medicare application process *disrupts the status quo*. This disruption to the status quo is a disruption because the proposed Post-Medicare application process for 90-years-olds, comprising an application choice among multiple options with an additional application for means-tested aid, interrupts the present process which delivers program benefits from age 65 years old to death. Likewise, Dynarki's (2015) suggestion to eliminate the application for federal financial aid for college-bound students is "radical" (her words) in part because it would disrupt (in the other direction) an application-based status quo for federal financial aid that has existed since 1972 (Archibald, 2002; Gladieux & Hauptman, 1995).

I make this point because *any* application to access a public program or policy inherently comprises compliance, learning, and psychological costs that potentially burden the application (Moynihan, Herd, & Harvey, 2015). The burden of submitting applications to access "Post-Medicare" is more readily apparent simply because Medicare's status quo contains no burdensome application process to maintain program benefits once an individual automatically enrolls. The status quo of submitting applications to access postsecondary education in the United States, however, is a deeply entrenched part of the education system and thus largely obscures the costs that individuals face in submitting applications. Only recently has the act of submitting applications to postsecondary institutions been seen as a consequential, potentially-burdensome step in an individual's pursuit of postsecondary education (Hoxby & Turner, 2013; Klasik, 2012). "Education is [a] policy area where burdens matter," note Moynihan, Herd, and Harvey (2015, p.

45), although the extent of this burden is only recently becoming apparent as researchers focus their attention on the postsecondary application process.

1.5 SUMMARY

Currie (2006) observed a decade ago that “relatively little insight into precisely what types of costs matter most, and what types of measures are most likely to reduce them” (p. 135) described the extant literature on application behavior and take-up. Since that time, a range of studies have made important contributions to an evolving understanding of how individuals apply for and take-up public programs and policies. In this chapter I set out to achieve two objectives: review and categorize the recent literature on application behavior, and draw from non-education examples of application processes to reveal insights specific to the secondary-to-postsecondary application process. The next three chapters continue to explore distinct dimensions of this secondary-to-postsecondary application process.

Chapter 2. THE ECOLOGY OF POSTSECONDARY APPLICATION BEHAVIOR

Abstract

An ecological understanding of postsecondary application behavior - one that avoids an oversimplified, atomistic description of an inherently complex subject matter - is missing from the extant literature on how students pursue postsecondary education in the United States. In this chapter I use a nationally-representative data set to explore and evaluate the patterns and nuances of postsecondary application behavior. I rely on two multivariate classification tools of statistical analysis, nonhierarchical cluster analysis and principal component analysis, to identify and visualize six types of application behavior. The unit of analysis for this chapter, which I call the application choice set, is not the individual submitting applications but rather the applications submitted in aggregate. Although this chapter's findings demonstrate that postsecondary application behavior does not fall into easily-defined categories, important patterns emerge to challenge conventional knowledge about postsecondary application behavior and inform future research on the topic.

2.1 INTRODUCTION

Randomized interventions to modify college application behavior or other discrete choices in the college application process (e.g. the choice to apply for financial aid) are an increasingly popular means to achieve desired postsecondary enrollment outcomes (Avery, 2010; Bettinger et al., 2012; Hoxby & Turner, 2013; Oreopoulos & Dunn, 2009). Yet a baseline understanding of this application behavior itself, using a nationally-representative sample of students with attention to how application behavior varies across the key institutional characteristics on which students make postsecondary application and enrollment choices, is missing from this research. This chapter addresses that gap in the literature by using the Education Longitudinal Study of 2002 (ELS:2002) to develop an ecological understanding of postsecondary application behavior and its relationship to postsecondary enrollment choices in the United States. I intentionally choose the word “ecological” given the term’s use in social science as an antonym to reductionist approaches that oversimplify an inherently complex, interconnected topic of study (Barrett, 2013). To bring forth an ecological inquiry is to consider patterns and connectedness, looking at the larger “whole,” instead of an atomistic focus on one singular element (Emery & Trist, 2012).

Hence, the unit of analysis in this chapter is what I call the application choice set. The application choice set represents in aggregate all postsecondary institutions to which an individual submits applications during her senior year of high school. I use the application choice set as an output in the logic of the college application process, rather than focus on individual postsecondary institutions to which students apply, because I seek to develop an empirical understanding of the complexity of college application behavior. This chapter’s objective is to uncover patterns in application behavior that emerge when students apply to both two-year and four-year colleges by

using exploratory multivariate statistical techniques and data visualization. This objective, in turn, motivates the chapter's research question: how does application behavior vary by postsecondary institutions across American high school students?

I begin with a review of extant research pertaining to the application stage of a student's pursuit of postsecondary education. After reviewing this literature, I describe why the chapter's statistical methods, principal component analysis and nonhierarchical clustering, are appropriate approaches to make sense of postsecondary application behavior. I then describe the data with a focus on how I construct an application choice set vector using student-level application data from ELS:2002 merged with postsecondary institutional data from the Integrated Postsecondary Education Data System (IPEDS). After reviewing results from the principal component analysis and cluster analysis, I also explain how the use of principal component analysis, cluster analysis, and data visualization are more effective, especially in the context of an exploratory research question such as the one considered in this study, when used together than if only one of these methods was used on its own. I conclude with a discussion of the implications of these findings relative to the chapter's research question regarding how application behavior varies empirically across high school students.

2.2 THEORETICAL FRAME

This study is grounded in, and makes a contribution to, research on the process through which a high school student in the United States pursues postsecondary education. A student's application choice set was indeed a central, albeit theoretical, part of early theory on this topic. Jackson (1982) considers the student's final choice within the college decision process – that is,

the choice to enroll at a particular college – “almost anti-climactic” since “all but a fraction of the decisions to ignore or exclude specific [postsecondary] options are made before students reach” the enrollment choice (p. 241). In other words, the decision of where to enroll is limited by colleges to which a student applied; the enrollment choice is constrained whereas the application choices a student makes are much less constrained, and thus represent a realm of potentially rich analysis.

While Jackson (1982) stands alone among college choice scholars in considering deeply the role of the application choice set in the process of choosing a college, his college choice model is not the only conceptual model of college choice to contain a choice set. Hossler and Gallagher (1987), for example, mention in passing the role of the choice set in the college choice; DesJardins and Toutkoushian (2005), while not actually proposing a model of college choice per se, reference at a high level the role of a choice set in the context of a proposed random utility model of student enrollment choice (p. 227).

Research on college application behavior centered on the application choice set has been largely absent in the college choice literature since the work of Jackson (1982) and to a lesser extent Hossler and Gallagher (1987). This is not to say that applied research has ignored the act of applying to college. On the contrary, scholars – especially economists – have developed a body of literature around what predicts whether a student applies to college and how students evaluate tradeoffs when making a postsecondary enrollment choice (e.g. Andrew, DesJardins, & Ranchhod, 2010; Avery, 2010; Bettinger, Long, Oreopoulos, & Sanbonmatsu, 2012; Dynarski, 2003; Griffith & Rothstein, 2009; Hill & Winston, 2010; Long, 2004a; Long, 2004b; Long, 2004c; Pallais, 2013; Rouse, 1994; Smith, 2013, among others). In these econometric studies of college choice, however, the outcome of interest is modeled as dichotomous or multinomial. That is, the dependent variable (and ultimately the research question) is either binary or categorical: Did the student apply to any

four-year institution? Did the student apply to a highly-selective four-year institution? While these research questions have significantly advanced a body of knowledge surrounding the mechanics of college choice making, this study departs from that convention and uses exploratory multivariate classification approaches to analyze application behavior across types of postsecondary institutions as a means to understand the intricacies and nuances of postsecondary application behavior itself.

Why focus on the nuances of application behavior and the application choice set? As Jackson (1982) notes, policy interventions to increase college-going behavior are not uniformly applicable to all stages of the student's college choice process. On one hand, Jackson's (1982) point rings true today considering Hoxby and Turner's (2013) interventions to intentionally nudge students' application behavior in a particular direction as part of a broader effort to increase postsecondary access. On the other hand, little is known about how policy interventions may affect the application stage of a student's pursuit of postsecondary education in a broadly generalizable sense; Hoxby and Turner (2013) present persuasive evidence that a particular intervention may shift high-achieving students from low socioeconomic backgrounds toward more selective colleges but these authors provide no insight into all other students' application behavior. This question of "all other students' application behavior" – that is, students from every type of socioeconomic background and all levels of academic achievement – motivates this study's research question.

Research on postsecondary application behavior using nationally representative samples is an important addition to extant research on college application behavior that often focuses exclusively on high achieving students (Avery & Hoxby, 2012; Hoxby & Turner, 2013), applications submitted to selective institutions (Avery, 2010), or applications only to four-year

colleges (Smith, 2013). These “subpopulations of selectivity” that have been the focus of much research represent, in reality, a small fraction of all college-bound students in the United States; in 2012, for example, more than half (52%) of the nation’s four-year colleges accepted 75% or more of all applicants (Kena et al., 2014). Put another way, more than half of the four-year colleges in the United States were closer to being openly accessible than selective. In addition, nearly a third of the nation’s postsecondary enrollment (30.9%) in 2012 was at two-year colleges (National Center for Education Statistics, 2012). Research on postsecondary application behavior with its predominate focus on four-year institutions has yet to fully fold community colleges into existing models of postsecondary choice.

Finally, the “undermatching” and “mismatching” literature in higher education research and economics, respectively, deserves a brief mention since this emerging body of research could ostensibly inform the study proposed here. Bowen, Chingos, and McPherson (2009) describe the “undermatch” phenomenon as “the surprisingly large number of high school seniors who [are] presumptively qualified to attend strong four-year colleges but did not do so” (p. 88). Similar findings from Smith, Pender, and Howell (2013) suggest that patterns of “undermatching” are more common among students from low socioeconomic backgrounds, rural areas, and whose parents did not attend college. This study intentionally avoids the term “undermatching” or “mismatching” because I evaluate students’ application behavior independent of any normative assumptions about how students ought to behave relative to applying and enrolling in college. Instead, this study leverages data on students’ postsecondary application behavior to create an evaluation of application behavior patterns. While potentially informing the “undermatch” literature by providing a baseline understanding of application behavior in the United States, this study deliberately avoids assigning judgment to students’ application behaviors.

2.3 METHODS

In the absence of empirical research or established theory on how to measure an application choice set, or how to measure the diversity of application choice sets that are relatively similar to one another, I use two types of multivariate analysis to develop an ecological understanding of the patterns underlying how students submit postsecondary applications in the United States. I use principal component analysis to develop a rich understanding of the underlying structure of the application choice sets in aggregate. My use of nonhierarchical cluster analysis complements the principal component analysis; whereas principal component analysis evaluates the underlying structure of the data in its entirety, cluster analysis is an observation-level approach examining each observation's characteristics relative to every other observations' characteristics. I describe each of these multivariate methods in turn.

The objective of principle component analysis (PCA) is to reduce p continuous variables to a set of uncorrelated variables j , known as principal components. Principal components can be thought of as latent characteristics or indices. The utility of principal component analysis, considered a data reduction technique, is that an underlying structure of the data is revealed such that the similarities and differences between variables and their general directionality are observable. Principal component analysis may be used, for instance, to distill a large number of survey responses into a few principal components that represent patterns across survey respondents. Imagine, for instance, a researcher administering a school-wide assessment to children that generates for each child 25 different personality measurements (such as scores on a zero-to-ten range for emotional stability, sensitivity, independence, etc.). The researcher could use principal component analysis to generate two (or more) principal components that would explain

much more of the variation in the data than would any single pair of the 25 different personality measures. One principal component might capture variation across 11 of the personality measures such that the researcher infers the component represented an introvert-extrovert continuum. A second component reflecting substantial variation across eight other personality measures might capture a separate dimension (known as being “orthogonal” to the first, a term I explain below) the researcher observes to correspond along a range of cognitive styles with concrete thinking at one end and an inclination toward abstraction at the other. The researcher in this example is left with two principal components that explain meaningful variation across 19 of the personality measures and six remaining personality measures that do not fall into any meaningful pattern.

This example illustrates that a principal component represents the proportion of the total variance explained by the singular component such that the allocation of variance across all components j is orthogonal and proportionately decreases with the addition of each component. This means a PCA’s first principal component, j_1 , is typically correlated with a majority of variables p while the second principal component j_2 captures the correlations orthogonal to those in j_1 . Another way to consider principal components is that j_1 is a measure of the most common correlations among p variables; j_2 is subsequently a measure of the second-most common correlations among p variables that are simultaneously the most *unrelated* (i.e. orthogonal) to those characteristics captured in the first component, j_1 (Afifi, May, & Clark, 2011).

The variance of principal component j is synonymous with eigenvalue λ_j derived from the data set’s covariance matrix of p variables. That is, let \mathbf{X} represent a data set with n observations and p variables, \mathbf{S}_x represent the covariance matrix that quantifies the correlations between all possible pairs of p variables, \mathbf{S}_y represent an optimized version of \mathbf{S}_x such that the off-diagonal terms in \mathbf{S}_y are zero, and \mathbf{Y} represent the optimized matrix of values from which \mathbf{S}_y is derived. A

PCA algorithm calculates an orthonormal matrix \mathbf{P} where $\mathbf{Y} = \mathbf{P}\mathbf{X}$ such that \mathbf{S}_y (the optimized version of \mathbf{S}_x) is diagonalized.¹⁰ The rows of \mathbf{P} , then, become the principal components of \mathbf{X} .

Turning next to a complementary exploratory multivariate approach, I use nonhierarchical cluster analysis to isolate patterns of postsecondary application behavior across observed college application choice set characteristics. Nonhierarchical cluster analysis is appropriate because the approach is “essentially about discovering groups in data” (Everitt, Landau, Leese, & Stahl, 2011, p. 7). The use of non-hierarchical cluster analysis in higher education research is relatively uncommon (see Tierney, 1983, and Pike & Kuh, 2005, as two of the few published examples) although Huberty, Jordan, and Brandt (2005) make a strong case for its application in the discipline.¹¹ Cluster analysis is, however, broadly applied in market research where the technique is known as “market segmentation” (Churchill & Iacobucci, 2010, p. 506). Market segmentation comprises: 1) examining a set of consumer behaviors, 2) using cluster analysis to group consumers by similar behavioral characteristics, and 3) targeting marketing strategies to subgroups based on their shared characteristics. Translating this market segmentation approach to my study, I cluster application choice sets, defined as the colleges to which the individual applies, because they are the relevant observable “consumer” behavior for each student in the data. With students grouped by their application behavior, I contend that policy interventions can be more narrowly tailored both in targeting and in developing expectations for realistic policy outcomes.

¹⁰ Specifically, \mathbf{S}_y is exactly equal to $\frac{1}{n-1}\mathbf{Y}\mathbf{Y}^T$ which consequently serves as the basis for calculating the vector of eigenvalues that are equal to variances of \mathbf{P} 's rows.

¹¹ Hierarchical cluster analysis, on the other hand, is more common (e.g. Blume & Zumeta, 2014; Meyers, Gornick, & Peck, 2000; Zumeta, 1996)

The non-hierarchical cluster algorithm I use, partitioning around medoids¹² (PAM) (Kaufman & Rousseeuw, 2009), begins with a dissimilarity matrix created from a $n \times p$ data set where n equals the number of application choice sets and p represents the number of characteristics; in this case the initial matrix of 11,283 observations by 7 characteristics (in the data discussed below) generates a dissimilarity matrix with its lower triangle containing 127,294,806 dissimilarity calculations.

The PAM algorithm also depends on the analyst setting a parameter for a range of k centrally-located observations that serve as initial medoids. The algorithm proceeds by looping through the dissimilarity matrix to assign every observation to its most similar medoid. The algorithm then seeks to find a local minimum for the objective function:

$$F(x) = \text{minimize} \sum_{i=1}^n \sum_{j=1}^n dist(i,j)$$

where $dist(i,j)$ is the distance between within-cluster observation i and outside-cluster observation j . Once the objective function is minimized, each application choice set is assigned to a cluster of similar sets thus yielding k clusters that, in this case, are interpretable as k types of distinct postsecondary application behavior. An optimal k is determined by a range of silhouette coefficients (Kaufman & Rousseeuw, 2009) which return goodness-of-fit measures for each of k centrally-located observations that served as initial medoids.

¹² A medoid is an actual observation within the data that lies at the center of a given cluster. This is compared to other cluster algorithms such as k-means clustering, where the center of the cluster is a mean value, not actually an observation taken from the data.

Two complementary features of PCA and cluster analysis, both related to data visualization, make these approaches particularly useful relative to this chapter's research questions. First, PCA and cluster analysis combine to provide insightful data visualization techniques of which neither approach is capable on its own. Non-hierarchical cluster analysis, for example, lacks a space in which clusters based on p dimensions can be plotted; PCA, on the other hand, generates principal components that are easily conceptualized as the x-axis and y-axis space in which clusters can be portrayed but PCA in and of itself does not provide a means to group observations by type.¹³ Second, the use of both PCA and cluster analysis allow for triangulated findings across the two methods (Chang, 1983; Everitt, 1994). Since PCA reveals the data's underlying correlational structure but also facilitates observation-level calculations of how application choice sets array across principal components, the visualization of these data allow for a confirmatory analysis of a cluster's structure relative to the variance explained by a particular principal component.

2.4 DATA

This study relies on two data sets from the U.S. Department of Education's National Center for Education Statistics. The primary data set is the Education Longitudinal Study of 2002, ELS:2002. I also rely on the Integrated Postsecondary Education Data System (IPEDS), a nationwide annual survey of all postsecondary institutions, from 2003-2004. The construction of

¹³ I explain how clusters are visualized relative to principal components in the findings section that follows. The technique of visualizing clusters across principal components, first proposed by Jolliffe et al. (1980) is a particularly common data exploration practice for high-dimensional data such as biostatistical gene expression (e.g. Yeung & Ruzzo, 2011).

the application choice set, a key variable on which this study depends, is made possible by the ELS:2002 variable, F2IORDER, which captures each postsecondary institution to which a student applied, was admitted, and if she enrolled. F2IORDER, therefore, provides the foundation to create an application choice set for a nationally representative sample of students who applied to at least one postsecondary institution during their senior year of high school in 2004. Since past and present NCES data sets (e.g. the National Education Longitudinal Study of 1988, NELS:88, and the High School Longitudinal Study of 2009, HSLs:09) do not contain this variable which captures all colleges to which a student applied, this study exploits a rare opportunity to empirically inform how we understand the nuances and complexities of postsecondary application behavior in the United States.

I construct the application choice set – that is, all postsecondary institutions to which a student submits applications – by creating a vector of institutional characteristics for each college to which the student applies. I take a count of the colleges in the application choice set (based on research suggesting that the number of colleges to which a student applies increases the probability of enrollment; see Smith, 2013) plus measures of the following institutional characteristics for each postsecondary institution:

1. An indicator to represent an “in-state” public postsecondary institution, i.e. a public college or university located in the student’s state of residence, recognizing that location, price, and the familiarity of a nearby public institution may be a powerful draw for applicants (e.g. Perez & McDonough, 2008; Perna & Titus, 2004; Dillon & Smith, 2013).

2. Distance between the student's home and the college, based on evidence that students have a preference to attend colleges closer to home (e.g. Hoyt & Brown, 2003; Long, 2004b; Sax et al., 2004);

3. A college's admit rate, as a proxy measure for prestige, assuming that institutional prestige matters to students in selecting colleges to which they will apply and attend (e.g. Avery, 2010; Hoyt & Brown, 2003; Sax et al., 2004; Tierney, 1983);

4. The price of tuition and fees, assuming in-state pricing for all students in a state and out-of-state pricing for public colleges and universities in all other states, acknowledging that students consider tuition price as a central factor in their college choice (e.g. Avery & Kane, 2004; Hoyt & Brown, 2003; McDuff, 2007; Sax et al., 2004, St. John & Asker, 2011).

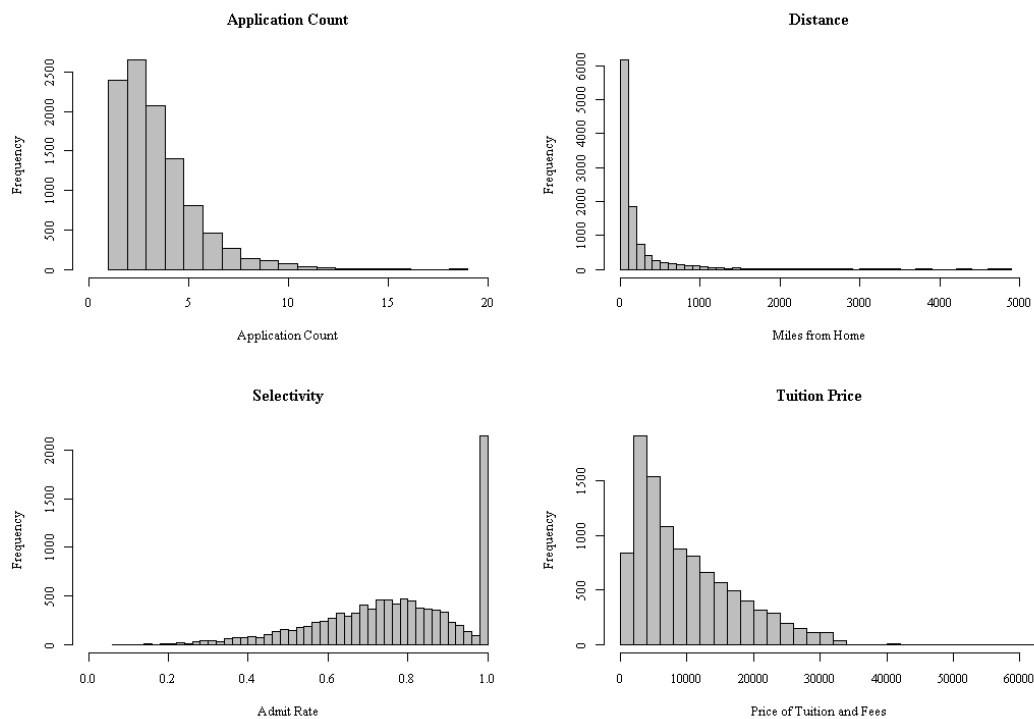
The inclusion of these characteristics of the student's application choice set are based not only on the relevant literature but also on survey responses published by Sax and colleagues (2004) about what institutional characteristics matter most to college freshmen when they make their postsecondary enrollment choice. I measure each of these institutional characteristics by capturing both the mean of the institutional characteristic and the magnitude of the characteristic's variation. The measure of magnitude, which I define as the spread between the highest and the lowest value, is zero in cases where a student applies to only one college. Table 2-1 contains a description of characteristics across all application choice sets.

TABLE 2-1: DESCRIPTIVE CHARACTERISTICS OF APPLICATION CHOICE SETS
(n=11,283)

	Mean (sd)	Median	Min	Max
Count	3.05 (2.02)	3	1	19
Admit Rate	76.4% (18.5%)	77.7%	7.4%	100%
Distance (miles)	193.5 (362)	73.5	0	4,890
Tuition (2004 dollars)	9,843 (7,465)	7,630	0	62,500

The distribution of these characteristics is also worthwhile to consider. when the mean values for the four characteristics are visualized for all application choice sets it becomes clear that many students in the United States, at least in 2004, were not caught up in “college application hysteria” (Poch, 2004) but rather applied to two or three colleges, applied to colleges close to home, applied to colleges that were largely nonselective, and applied to colleges that had a range of tuition prices (Figure 2-1).

FIGURE 2-1: DISTRIBUTIONS OF MEAN CHARACTERISTICS OF APPLICATION CHOICE SETS
(n = 11,283)



Given the important role that tuition price and federal, state, and institutional financial aid play in a student's college choice (Dynarski, 2000), using a college or university's published price for tuition and fees could be construed as an incomplete measure of the actual costs a student would face at any particular institution. Recall, however, that the unit of analysis here is based on the submission of college applications, which occurs before students have access to financial aid information. As Dynarski and Scott-Clayton (2008) and others have noted, students in the United States from all backgrounds but especially those from financially disadvantaged families face a challenge in that they submit college applications before knowing what financial aid is available to them. For this reason, the tuition measures are based on tuition "sticker price" because this is the most realistic information students would have available at the time of application submission.

The data for this study are assembled across ELS:2002 and IPEDS using the following protocol for each student who submitted at least one college application:

1. I create a vector of colleges for each student's application choice set using F2IORDER and an accompanying vector of distances (in miles) between the student and each college to which she applied using the centroid of the student's home ZIP code (or high school ZIP code if home ZIP code is missing) and the centroid of each college's ZIP code (from IPEDS);
2. For all colleges in each application choice set vector, I calculate and store in a student-specific matrix the pertinent institutional characteristics (public institution indicator, admit rate, distance, and tuition price) using IPEDS data and home-to-college distances;
3. I then create the vector of application choice set characteristics by looping through this student-specific matrix to record the proportion of public institutions, the mean of the three institutional characteristic (admit rate, price, and distance) and the magnitude of each characteristic's variation (i.e. the maximum value minus the minimum value).

Finally, I assemble an $n \times p$ matrix with these student-level vectors which I then use for the PCA.

This matrix is also used to generate the corresponding dissimilarity matrix for the cluster analysis.

2.5 RESULTS

2.5.1 *Principal component analysis*

The magnitude of the dissimilarity matrix which undergirds the cluster analysis is too large to interpret but correlations provide an accessible means to examine relationships between the variables on which the principal component analysis and cluster analysis are carried out (Figure 2-2).

FIGURE 2-2: CORRELATION MATRIX FOR APPLICATION BEHAVIOR CHARACTERISTICS

	Count						
Average No. of Publics	-0.34						
Mean Admit Rate	-0.52	0.38					
Admit Rate Spread	0.7	-0.25	-0.53				
Mean Distance	0.26	-0.44	-0.27	0.21			
Distance Spread	0.5	-0.33	-0.34	0.4	0.65		
Mean Price	0.48	-0.81	-0.59	0.35	0.38	0.37	
Price Spread	0.67	-0.45	-0.47	0.6	0.25	0.47	0.59

Figure 2-2 illustrates, for example, mean admit rate's negative correlation with all other variables in the cluster analysis. This negative relationship warrants careful consideration because of an admit rate's inverse relationship to institutional selectivity; a lower admit rate means higher selectivity. In other words, the relatively negative correlation between mean admit rate and mean tuition price (-0.56) is to be expected since admit rates heading toward lower values (i.e. more selective institutions) would be expected to correspond with tuition prices heading toward higher

values. The color scheme in Figure 2-2 is helpful to illustrate the fact that mean admit rate is negatively correlated with all other application choice set characteristics except the average number of public institutions in the choice set. Moreover, the pattern of positive correlations between distance and price is easily observed, reflecting an intuitive correlation between students applying to universities that are both farther from home and more expensive.

The principal components in Table 2-2 illustrate that the first component, with eigenvalue λ equal to 4.18, explains 52% of the variance in the data; the second component explains an additional 15% of variance orthogonal to the first component. Orthogonal to Components 1 and 2 is the 12.64% of the variance represented in Component 3. Principal component analyses typically include components with variance greater than 1.0 and components which cumulatively capture 75% or more of the variance in the data (Bartholomew et al., 2008). These guidelines support the use of Components 1, 2, and 3, which capture nearly 80% of the data's variance, as a multivariate tool to explore the patterns of how application choice sets vary.

TABLE 2-2: VARIANCE EXPLAINED BY EACH COMPONENT

Component	Variance		
	λ_j Variance	Percent	Cumulative Percent
1	4.18	52.20	52.20
2	1.21	15.09	67.29
3	1.01	12.64	79.93
4	0.57	7.13	87.06
5	0.36	4.53	91.59
6	0.30	3.69	95.28
7	0.25	3.08	98.36
8	0.13	1.64	100.00

The interpretation of these three components requires an understanding of how application choice set characteristics vary across the components. This variation in a component, known as component loadings, across the application choice set characteristics is a rescaled correlation coefficient between each variable and component j . In Table 2-3, the loadings reveal that Component 1 separates the individual application choice sets with higher proportions of public universities and average higher admit rates from all other choice sets. Component 2, on the other hand, is positively correlated with the choice set's application count, the proportion of public institutions in the application choice set, and the spread (i.e. the variation's magnitude) of the admit rates and the tuition prices of postsecondary institutions in the application choice set. The magnitude of Component 2's loadings deserve attention as the loading for mean distance, 0.54, is twice that of any other positive loading for Component 2. This relatively large loading implies that while four application choice set characteristics are positively associated with Component 2, mean distance is a substantial factor in this particular component. Moreover, compare Component 2's substantial positive loading for mean distance to the positive loadings of Component 1, which are all relatively uniform ranging from 0.28 to 0.39. The similar magnitude of these six loadings for Component 1 suggests the component could be interpreted as a general index across these six characteristics (Bartholomew et al., 2008). Finally, distance, tuition price, and the proportion of public institutions in the application choice set are drivers behind Component 3. This component has a relatively large positive loading for the proportion of public institutions and the distance measures, coupled with a relatively large negative loading for average price. An application choice set with a high Component 3 therefore is likelier to contain more public institutions, farther from home, at relatively lower tuition prices.

TABLE 2-3: COMPONENT LOADINGS FOR FIRST THREE PRINCIPAL COMPONENTS

Application Choice Set Characteristic	Principal Component		
	a_{i1}	a_{i2}	a_{i3}
Count	0.39	-0.36	0.12
Proportion of Publics	-0.34	-0.42	0.43
Admit Rate, Mean	-0.35	0.12	0.19
Admit Rate, Spread	0.35	-0.48	0.15
Distance, Mean	0.28	0.54	0.44
Distance, Spread	0.33	0.21	0.58
Price, Mean	0.39	0.23	-0.45
Price, Spread	0.39	-0.22	-0.05
Proportion of Total Variance	52.2%	15.1%	12.6%

In sum, principal component analysis paints a broad picture of postsecondary application behavior in which an application choice sets with a lower proportion of public institutions and a lower average admit rate are distinct from the other application choice sets characteristics. Orthogonal to this pattern of application behavior, however, is the fact that application choice sets with more applications submitted are likely to have a higher proportion of publics and greater variation in price and institutional selectivity. Perpendicular to these two patterns, the principal component analysis also reveals an association with institutional price where the average tuition prices of an application choice set are negatively correlated with all other application choice set characteristics. Yet while of some interest, these broad patterns do not provide insight into distinct *types* of application behavior. To address this, I now turn to cluster analysis to further explore patterns in postsecondary application behavior.

2.5.2 Cluster analysis

Determining an optimal number of k clusters is a critical question in non-hierarchical clustering. Silhouette coefficients, often used with the partitioning-around-medoids approach (PAM), simultaneously consider intra- and inter-cluster distances to identify an optimal k (Kaufman & Rousseeuw, 2009). I considered silhouette values for cluster sets, ranging from two clusters to thirteen clusters, and identified six as the optimal number of clusters (coefficient = 0.467) given the data's structure.

Recall that a nonhierarchical cluster algorithm groups observations in a dataset such that objects within the same cluster are as similar as possible and simultaneously as different as possible from the objects in all other clusters. Given an optimal six clusters with all observations assigned to one of six clusters, the characteristics of the clusters can be analyzed based on the aggregate characteristics of the application choice sets within each cluster (Table 2-4).

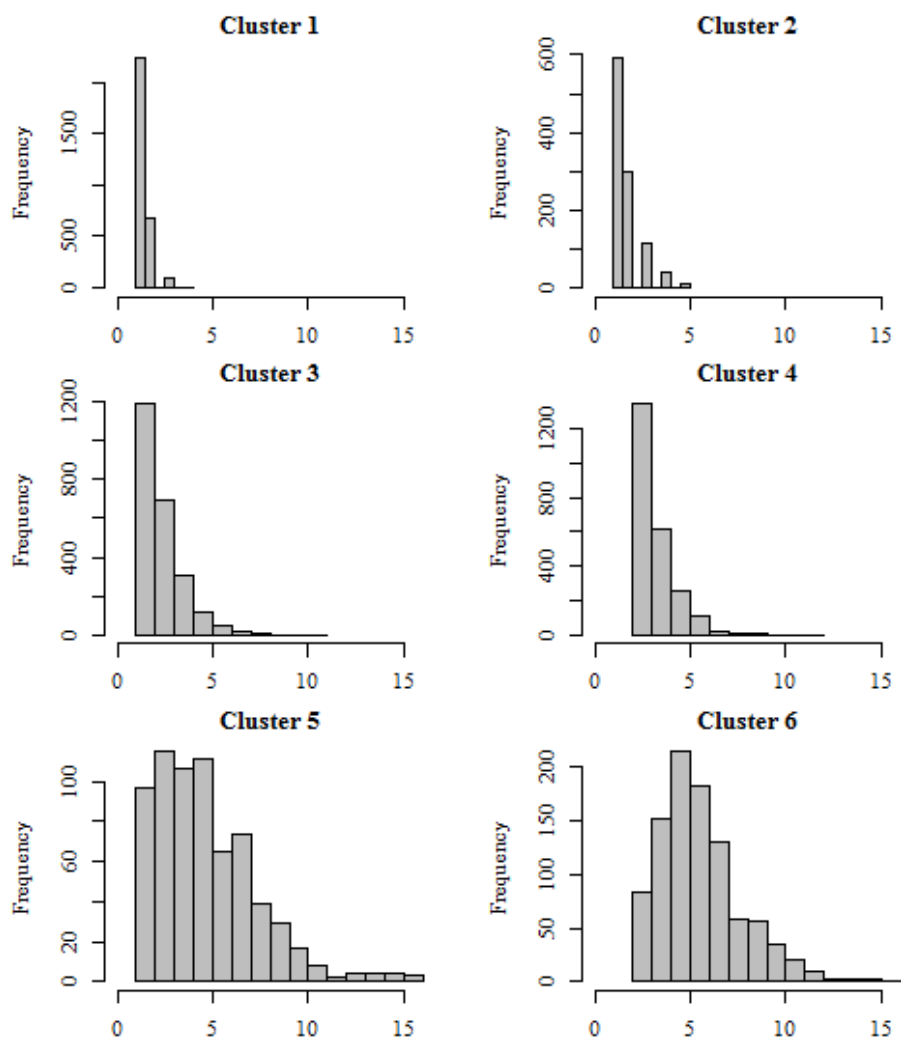
TABLE 2-4: CLUSTER CHARACTERISTICS

Cluster	% of sample	Within Cluster		Within-Cluster Admit Rate	Within-Cluster Spread	Within-Cluster Distance (miles)		Within-Cluster Price (2006)	
		Count	% Public			Mean	Spread	Mean	Spread
1	28.7	1.29	0.96	0.96	0.00	34.5	17.5	\$3,076	\$411
2	10.0	1.65	0.01	0.75	0.08	244.9	76.8	\$15,839	\$1,881
3	22.9	2.75	0.95	0.73	0.28	75.8	103.9	\$4,388	\$2,123
4	22.6	3.47	0.50	0.74	0.31	126.9	204.0	\$10,931	\$14,399
5	6.6	5.06	0.26	0.62	0.42	1,127.2	1,826.0	\$16,336	\$16,389
6	9.2	6.04	0.24	0.56	0.48	265.7	496.9	\$19,279	\$19,992

Examining similar clusters as pairs can help make sense of the significant amount of information in Table 2-4. For example, in terms only of number of application submitted, Cluster 1 and Cluster 2 can both be described as types of nominal application behavior i.e. students apply on average to one or two colleges. Yet the characteristics of the application choice sets diverge beyond the count. This difference is most stark in terms of the average proportion of public postsecondary institutions in each cluster; on average nearly all postsecondary institutions in Cluster 1 application choice sets are public (96%) while public institutions in Cluster 2 are very rare. Likewise, postsecondary institutions in Cluster 2 have average tuition prices that are \$12,763 higher than colleges in Cluster 1. Whereas students in Cluster 1 appear to overwhelmingly apply to colleges with open enrollment, students in Cluster 2 apply to a mix of colleges that are more varied along the selectivity spectrum and nearly all of them are nonpublic.

The distribution of a characteristic across each of the six clusters provides an alternative approach to analyze the extent to which the clusters, and thus application behavior, vary.

FIGURE 2-3: CHOICE SET'S AVERAGE APPLICATION COUNT ACROSS SIX CLUSTERS

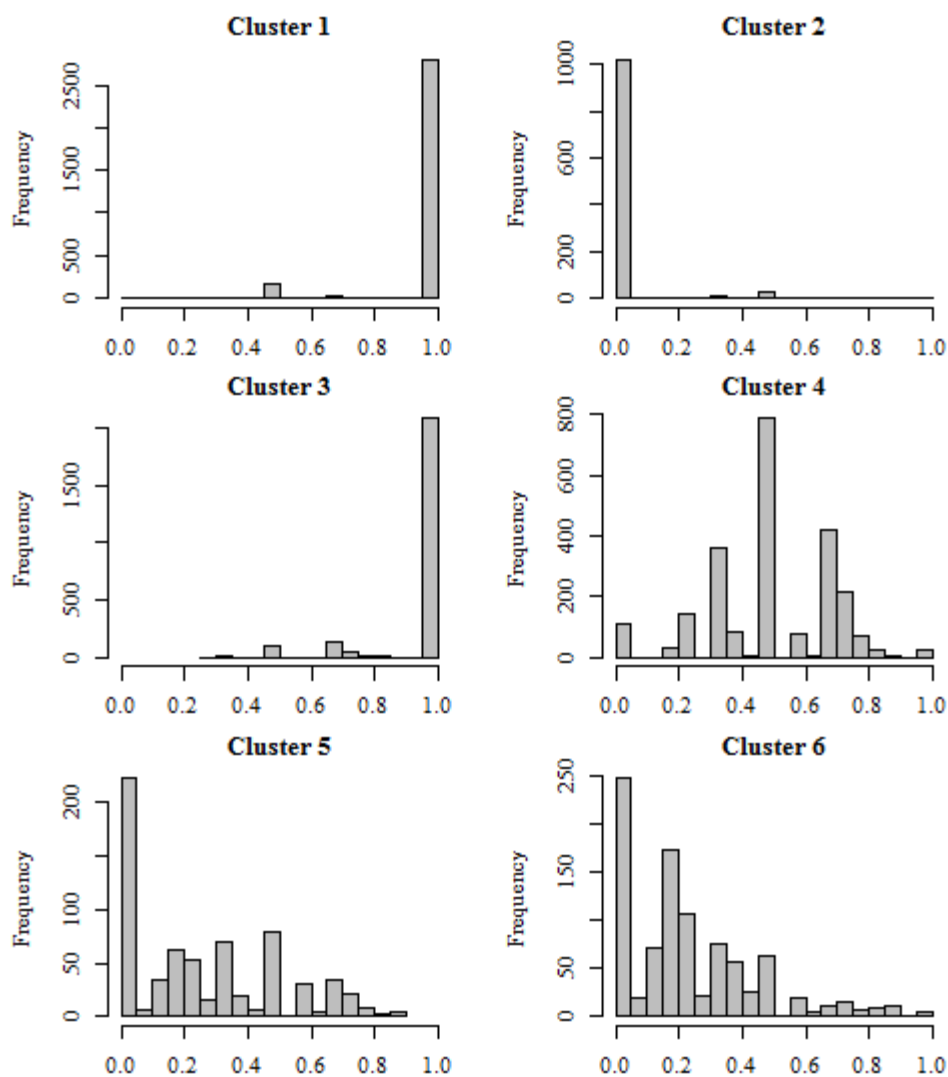


The count of applications in a given application choice set (Figure 2-3) demonstrates that Cluster 1 and Cluster 2 contain application choice sets with relatively few applications submitted whereas Cluster 5 and Cluster 6 contain a more normally-distributed number of applications submitted (mean counts are 5.06 and 6.04, respectively).

The average proportion of public institutions in each of the six clusters also varies widely (Figure 2-4). In Cluster 1 and Cluster 3 the proportion of public institutions is highly skewed toward 100% of the application choice set; alternatively, on average very few public institutions

comprise application choice sets in Cluster 2. Cluster 5 and Cluster 6 also contain application choice sets that are skewed toward fewer public institutions. Only Cluster 4 application choice sets contains a broad range of public and private postsecondary institutions.

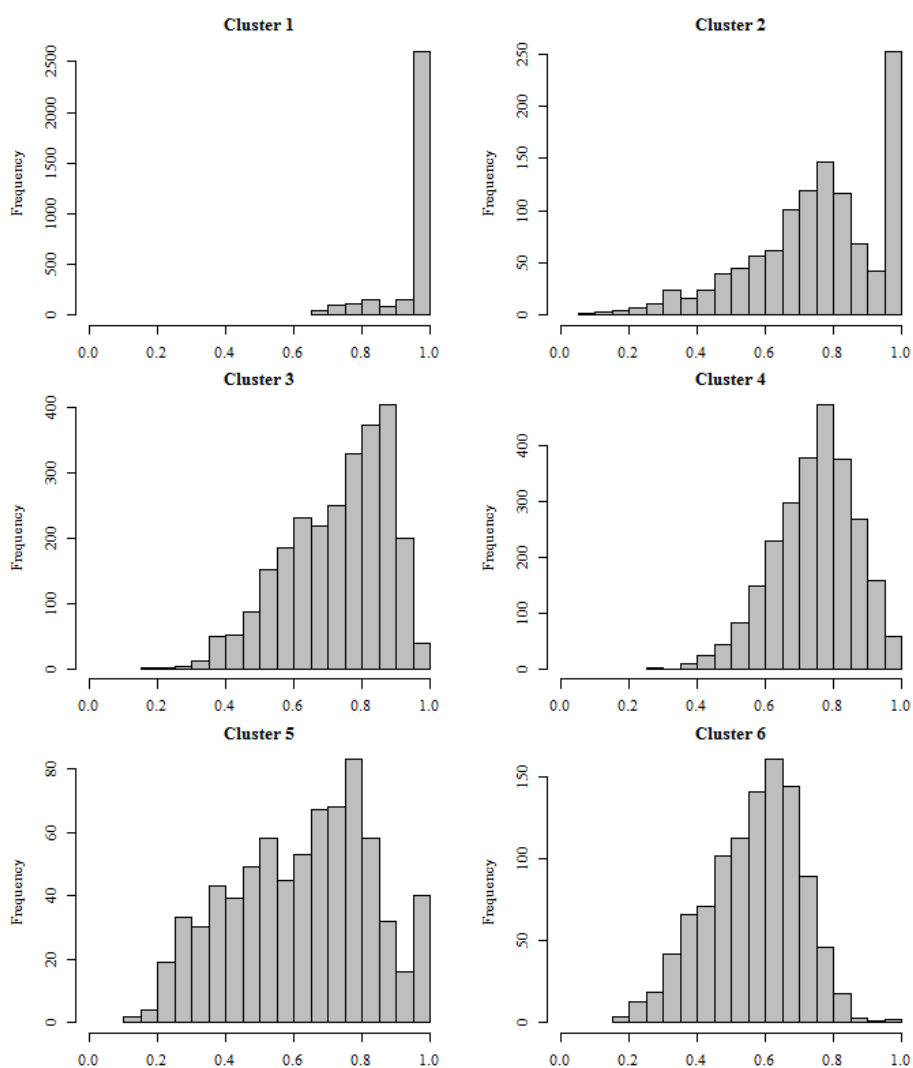
FIGURE 2-4: CHOICE SET'S PROPORTION OF PUBLIC INSTITUTIONS ACROSS SIX CLUSTERS



The within-cluster average admit rate across the six clusters varies as do the other application choice set characteristics but in Clusters 3, 4, 5, and 6 the within-cluster distribution of the admit rates appear to take the shape of a relatively normal distribution of values. To varying extents

Clusters 3, 4, 5, and 6 each contain application choice sets with mean admit rates ranging from the highly selective (e.g. <0.25) to nonselective. Cluster 1, dominated by application choice sets that contain all open admission institutions (i.e. those with a 100% admit rate), and Cluster 2, with its disproportionate number of open admission institutions, stand out compared to the other four clusters.

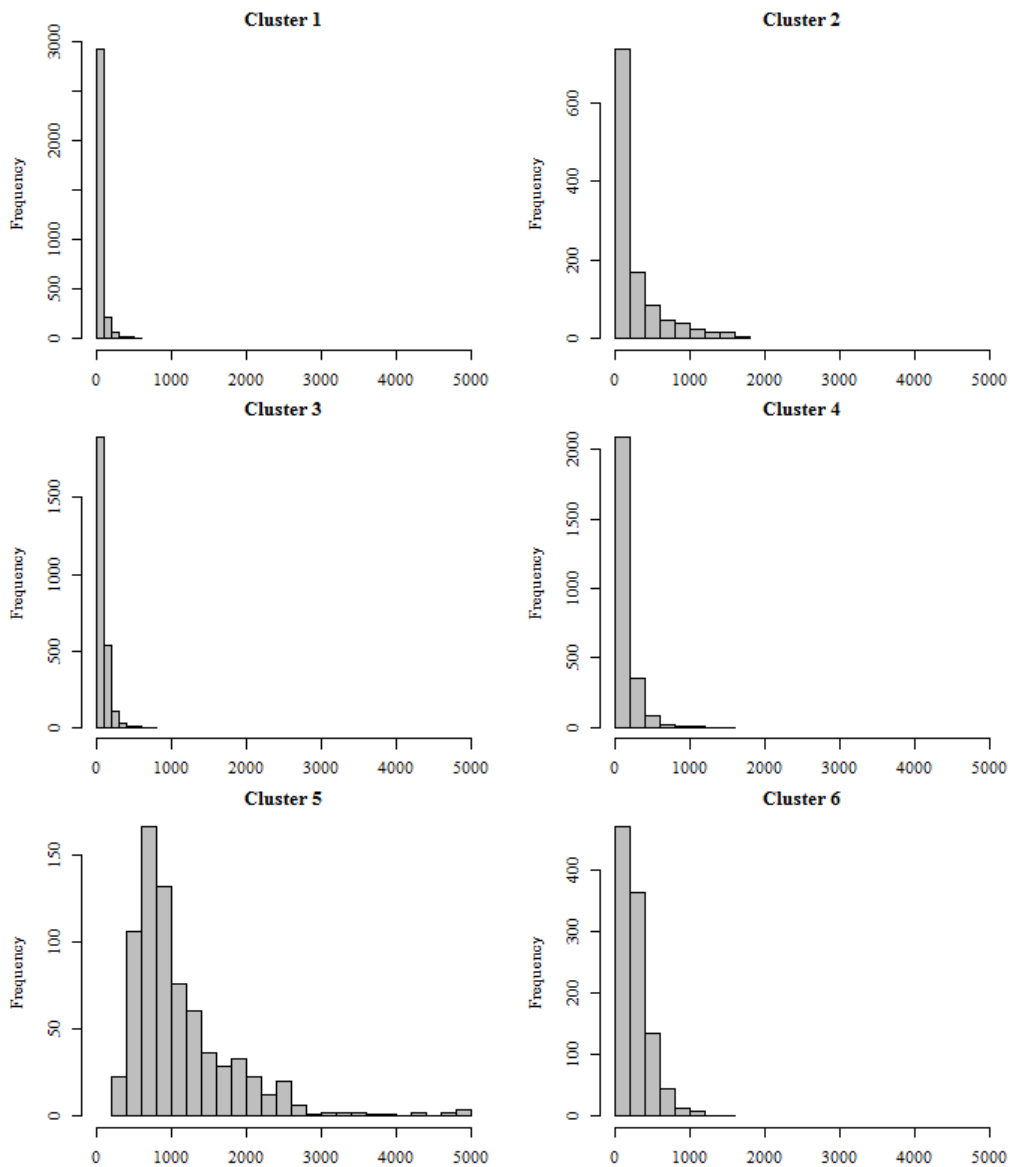
FIGURE 2-5: DISTRIBUTION OF MEAN ADMIT RATES ACROSS SIX CLUSTERS



As Blume and Long (2013) have noted (among others e.g. Hoyt & Brown, 2003; Long, 2004b; Sax et al., 2004), the distance between a student's home and the college to which she

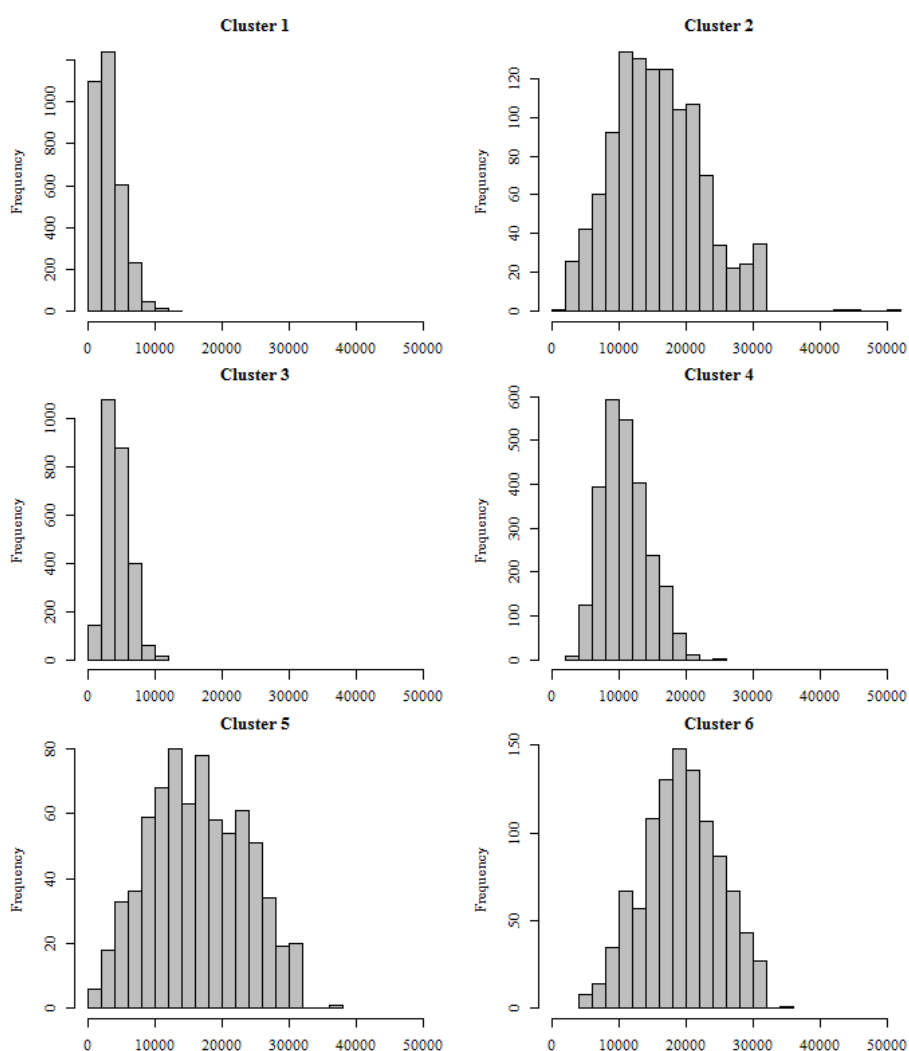
applies is a critical factor in making a postsecondary application choice. It is perhaps not surprising then that each of the six clusters contain application choice sets that are skewed toward distances closer to the student's home (Figure 2-6). Only Cluster 5 contains meaningful variation in distance, both in the sense of a more normally-distributed set of values and in that the tail extends toward extreme values.

FIGURE 2-6: DISTRIBUTION OF MEAN DISTANCE ACROSS SIX CLUSTERS



The distributions of average tuition price across the six clusters illustrates clear patterns with Cluster 1 and Cluster 3 compared to Clusters 2, 4, 5, and 6; Cluster 1 and Cluster 3 are skewed toward less expensive postsecondary institutions while the remaining clusters are more evenly distributed across a range of prices (Figure 2-7). The distributions for Clusters 2, 4, 5, and 6 across a range of average tuition prices accordingly correspond with higher within-cluster average tuition prices (\$15,839, \$10,931, \$16,336, and \$19,279, respectively).

FIGURE 2-7: DISTRIBUTION OF MEAN PRICE OF TUITION AND FEES ACROSS SIX CLUSTERS



These findings from the cluster analysis provide insight into how postsecondary application behavior varies significantly across high school students in the United States. Two patterns of postsecondary application behavior also emerge that complement the principal component analysis. First, the assignment of observations to clusters allows for insight into the prevalence of particular types of behavior. Cluster 1, for example, containing application choice sets in which students on average apply to one or two nonselective close-to-home public institutions, represents more than a quarter of the total sample while Cluster 5, representing application choice sets with an average of five applications submitted to predominately private, more selective institutions across the United States, represents less than 7% of the sample.

The second pattern among clusters that complements the principal component analysis relates specifically to the third principal component. Recall that relative to Components 1 and 2, the third principal component captures an orthogonal relationship among distance and tuition price relative to Component 1 and Component 2. A similar relationship also appears when comparing clusters that are observably similar (to varying extents) except on tuition price and the proportion of public institutions in the application choice set. Cluster 1 and Cluster 2, for example, vary substantially on tuition price and are at two extremes relative to the average proportion of public institutions in the application choice set, yet these clusters vary significantly less across the other application choice set characteristics. Similarly, Cluster 4's lower average proportion of public institutions and its substantially higher average tuition price make it observably distinct from Cluster 3. Ultimately, these observable within-cluster and across-cluster traits are quantified across the entire data set with the principal component analysis to suggest important relationships among application submission, institutional control, and tuition price.

2.6 VISUALIZING CLUSTERS ACROSS PRINCIPAL COMPONENTS

Principal component analysis and nonhierarchical cluster analysis integrate seamlessly in visualizing how application choice sets vary within and across components and clusters. In addition to the findings discussed above that are generated by these methods independent of each other, I use data visualization here as a key tool in understanding the patterns of postsecondary application behavior that are not readily observed using either principal component analysis or cluster analysis alone.

To visualize each application choice set, a “component score,” based on the components’ loadings, must first be calculated. Each application choice set’s component score, in turn, facilitates a visualization of the application choice set in component-based multidimensional space. I calculate each application choice set’s component score as follows. First, I standardize the principal component loadings such that standardized component loading $\tilde{a}_{ij} = a_{ij} / \sqrt{\lambda_j}$ where a_{ij} is the component loading for component j relative to application choice set characteristic i and λ_j is the eigenvalue for component j (Bartholomew et al., 2008). The first three columns of Table 2-5 contain these standardized loadings (which become “score coefficients”) for Components 1, 2, and 3. Table 2-5 also contains, for illustrative purposes, the eight standardized values x_i ¹⁴ for the characteristics of a hypothetical application choice set.¹⁵ Since I carry out the principal component analysis using eight characteristics of the application choice sets, component score $\tilde{y}_j = \tilde{a}_{1j}x_1 + \tilde{a}_{2j}x_2 + \dots + \tilde{a}_{8j}x_8$. Table 2-5 illustrates the mechanics of this calculation such that for the

¹⁴ Following Bartholomew et al.’s (2008) convention, in this case i indexes the eight application choice set variables e.g. x_1 is the standardized value of the count of applications submitted.

¹⁵ In particular, this application choice set would be expected to have few colleges in the application choice set (i.e. 1.3 fewer standard deviations) than average and fewer public institutions than average; conversely, the mean admit rate for the colleges in this application choice set would be much higher (2.6 s.d.) than average. Postsecondary institutions in this hypothetical application choice set would be expected to be farther away from home.

hypothetical application choice set in question, $\tilde{y}_1 = -0.07$, $\tilde{y}_2 = 1.57$, and $\tilde{y}_3 = 2.05$.¹⁶ These standardized component scores become the x, y, and z coordinates when plotting this observation.

TABLE 2-5: SCORE COEFFICIENTS AND HYPOTHETICAL STANDARDIZED COMPONENT SCORES

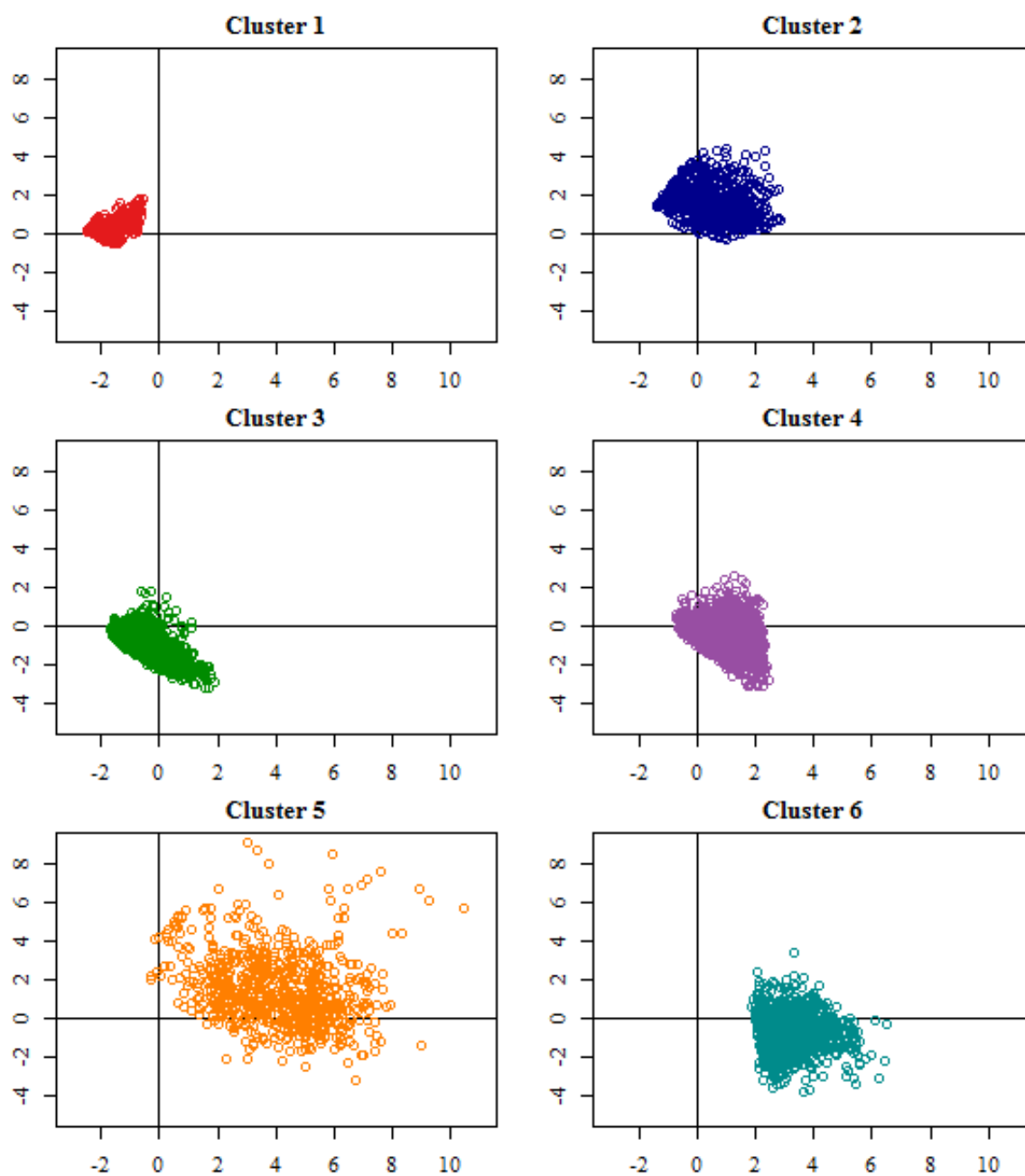
	Score Coefficients			Standardized Component Scores for Hypothetical Application Choice Set			
	\tilde{a}_{i1}	\tilde{a}_{i2}	\tilde{a}_{i3}	x_i	$\tilde{a}_{i1}x_i$	$\tilde{a}_{i2}x_i$	$\tilde{a}_{i3}x_i$
	Count	0.19	-0.33	0.12	-1.390	-0.26	0.46
Average No. of Publics	-0.17	-0.38	0.43	-0.629	0.11	0.24	-0.27
Admit Rate, Mean	-0.17	0.16	0.19	2.657	-0.45	0.43	0.50
Admit Rate, Spread	0.17	-0.44	0.15	1.980	0.34	-0.87	0.30
Distance, Mean	0.14	0.49	0.44	0.850	0.12	0.42	0.37
Distance, Spread	0.16	0.18	0.57	2.363	0.38	0.43	1.35
Price, Mean	0.19	0.22	-0.45	0.334	0.06	0.07	-0.15
Price, Spread	0.19	-0.20	-0.06	-1.925	-0.37	0.39	0.12

Once every application choice set has these x, y, and z coordinates based on \tilde{y}_1 , \tilde{y}_2 , and \tilde{y}_3 , I merge the standardized component scores with cluster assignment to link each cluster to its three-dimensional coordinates. I combine the standardized component scores with cluster assignments because without principal components, the visualization of clusters is only possible in two-dimensional space where the two axes must take on values of two of the eight application choice set characteristics and ostensibly represent in aggregate only approximately 25% of the variance (i.e. assuming each one of the eight variables represents an equal amount of variance, 12.5%, across the data). With principal components, on the other hand, arraying application choice sets by cluster with Component 1 and Component 2 serving as the x and y axes, respectively, an

¹⁶ In other words, \tilde{y}_1 is simply a sum of the $\tilde{a}_{i1}x_i$ column in Table 5.

observation can be plotted in a space that captures more than two-thirds (67.29%) of the variance. A three dimensional plot is also feasible, which would provide a space across Components 1, 2 and 3 that captures 79.9% of the variance in the data.

Visualizing each cluster of application choice sets in two-component space provides the means to examine the attributes of each cluster relative to Components 1 and 2 (Figure 2-8). Easily observed is that each cluster (except Cluster 5) is grouped relatively tightly, a relationship that is unsurprising considering these components reflect a significant amount of the data's variance and one would expect similar application choice sets as defined by their dissimilarity measures to have similar standardized component scores. Note that Cluster 1 and Cluster 6 reflect two extremes along Component 1; all Cluster 1 observations have a negative value for \tilde{y}_1 while all Cluster 6 observations have a positive value for \tilde{y}_1 .

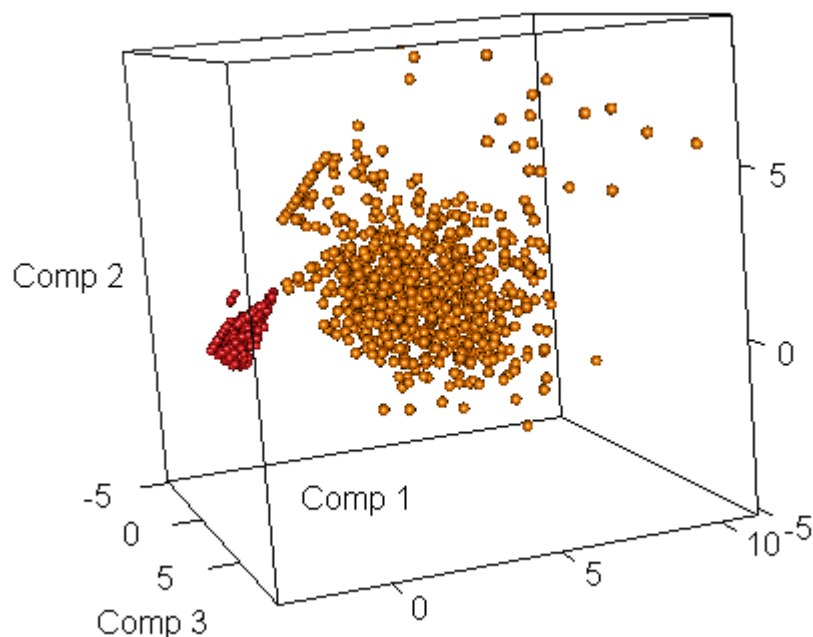
FIGURE 2-8: CLUSTERS ARRAYED ACROSS COMPONENT 1 AND COMPONENT 2¹⁷

¹⁷ A high value for Component 1 (the x-axis in these plots) reflects a modest, above average value across all the application choice set characteristics. An application choice set with a higher value on Component 1 would be expected to be larger in terms of application count, comprising postsecondary institutions with greater selectivity, higher tuition prices, and distances closer to home; a higher value for Component 2 (the y-axis) captures, on the other hand, smaller application choice sets with postsecondary institutions that are moderately selective, moderate tuition prices, and distances that are farther from home.

Given Component 1's loadings, this would suggest that nearly all application choice sets in Cluster 1 comprise public nonselective institutions, an observation substantiated by the characteristics of the clusters (Table 2-4). Cluster 6, alternatively, would be expected to contain application choice sets with higher values across all application choice set characteristics except the proportion of public institutions and the average admit rate (the obverse of selectivity) of institutions in the application choice set. This again is a supposition substantiated by within-cluster characteristics as application choice sets in Cluster 6 average a count of six applications with an average of only 26% of the postsecondary institutions being public. Turning to Component 2 and recalling both its disproportionately large loading on average distance (Table 2-3) and the distribution of mean distances across the six clusters (Figure 2-6), the relative compactness of all the clusters, save for Cluster 5, along the y-axis is intuitive given that in most cases students are more likely than not to apply to closer-to-home postsecondary institutions.

Clusters can also be plotted against both Component 1 and Component 3, although the relatively low variance explained by Component 3 (12.6%) reveals no additional patterns gained by this visualization (these plots appear in the appendix). Including Component 3 alongside Components 1 and 2, on the other hand, is useful to further compare and contrast clusters. Cluster 1 and Cluster 5 are portrayed in Figure 2-9 to demonstrate how the third component, which largely separates tuition price from all other application choice set characteristics, serves to further expand the heterogeneity of Cluster 5 but does little to differentiate Cluster 1.

FIGURE 2-9: CLUSTER 1 (RED) AND CLUSTER 5 (ORANGE) IN THREE-COMPONENT SPACE



This three-dimensional portrayal of Cluster 1 ($n=3,238$) and Cluster 5 ($n=739$) can be deceiving given that Cluster 5's dispersion and Cluster 5's compactness make Cluster 5 appear larger when in fact Cluster 1 contains four times as many application choice sets as Cluster 5.

Cluster 5, in fact, presents interesting insight into both the characteristics of application behavior and the cluster algorithm's underlying efficacy. Empirically, visualizing the clusters across Components 1, 2, and 3 illustrates that Cluster 5 is clearly the most heterogeneous of the six clusters. This heterogeneity, the within-cluster characteristics (e.g. average application choice sets comprising an average of five applications to relatively selective, expensive, far-from-home postsecondary institutions), plus the fact that it represents the smallest proportion of the sample across the six clusters, makes Cluster 5 noteworthy given the preponderance of attention paid to students who demonstrate this type of application behavior (e.g. Avery, 2010; Avery & Levin, 2009; Bowen & Bok, 1998; Espenshade & Radford, 2009; Griffith & Rothstein, 2009; Hill & Winston, 2010; Hoxby & Turner, 2013; Hurwitz, 2011; Wechsler, 2014).

In a technical sense, Cluster 5 also demonstrates the effectiveness of the partitioning-around-medoids algorithm because the smallest cluster is the cluster with the greatest within-cluster heterogeneity, an indicator in cluster analyses that the underlying structure of the data was amenable to clustering (Everitt, 1994; Leisch, 2008). Given an optimal k of six clusters in this case, Figure 2-8 visually represents how the cluster algorithm assigned each observation in the data to one of five clusters (i.e. Clusters 1, 2, 3, 4, and 6) with Cluster 5 serving as the remaining cluster for application choice set with dissimilarity measures farthest from the more homogenous characteristics of the five other clusters.

2.7 DISCUSSION AND IMPLICATIONS

Postsecondary application behavior in the United States is complex. Students have a wide range of motivations for applying to particular colleges. Diverse sources of information, perceived financial returns to a degree, complex personal considerations, and a host of other factors all affect the process through which students aspire, search, apply, and enroll in postsecondary education (Hossler, Braxton, & Coopersmith, 1989; Long, 2004a; Long, 2007; Perna, 2000).

This study is the first attempt to look exclusively at patterns in students' application behavior *in aggregate* as the focal point of the research. By focusing exclusively on the observable characteristics of the application behavior and thus setting aside a student's motivations, sources of information, background demographics, and academic attributes, this study uses principal component analysis and nonhierarchical cluster analysis in a manner similar to the way a consumer behavior researcher would develop a typology of consumers for a product or brand. The utility of such an approach is that the exploratory findings generated here provide fertile ground for

generating hypotheses and challenging conventional assumptions about individual-level behaviors (Mooi & Sarstedt, 2011).

This study's findings demonstrate that postsecondary application behavior does not fall into easily-defined categories. The principal component analysis, which reveals broad underlying patterns in the application data, and the six clusters, analogous to six distinct types of application behavior, converge to suggest there is no single archetypal postsecondary application behavior in the United States. For instance, clusters could be categorized by the count of applications submitted. This would mean Cluster 1 and Cluster 2 represent a type of behavior typified by the submission of one or two applications; Cluster 3 and Cluster 4 capture the behavior of those submitting two to four applications, and Cluster 5 and Cluster 6 represent the submission of five or more applications. But as we consider *all* the behavioral traits of Cluster 1 and Cluster 2, the application behaviors these clusters reveal are decidedly distinct from one another: application behavior represented by Cluster 2 tends to involve applications submitted to private postsecondary institutions that have a tuition sticker price more than five times that of the institutions in Cluster 1 application choice sets. Relative to Cluster 1, the application behavior of Cluster 2 also leads to applications being submitted to institutions much farther from the student's home. Therefore, given these salient differences, it is difficult to say that Cluster 1 and Cluster 2 together represent a higher-level "type" of application behavior because their application counts are similar. A similar divergence is observable for the other clusters grouped together based on an average count of application submitted; in each case, substantial differences across selectivity, distance, and price make the application count an inadequate criterion on which to group application behaviors.

Identifying patterns based on other application choice set characteristics is also possible but still fails to present a unifying, higher-level typology of behaviors. One could argue, for

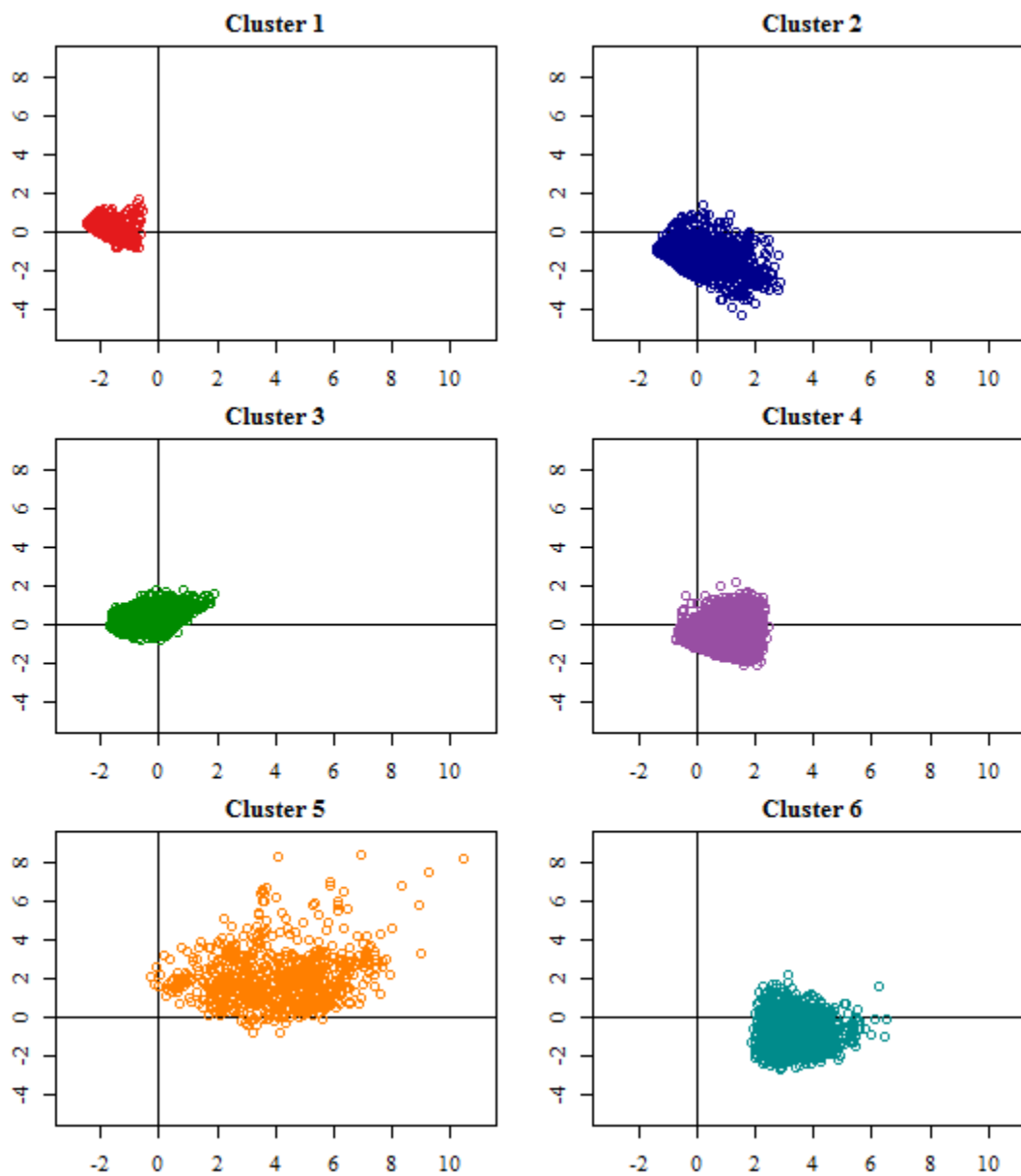
instance, that grouping clusters by within-cluster average tuition price leaves the application behaviors of Clusters 2, 4, 5, and 6 distinct from Cluster 1 and Cluster 3. A supposition about the similarities between Clusters 1 and 3 is reinforced by the fact that both types of application behaviors captured by the clusters involve the submission of applications to predominately public, moderately-selective to open enrollment, relatively close-to-home postsecondary institutions. Cluster 3's behavior appears more varied given the wider spread for each of the application choice set characteristics but this wider variation is expected given the average count of applications submitted in Cluster 3 hovers near three.

On the other hand, using an average within-cluster tuition price as a grouping criterion does not reveal as clear of patterns among Clusters 2, 4, 5, and 6 as with Cluster 1 and Cluster 3. Cluster 2 and Cluster 4 vary substantially on the proportion of public institutions in the application choice set with Cluster 2 representing application behavior solely involving private institutions and Cluster 4 representing application behavior split evenly between publics and privates. Cluster 4's even split between publics and privates, in turn, is the likely reason why Cluster 4 behavior relative to Cluster 2 involves less costly, closer-to-home institutions. Likewise, Cluster 5 and Cluster 6 are observably comparable save for the fact that Cluster 5 captures the submission of applications to far-from-home institutions.

In the end, two factors are likely tied to the distinctness of the application behaviors identified in this study. First, these findings suggest the nonhierarchical cluster analysis efficiently grouped application choice sets in a manner that minimized within-cluster dissimilarity and maximized cross-cluster variation. An inability to identify distinct patterns across behaviors is, in fact, a positive outcome of the cluster algorithm. The second factor likely driving these substantial differences in application behavior types is the earlier-stated point that at first glance seems banal:

Postsecondary application behavior is complex. Yet until this study, no research has empirically explored the interconnected complexity of postsecondary application behavior as defined by the application choice sets of a recent, nationally representative and large sample of students. Returning to this chapter's research question of how postsecondary application behavior varies across American high school students, the answer is that application behavior varies substantially by the number of applications submitted, whether the institutions applied to are public or private, and their selectivity, price, and distance from home. Several identifiable combinations of these characteristics were empirically derived and they appear plausible and comprehensible. Beyond that claim, this study demonstrates that few other pithy descriptions suffice to explain the complexity of postsecondary application behavior in the United States.

2.8 APPENDIX

FIGURE 2-10: CLUSTERS ARRAYED ACROSS COMPONENT 1 AND COMPONENT 3¹⁸

¹⁸ As noted previously, an application choice set with a higher value on Component 1 would be expected to be larger in terms of application count, comprising postsecondary institutions with greater selectivity, higher tuition prices, and distances closer to home. Application choice sets with high values on Component 3 (y-axis) would be likely to be disproportionately smaller, contain public postsecondary institutions that have much lower prices on average, and be relatively farther from home.

Chapter 3. TO ENROLL YOU MUST APPLY: HOW DO DISTINCT TYPES OF APPLICATION BEHAVIOR PREDICT ENROLLMENT?

Abstract

This chapter explores three questions that extend the previous chapter's multivariate classification of application behavior types. First, how do students' demographic and academic characteristics vary across application behavior types? Second, to what extent does an individual's background characteristics, specifically race and socioeconomic background, predict her likelihood of demonstrating a particular type of application behavior? Finally, how do different types of application behavior predict enrollment choice? I find that demographic and academic characteristics vary meaningfully across types of application behavior and also strongly predict certain types of application behavior. Application behavior, in turn, predicts postsecondary enrollment choices although socioeconomic status is also a significant predictor. I discuss the implications of such findings relative to public policy, especially in light of recent behavioral interventions that target the postsecondary application behavior of certain subpopulations of college-bound students.

3.1 INTRODUCTION

Postsecondary choice making has captured the attention of policymakers and researchers since at least the 1970s (Manski & Wise, 1983; Kinzie et al., 2004). A focus on postsecondary enrollment, and the public policy designed around increasing postsecondary access, has been framed around economic benefits and increased social mobility for the individual earning the degree (Daly & Bengali, 2014; Baum, Ma, & Payea, 2013) and the social benefits gained from increased rates of postsecondary degree attainment in the population (Bowen, Chingos, & McPherson, 2009; Dee, 2004). As with public K-12 education in the United States, policymakers and scholars also argue that broad access to postsecondary education is a matter of social equity (e.g. Bok & Kurzweil, 2006; Bowen & Bok, 1998).

An emphasis on postsecondary application behavior (and other choices that precede the enrollment choice) in more recent years has emerged as both a subfield for researchers interested in postsecondary enrollment (Klasik, 2013) and as a target for interventions that seek to “nudge” students toward enrollment at more selective institutions than they might otherwise choose (Hurwitz et al., 2016; Hoxby & Turner, 2013). This growing interest in postsecondary application behavior continues to evolve as researchers describe the characteristics of postsecondary application behavior (Holland, 2014) and how application behaviors relate to enrollment choice (Hoxby & Turner, 2013; Smith, 2013).¹⁹ This chapter builds on the previous chapter, which set out to develop an ecological understanding of postsecondary application behavior in the United States. Based on the findings in that chapter, I examine three exploratory research questions:

¹⁹ The extent to which students apply to postsecondary institutions matching their academic ability (Smith, Pender, & Howell, 2013) is an additional area of postsecondary application behavior garnering interest from scholars but beyond the scope of this dissertation’s research questions.

- 1) How do students' characteristics vary across application behavior types?
- 2) To what extent does an individual's background characteristics (race/ethnicity and socioeconomic background) predict her likelihood of demonstrating a particular type of application behavior?
- 3) How do different types of application behavior predict enrollment choice?

This chapter makes an empirical contribution to the extant literature on postsecondary application behavior and also provides theoretical insight on policy efforts designed to target application behavior. Empirically, this chapter connects my earlier work on the classification of application behavior to models that predict enrollment outcomes based on such classifications. Exploring these predictive relationships between types of application behavior and enrollment outcomes reveals the *implications* of application behavior. These implications, in turn, shed light on the underlying patterns of postsecondary application behavior increasingly targeted by policy interventions. I illustrate in this chapter how exploring postsecondary application behavior, especially with socioeconomics and demographics in mind, as a juncture in the broader processes through which individuals pursue postsecondary education can potentially inform policy interventions that target a broad range of students choosing to attend a diverse range of postsecondary institutions.

3.2 BACKGROUND

In her summary of extant college application research spanning sociology, economics, and public policy, Holland (2014) notes that the question, “How do *different* approaches to the application process affect [college] enrollment?” deserves to be a focus of future research on postsecondary access (p. 1200, emphasis added). Holland (2014) goes on to observe that while no single study has developed a model of postsecondary application behavior in the United States *per se*, a growing body of research emphasizes the application step as one along a sequential pathway of choices that lead to postsecondary enrollment.

Smith (2013) observes that scholarly research on an individual’s pursuit of postsecondary education typically takes on one of two themes, which he calls the “determinants of college applications” and the “determinants of college enrollments” (p. 154). “Determinants,” in this sense, are the predictors (or independent variables) in a model with application submission or postsecondary enrollment as the outcome (or dependent variable).

Determinants of application behavior include such factors as affirmative action policies (Long, 2004b), tuition prices (McDuff, 2007), and a student’s demographic and academic background (DesJardins et al., 1999). The determinants of enrollment likewise include affirmative action (Long, 2004b) and demographics (Black & Sufi, 2002) but also such factors as access to financial aid (Fuller, Manski, & Wise, 1982; Van der Klaauw, 2002, among many others, as cited in Smith, 2013). Given this divide between research on applications or enrollments, Smith (2013) notes that his study is the first to examine how one particular aspect of an application choice set, that is, the number of applications submitted, affects enrollment rates. Smith (2013) finds that submitting an additional application increases the probability of enrolling at a four-year institution but this effect is greatest “for those applying to very few colleges” (p. 181). Somewhat similar to

Smith's (2013) analysis of a single characteristic of application behavior as a determinant of enrollment, I use a multidimensional description of postsecondary application behavior in this chapter to explore the extent to which distinct types of application behavior are, in and of themselves, determinants of enrollment.²⁰

Klasik's (2012) analysis of a nine-step process that traces four-year postsecondary enrollment from 10th grade bachelor's degree aspirations to enrollment at a four-year postsecondary institution is a complementary example of research that examines the sequential pathway through which students pursue postsecondary education and the significance that application behavior represents in this process. By modeling sequential choice making in this manner, along a continuum of what he calls "steps," Klasik (2012) finds noteworthy relationships among race and the likelihood of accomplishing subsequent application and enrollment steps; he finds that Black students, compared to White students, have a higher probability of application submission to a four-year postsecondary institution but a lower probability of postsecondary enrollment conditional on having applied (Klasik, 2012, p. 541). On the other hand, Klasik (2012) found that among Hispanic students and White students with the same level of bachelor-degree aspirations in the 12th grade, Hispanic students were "significantly less likely to apply to four-year colleges than their White peers" (p. 541).

In this chapter I focus on prediction: I analyze the student characteristics that *predict* the types of application behavior identified in the previous chapter, and I analyze the ways in which application behavior *predicts* postsecondary enrollment. In this manner I use postsecondary application behavior to incorporate both of Smith's (2013) "determinants of college applications" and the "determinants of college enrollments" into a single analysis focused on one

²⁰ I extend my thanks to Jonathan Smith for engaging in many helpful conversations on this topic of how application choice set characteristics may serve as determinants of enrollment.

particular step, as Klasik (2012) has modeled it, in a student's pursuit of postsecondary education.

3.3 METHODS

In the previous chapter I used nonhierarchical cluster analysis to identify six types of postsecondary application behavior. I distinguished these six types of application behavior by the characteristics of the postsecondary institutions to which students apply; at one end is a type of behavior where students submit only one or two applications to non-selective, low-tuition, close-to-home postsecondary institutions, while at the other end are students who submit, on average, five or six applications to relatively selective, high-tuition postsecondary institutions across the United States.

Since every student in the data set used for the nonhierarchical cluster analysis can be assigned to one of six clusters (which represent one of six application behavior types), my statistical analysis in this chapter revolves around a series of multinomial logits (MNL) that predict a student's 1) type of application behavior as defined by the six clusters and 2) type of postsecondary enrollment. I begin my analysis by first investigating the extent to which a student's socioeconomic characteristics and race, controlling for academic ability, predict a particular type of application behavior. In this case I am defining "application behavior" as one of the six types of application behavior I identified previously with the nonhierarchical cluster analysis and setting this as the present model's categorical outcome variable. This model thus uses a student's academic background and demographic characteristics as "determinants of college applications."

In addition to the student-level covariates on which I regress application type, I also include a variable to capture if the student visited her high school counselor to obtain information on the college application process. I include this variable based on extant research demonstrating that more visits to a high school counselor increase the odds of enrollment at a four-year university (Belasco, 2013; Robinson & Roksa, 2016). Hence, in the context of this study I include a counselor variable to explore the extent to which a student's interactions with a high school counselor are a determinant of college applications and associated with particular *types* of application behavior.

Specifically, I calculate the log-odds (following Agresti, 1990) of an individual's application choice set falling in each of k clusters as:

$$\text{Model \#1} \quad \text{Log} \frac{P(Y_i = \text{Cluster}_r)}{P(Y_i = \text{Cluster}_q)} = \beta_{r0} + z_i \beta_{r1}$$

where z_i is the vector of covariates representing a student's socioeconomic characteristics, race, academic achievement, and a dummy variable noting student i 's identification of her counselor as a source of college-related information, that predict the log odds of student i 's assignment to cluster r with respect to referent cluster q . This model thus illustrates the extent to which a student's race and socioeconomic status predicts her type of college application behavior as defined by the cluster analysis.

Turning to an analysis of how application behavior predicts a type of enrollment choice (i.e. a model of application behavior that Smith (2013) would deem a "determinant of enrollment") I then regress a categorical dependent variable containing four types of postsecondary enrollment on a categorical cluster variable along with the socioeconomic, academic, and counselor variables modeled as independent variables:

$$\text{Model \#2} \quad \text{Log} \frac{P(Y_i=Enroll_m)}{P(Y_i=NoEnroll)} = \beta_{r0} + z_i\beta_{r1} + c_i\beta_{r2}$$

where z_i is the same vector of covariates representing student i 's controls plus c_i , the student's cluster assignment, that provides the log odds for student i enrolling at postsecondary institution type m with respect to the reference category of no postsecondary enrollment. I structure the categorical outcome variable as no postsecondary enrollment with additional categories being enrollment at a 1) two-year college, 2) four-year open or moderately-selective four-year college, and 3) selective or highly-selective four-year college.

Modeling student i 's enrollment choice as a function of application behavior (as defined by cluster c_i) allows me to determine the extent that types of application behaviors predict particular enrollment outcomes. In other words, when a cluster variable is statistically significant, application behavior of that type meaningfully predicts that postsecondary enrollment outcome. These predictive relationships set the stage to better understand the implications of application behavior types and potentially generate hypotheses with an eye to how changes in application behavior could affect enrollment choice.

Both conceptual and empirical reasons motivate my use of a parsimonious model to explore the relationship of application behavior and enrollment choice. Conceptually, given this chapter's research questions and its predominant focus on application behavior, I use relatively few independent variables in the model to focus attention on the variable of interest, namely, cluster assignment which serves as the dependent variable in Model 1 and the central independent variable in Model 2. In addition to cluster assignment, each of these models contain three academic measures: student i 's grade point average, the number of Advanced Placement or International Baccalaureate courses she completed in high school, and her score from the reading section of the

Program for International Student Assessment (PISA), an academic assessment that was administered to all students in the data set²¹. In a general sense, I expect a student's higher academic achievement to correspond with more options for postsecondary education. I assume this increase in postsecondary options increases her odds of applying, on average, to more postsecondary institutions that are more selective and farther from home. This increase in selectivity and distance from home likewise is associated with higher average cost of tuition at the institution to which this student applies. Hence, I assume higher academic achievement corresponds with demonstrating application behavior like that characterized by Clusters 4, 5, and 6.

In Model #1 and Model #2 I code student *i*'s race as a binary variable either as White/Asian-American or as an underrepresented minority which includes Black/African-American, Hispanic, or American Indian.²² My general supposition for this variable is that, all else equal, students from underrepresented minority backgrounds are more likely to demonstrate application behavior characterized as applying to fewer postsecondary institutions that are closer to home (Freeman, 2005; Perez & McDonough, 2008). I include a composite socioeconomic index created by the National Center for Education Statistics (described below) to capture the range of broad factors (parental level of education, family income, etc.) that prior research has demonstrated negatively affects the odds of pursuing postsecondary education (An, 2010; Perna, 2006). As noted

²¹ I include these particular variables because I assume students in the data set, regardless of their postsecondary aspirations, are least likely to have missing values for these three academic measures. There are no missing values for the Program for International Student Assessment (PISA) scores since the assessment was administered to all participants as part of the ELS:2002 survey; SAT/ACT scores, on the other hand, are missing disproportionately across clusters (48.7% of students in Cluster 1 are missing SAT/ACT scores compared to 9.5% of the students in Cluster 6) to such an extent that I consider this variable a poor candidate for imputation.

²² I collapse these three race/ethnicity categories into one singular category because the small number of African-American/Black and Hispanic/Latino students enrolling at selective institutions make Model #2 otherwise implausible.

earlier, I also include a dummy variable to reflect if student i considered her school counselor to be a useful source of college-related information.

Empirically, given “the difficulties of interpretation that are associated with the multinomial logit model” (Long & Freese, 2006; see also Fox & Andersen, 2006), I err on the side of including only essential covariates related to this chapter’s research question. A parsimonious model specification facilitates a more straightforward interpretation of the study’s findings when visualizing parameters (Tutz & Schauburger, 2013). As I will explain in the findings section, model parsimony allows me to simulate predicted probabilities across a continuous variable of interest, in this case the composite socioeconomic index, and focus on application behavior, socioeconomic status, and race, while holding all else constant. I use simulated probabilities because they give a clearer answer to the question of how socioeconomic status and race predict application behavior because I can examine the probability of demonstrating a particular type of application behavior across the entire range of the socioeconomic index.

3.4 DATA

The data for this analysis come from the National Center for Education Statistics’ Education Longitudinal Survey of 2002 (ELS:2002), a national longitudinal survey administered from 2002 to 2012 that follows a cohort of high school students to and through postsecondary education and the workforce. I use ELS:2002 because the data set contains the key variable capturing all postsecondary institutions to which the student applied; this variable was the

empirical origin of Chapter 2's statistical analysis that determined the six clusters which best represent postsecondary application behavior.

I begin by merging a vector of student-level characteristics to student i 's cluster assignment, k (e.g. Cluster 2, Cluster 5). To measure socioeconomic status (SES), I use the socioeconomic composite variable constructed in ELS:2002 that combines mother's education, father's education, mother's occupation, father's occupation, and family income or an income proxy (Ingels et al., 2004, p. H-5). The SES variable ranges from -2 to 2, which is important to note because the continuous nature of this variable allows me to use a set of SES values across the [-2, 2] range (e.g. -2, -1, 0, 1, 2) to simulate the probability of being in cluster k for each value. Given the inclusion of this variable, I do not otherwise include these socioeconomic factors by themselves as independent variables.

TABLE 3-1: STUDENT-LEVEL CHARACTERISTICS

	Mean (s.d.)	Median	Min	Max
Grade point average	2.79 (0.74)	2.86	0.27	4.0
PISA-Reading	549 (83.8)	557	344	709
AP/IB courses	0.87 (1.77)	0	0	18
Socioeconomic index	0.17 (0.75)	0.15	-1.97	1.98

For academic achievement I use the student's grade point average at the end of her senior year and if she enrolled in Advanced Placement or International Baccalaureate courses during high school. Finally, ELS:2002 contains survey questions about how the student gathered information during their college search; assuming these approaches to information gathering may be associated

with variations in application behavior, I include a binary variable to reflect if the student visited her high school counselor for college-related information during the latter years of high school.

Data are also merged to each student-level record containing the postsecondary institution at which the student enrolled to create a categorical enrollment outcome for Model #2. Using the Integrated Postsecondary Education Data System (IPEDS), I recode enrollment choice as no postsecondary enrollment or enrollment at a two-year institution; enrollment at a four-year institution that has open enrollment or is moderately selective; or enrollment at a selective or highly selective postsecondary institution. These selectivity categories are a collapsed version of the institutional selectivity variable in IPEDS which, in turn, is derived from the 2005 Carnegie classifications for selectivity based on the number of students admitted to a postsecondary institution relative to the number who applied.

3.5 RESULTS

3.5.1 *How do student characteristics vary across application behavior?*

Recalling that clusters represent six distinct types of postsecondary application behavior, differences in student characteristics across clusters demonstrate that the same *types* of students are not uniformly distributed across distinct types of application behavior (Table 3-2). The primary measure of academic achievement, grade point average, largely follows a parallel relationship to the average count of applications. The number of applications a student submits, her application choice set's average count of applications, increases alongside increases in the average grade point average. Submitting a higher number of postsecondary applications also corresponds with a

higher average within-cluster SES level (although Cluster 2, with an average of 1.65 applications submitted, does not fit this pattern).

TABLE 3-2: VARIATION IN STUDENT CHARACTERISTICS ACROSS CLUSTERS

Within-Cluster Institutional Characteristics							Within-Cluster Student Characteristics					
	% of sample	Count	% Public	Admit Rate	Dist.	Tuition Price	GPA	PISA	AP/IB	SES	URM	Counselor Visits
1	28.7	1.29	0.96	0.96	34	\$3,076	2.49 (0.73)	518.3 (82.5)	0.28 (0.88)	-0.08 (0.67)	27.1%	51.9%
2	10.0	1.65	0.01	0.75	244	\$15,839	2.77 (0.78)	556.6 (86.0)	0.78 (1.53)	0.22 (0.74)	21.3%	54.1%
3	22.9	2.75	0.95	0.73	75	\$4,388	2.84 (0.67)	546.8 (77.5)	0.86 (1.67)	0.09 (0.71)	25.8%	66.4%
4	22.6	3.47	0.50	0.74	126	\$10,931	2.85 (0.72)	556.2 (80.4)	0.83 (1.59)	0.25 (0.71)	25.1%	66.9%
5	6.6	5.06	0.26	0.62	1,127	\$16,336	3.15 (0.69)	585.5 (77.3)	2.21 (2.78)	0.57 (0.77)	19.7%	61.9%
6	9.2	6.04	0.24	0.56	265	\$19,279	3.25 (0.58)	599.0 (73.5)	2.43 (2.64)	0.67 (0.73)	19.5%	72.3%
<i>Across all application choice sets</i>							2.79 (0.74)	549.0 (83.8)	0.87 (1.77)	0.17 (0.75)	24.6%	61.4%

Since the socioeconomic status of students in Cluster 1 and Cluster 3 hover around zero (-0.08 and 0.09, respectively), these clusters capture, on average, lower-to-average socioeconomic students. At the other end of socioeconomic status, Cluster 5 and Cluster 6 clearly reflect the application behavior of students from higher socioeconomic backgrounds.

The proportion of underrepresented students (African American, Hispanic/Latino, and Native American) in each of the clusters ranges from a high of 27.1% in Cluster 1 to a low of 19.5% in Cluster 6. No clear pattern emerges between the proportion of underrepresented students in a given cluster and a single application choice set characteristic. However, the clusters with the highest proportion of underrepresented students, Clusters 1, 3, and 4, are also the clusters comprising the greatest share of public institutions, the shortest average distances between the

student's home and the institutions to which they apply, and the lowest average tuition prices. These three clusters also in aggregate represent nearly three-quarters (74.2%) of the entire sample of high school students in ELS:2002 who submitted at least one application to a postsecondary institution.

The findings of the within-cluster student characteristics are intuitive in that I assume grade point average and socioeconomic status increase postsecondary opportunities which, in turn, lead to application behavior characterized by the submission of more applications to more selective, farther-from-home postsecondary institutions. That is, building on a hypothesized connection between disadvantaged students having on average lower aspirations, lower levels of academic achievement, and fewer resources to navigate the college search process, thus leading them to experience a “constrained or limited amount of choices,” (Holland, 2014, p. 1196), Table 1 illustrates how higher levels of academic achievement and socioeconomic status correspond with application behavior characterized by the submission of more applications to more selective, more expensive, farther-from-home postsecondary institutions.

It is helpful to recall at this point that the cluster algorithm discussed in Chapter 2 segmented the nationally-representative sample of application choice sets using only characteristics of the application choice sets themselves. Application choice sets were intentionally constructed independent of any student-level characteristics. Observable patterns exist, however, between application choice set characteristics and the average characteristics of the students demonstrating such behavior. For example, a cluster's average number of applications submitted and the average tuition price of postsecondary institutions generally increase, while the cluster's average admit rate decreases, alongside higher average levels of academic achievement and socioeconomic status . This pattern aligns with the general consensus in the “determinants of

college applications” literature that finds positive associations between these student-level characteristics (e.g. academic achievement, socioeconomic status) and the likelihood a student applies to more colleges (Smith, 2013) that are more expensive (McDuff, 2007) and more selective (DesJardins et al., 1999).

Cluster 2 deserves a brief discussion here because at first glance this cluster may appear anomalous within a general pattern of within-cluster characteristics corresponding with student-level academic achievement and average socioeconomic status. Cluster 2 appears as the second of six clusters because I arbitrarily chose to sort and number clusters by average within-cluster count of applications submitted, based on the fact that the only other study to examine a specific trait of the application choice set (i.e. Smith, 2013) used application count as the key characteristic of interest. If clusters were sorted and numbered based on tuition price, alternatively, a slightly different ordering would emerge but the same overarching pattern across application behavior and a student’s background characteristics would remain unchanged. Arranging or describing clusters by a single application choice set characteristic, while useful for descriptive purposes, is problematic because the output of a multidimensional statistical tool like nonhierarchical cluster analysis is inherently unamenable to simple ordered classification schemes.

3.5.2 *To what extent does a student’s socioeconomic characteristics predict a particular type of postsecondary application behavior?*

I turn to the first of the two multinomial logit models used in this chapter to uncover predictive relationships between student characteristics and types of application behaviors. Specifically, I regress cluster assignment on race, socioeconomic status, and the academic

achievement variables. Longstanding college choice research has demonstrated a positive relationship between students' high school academic achievement and the likelihood of their pursuit of postsecondary education (Manski & Wise, 1983; Perna, 2000, Perna, 2006). The extent to which socioeconomic status and race predict application behavior (as defined by the six clusters identified in the previous chapter), on the other hand, is a key contribution made by this study; in this section I explore the extent to which socioeconomic status predicts each type of application behavior.

Table 3-3 contains the exponentiated coefficients of the multinomial logit regressing cluster assignment on the vector of student-level characteristics. These exponentiated coefficients provide the “relative risk” of a student demonstrating one of five types of application behavior (with Cluster 1 set as the reference category). An example from Table 3-3 helps to contextualize this approach to interpretation. Consider the effect of socioeconomic status on a student's likelihood of having application behavior as represented by Cluster 2. A relative risk of 1.509 is interpreted as a one-unit increase in socioeconomic status making a student 1.509 times more likely to be in Cluster 2 relative to being in Cluster 1. Relative risk can also be interpreted as a percent relative risk. In this case where the RR (relative risk) is 1.509, the percent increase is simply $(RR - 1) \times 100$, or a 50.9% increase in the odds a student would be in Cluster 2 compared to Cluster 1 given a one-unit increase in socioeconomic status. When less than one, as is the case for the odds of an underrepresented students to fall in Cluster 2 relative to Cluster 1, the relative risk of 0.719 translates to a 28.1% decrease in the odds a student would be in Cluster 2 instead of Cluster 1 (i.e. $(1 - RR) \times 100$).

The results of the multinomial logit illustrate that race and socioeconomic status broadly predict the type of application behavior a student demonstrates. Being African American/Black,

Hispanic/Latino, or Native American, for instance, net of other individual characteristics, decreases the odds of having application behavior like that represented by Clusters 2, 4, 5, and 6 relative to the baseline application behavior (Cluster 1). This decreased likelihood of underrepresented students being in other clusters ranges from a modest 11.3% lower odds of being in Cluster 2 to a 34.5% lower odds of having application behavior similar to those in Cluster 6.

Higher levels of socioeconomic status likewise increase the odds, in some cases substantially, that a student demonstrates application behavior characterized by the submission of a larger number of applications to more selective institutions. Consider that a one-point increase in socioeconomic status, which is a large increase on a five-point scale, increases the odds by 30.9% of a student being in Cluster 3 compared to Cluster 1 whereas the same one-point increase in socioeconomic status increases the odds of being in Cluster 5 and Cluster 6 by 179% and 193%, respectively, again relative to Cluster 1.

TABLE 3-3: PREDICTIVE RELATIONSHIPS AMONG APPLICATION BEHAVIOR, DEMOGRAPHICS, ACADEMIC ACHIEVEMENT, AND COUNSELOR VISITS
(Reference Category – Cluster 1)

	Cluster 2			Cluster 3			Cluster 4		
	Est.	RR	95% CI ²³	Est.	RR	95% CI	Est.	RR	95% CI
URM	- 0.329	0.719	0.655-0.790	-0.078	0.924	0.758-1.127	-0.119	0.887	0.788-0.998
SES	0.412	1.509	1.414-1.612	0.269	1.309	1.307-1.310	0.548	1.730	1.710-1.751
GPA ²⁴	0.015	1.015	0.930-1.108	0.004	1.041	1.031-1.051	0.033	1.033	0.911-1.173
AP/IB	0.248	1.282	0.601-2.735	0.259	1.296	1.062-1.582	0.218	1.243	1.104-1.402
PISA-R	0.002	1.002	1.001-1.004	0.001	1.001	0.825-1.213	0.002	1.002	0.942-1.068
Counselor	-0.128	0.879	0.866-0.893	0.438	1.548	1.460-1.642	0.447	1.563	1.378-1.773
	Cluster 5			Cluster 6					
	Est.	RR	95% CI	Est.	RR	95% CI			
URM	-0.417	0.659	0.607-0.715	-0.422	0.655	0.551-0.779			
SES	1.027	2.793	2.405-3.244	1.073	2.925	1.929-4.436			
GPA	0.054	1.055	0.998-1.116	0.069	1.071	1.071-1.072			
AP/IB	0.462	1.587	1.383-1.821	0.464	1.591	1.565-1.617			
PISA-R	0.003	1.003	0.486-2.069	0.004	1.004	0.835-1.208			
Counselor	0.077	1.081	1.079-1.081	0.467	1.595	1.329-1.916			

²³ The multiplicative nature of odds make confidence intervals an appropriate gauge of statistical significance; the confidence interval assesses with 95% confidence that the odds are distinct from zero (assuming zero does not fall within the confidence interval's range).

²⁴ For ease of interpretation the student's grade point average reported in ELS:2002 was multiplied by 10 to convert it from a 4-point scale to a 40-point scale. This does not change the analysis but allows for smaller-magnitude coefficients that are easier to interpret i.e. the coefficient represents a one-tenth increase in grade point average instead of a one-point increase.

To aid in the interpretation of these multinomial logit coefficients, I present a visualization of the model's findings. I first use the baseline model to generate predictions for each student of the probability of having application behavior characterized by each of the six clusters. I also simulate a data set so as to show the relationship between a student's background characteristics, specifically race and socioeconomic status, and the type of application behavior she demonstrates. These simulated data in particular present two benefits. First, the simulated data allow for a thorough examination of relationships between covariates *across a range*, such as socioeconomic status, and the probability of a particular outcome of interest. This simulation across a range is valuable given that coefficients alone (as is reported in Table 3-3) obscure the nonlinear characteristics of multinomial logit models (Fox & Andersen, 2006). Second, the simulated data facilitate a clear visualization of multiple subpopulations, such as by race, which can allow for further analysis and interpretation of findings that are again otherwise constrained by examining only coefficients. I create these predicted probabilities and simulated data as follows. First, I extract the coefficients from the original multinomial logit model. I also extract the standard errors via the squared diagonal values of the variance-covariance matrix.²⁵ For the simulated data, I use these coefficients and standard errors to simulate multivariate-normal expected values. Simultaneously, I create vectors for all possible values of the model's demographic covariates of interest (i.e., values for socioeconomic status across all possible values of the composite index [-2 to 2] and a dichotomous variable for race/ethnicity). I set all other variables in the model at their mean to hold them constant in this simulation. I then simulate probabilities by looping through

²⁵ The variance-covariance matrix in this circumstance is the inverse of a Hessian matrix. The special properties of the multinomial logit require extracting the Hessian matrix from the multinomial logit's output and taking its inverse, which approximates the variance-covariance matrix (Hausman & McFadden, 1984).

every combination of these possible covariates and their corresponding expected values. Formally, in the case of simulating a probability for Cluster 2, for example;

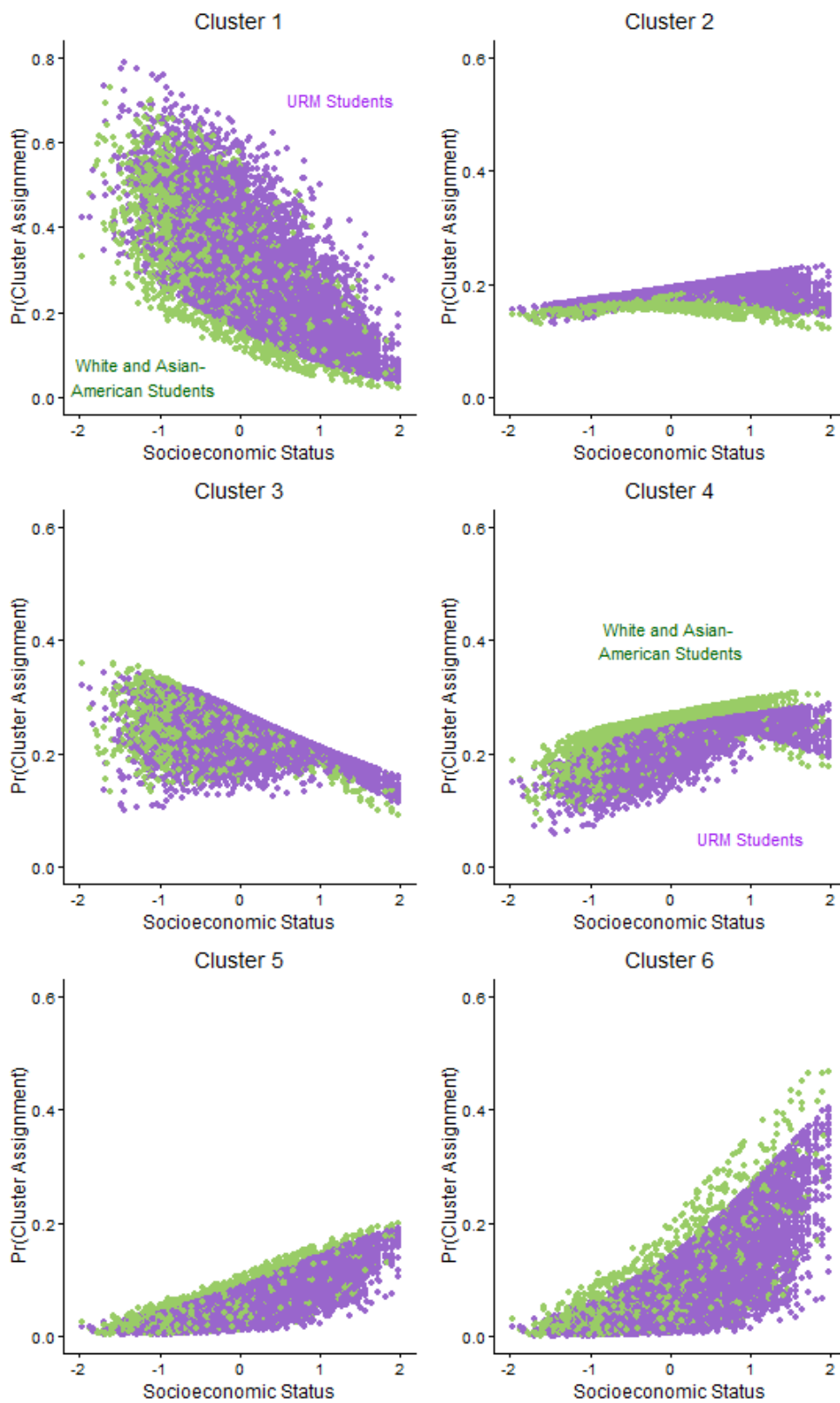
$$\Pr(\widehat{\text{Cluster 2}}) = \frac{e^{(X\widehat{\beta}_2)}}{1 + e^{(X\widehat{\beta}_2)} + e^{(X\widehat{\beta}_3)} + e^{(X\widehat{\beta}_4)} + e^{(X\widehat{\beta}_5)} + e^{(X\widehat{\beta}_6)}}$$

where X is the vector of hypothetical covariate values and $\widehat{\beta}_2$ are the expected values from the simulated matrix corresponding to Cluster 2.

I follow a similar approach to create the predicted probabilities. For the predicted probabilities, however, instead of using a simulated data set I return to the actual data on which the model is based. I use student i 's demographic and academic characteristics to predict the probability that her application behavior falls in one of the six clusters that represent distinct types of application behavior. I then store these predicted probabilities in a $n \times p$ matrix where n is the number of students in the data set and p is the number of probabilities predicted for each student (in this case, $p=6$). To this matrix I merge student i 's score on the socioeconomic index and whether she is from an underrepresented minority background. I then visualize the predicted probability of student i having application behavior characterized by cluster k (on the y-axis) relative to her socioeconomic status (portrayed across the x-axis) with variation in color to delineate between White/Asian-American students and underrepresented minority students.

In light of the predicted probability plots, the clearest relationships between socioeconomic status and the probability of being in a given cluster can be seen with Cluster 1 and Cluster 6 (Figure 3-1). The predicted probabilities are highly dispersed in Cluster 1 but a general downward pattern in the probability of being in Cluster 1 is observable relative to increasingly socioeconomic status. The opposite pattern is observable with Cluster 6. In Cluster 6 an increasing level of socioeconomic status predicts a higher probability of demonstrating this type of application behavior.

FIGURE 3-1: PREDICTED PROBABILITIES OF CLUSTER ASSIGNMENT



Visualizing the simulated probabilities using an approach specifically designed for such purposes (Adolph, 2015) yields valuable insight into application behavior that is otherwise unobserved in Table 3-3. Figure 3-2, which contains the probabilities of a student being assigned to one of six clusters based on the simulated data described above, demonstrates the significant variation in application behavior given a range of socioeconomic status values. The unique attributes of each cluster's probabilities merit a brief review in the context of each cluster's characteristics.

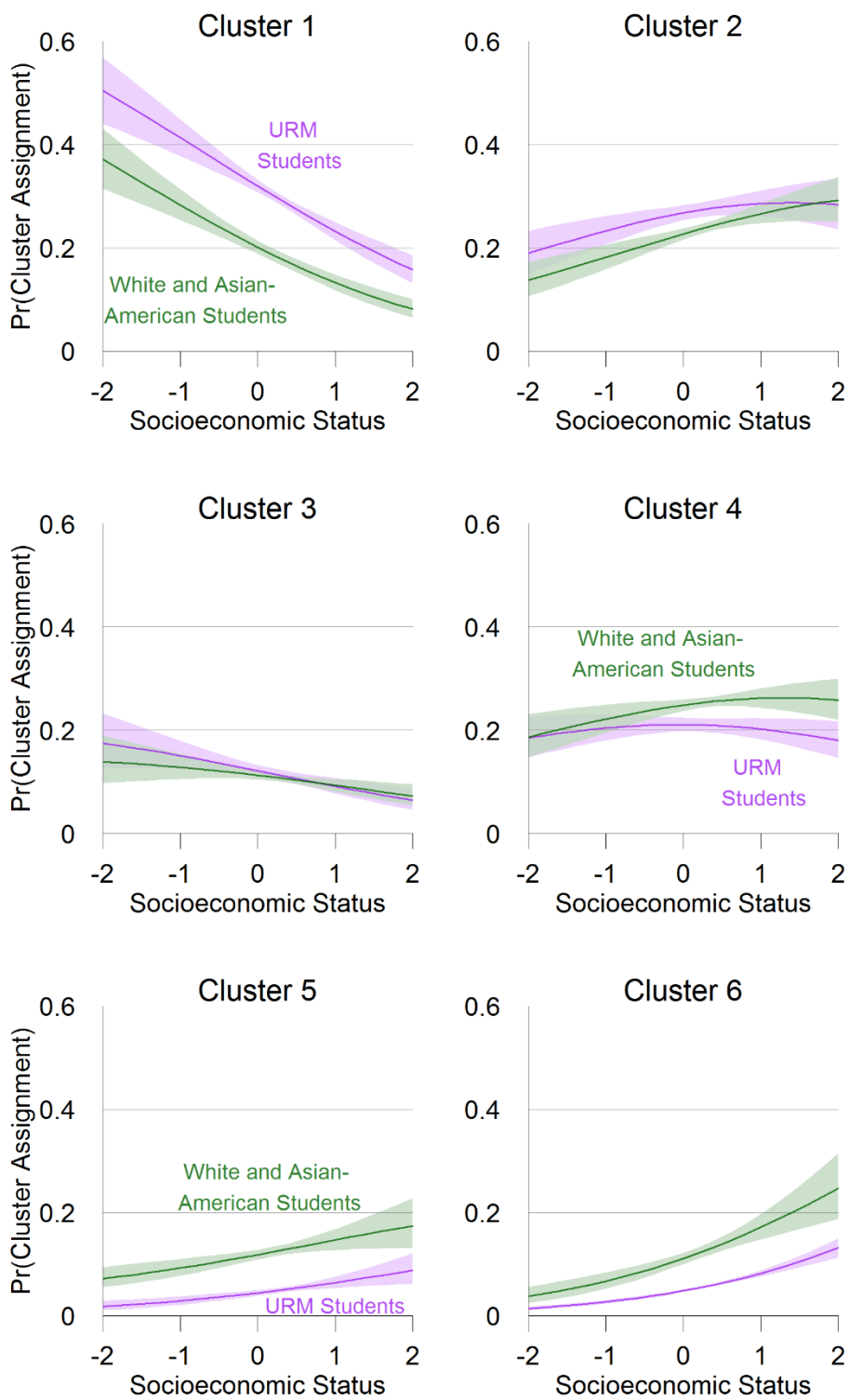
Cluster 1, to which more than a quarter of the sample was assigned by the cluster algorithm, contains students who apply to, on average, 1.3 postsecondary institutions that have open enrollment and low-price tuition. These students, on average, have the lowest mean level of socioeconomic status but the simulated data demonstrate that as socioeconomic levels increase, a student is substantially less likely to demonstrate the types of application behavior common in Cluster 1. This general relationship between socioeconomic status and Cluster 1 is clearly observed in Table 2 because Cluster 1 is set as the reference category, but the stark linear relationship between increasing socioeconomic status and a decreasing likelihood of demonstrating application behavior as is represented by Cluster 1 makes this type of application behavior unique among the six clusters visualized in Figure 3-2. Also noteworthy is that across all levels of socioeconomic status, students from underrepresented minority backgrounds are *more* likely to have application behaviors like those in Cluster 1 compared to their White and Asian-American peers when levels of socioeconomic status are considered at the same point, i.e. is controlled, for both subpopulations.

The relatively consistent probabilities across socioeconomic status for Cluster 2 suggest that a student's background is not a strong predictor of this type of application behavior. As noted,

although Cluster 1 and Cluster 2 contain students who submit on average fewer than two college applications (1.29 and 1.65, respectively), the characteristics of the colleges to which these students apply vary widely; significant intra-cluster heterogeneity could explain why the type of application behavior found in Cluster 2 does not vary widely across socioeconomic status.

Cluster 3 and Cluster 4 are similar in that both clusters contain application choice sets with an application count of around three and an average institutional admit rate near 75%. The distinguishing factor between the two clusters is that the average tuition price of colleges in Cluster 3 application choice sets is less than half that of the average tuition price for colleges in Cluster 4. Perhaps not surprisingly, then, is the fact that a student's probability of being in Cluster 3 declines with higher socioeconomic status. Alternatively, a student's probability of being in Cluster 4 remains constant or increases slightly at higher socioeconomic levels. The relationship between socioeconomics and race presents an additional contrast between Cluster 3 and Cluster 4; the probabilities for White and Asian-American students and underrepresented minority students are indistinguishable in Cluster 3 whereas at higher levels of socioeconomic status, White and Asian-American students are more likely than underrepresented students to have application behavior represented by Cluster 4.

FIGURE 3-2: SIMULATED PROBABILITIES OF CLUSTER ASSIGNMENT



Note: Shaded bands represent 95% confidence intervals.

Cluster 5 and Cluster 6 are easily summarized in tandem since both present similar patterns that vary only in magnitude; an increasing level of socioeconomic status clearly predicts a greater probability of being in either cluster. Also illustrated here is that at any given point on the socioeconomic spectrum for Cluster 5 and Cluster 6, a White or Asian-American student is more likely than her underrepresented peer to demonstrate the type of application behavior represented by these clusters.

The primary finding from this analysis, and from Figure 3-2 in particular, is that race and socioeconomic status meaningfully predict the type of application behavior a student demonstrates in the United States. To make this point it can be helpful to consider what the predicted probabilities in Figure 3-2 might look like if race and socioeconomic status were *not* predictive of application behavior. First, the predicted probabilities would have no slope because a probability would remain constant across varying levels of socioeconomic status. The closest example of this can be seen with Cluster 4 in Figure 3-2; note that the probability of a student being assigned to this cluster hovers around 20% across the [-2,2] range of socioeconomic status. Similarly, if race was not a significant predictor of application behavior then the predicted probabilities of being in a particular cluster would be indistinguishable for White/Asian-American students and URM students. Observable in Figure 3-2, however, is the fact that for some clusters, particularly Cluster 1 and Cluster 6, a student's race is notably predictive of her probability of manifesting that application behavior type.

3.5.3 *What relationships exist between types of postsecondary application behaviors and the probability of enrollment at a particular type of postsecondary institution?*

Exploring to what extent application behavior (represented by the six clusters) predicts postsecondary enrollment expands on the findings that socioeconomic background and race predict certain types of application behavior. A preliminary look at enrollment outcomes across the six clusters (Table 3-4) demonstrates observable patterns, keeping in mind the within-cluster makeup of postsecondary institutions and the varying demographic composition of each cluster.

TABLE 3-4: DISTRIBUTION OF CLUSTER TYPE RELATIVE TO ENROLLMENT TYPE

	Cluster					
	1	2	3	4	5	6
No enrollment	17.7%	14.6%	7.1%	6.6%	4.9%	2.4%
Two-year college	60.8%	14.2%	27.4%	17.3%	12.0%	5.1%
Four-year college, open or moderately selective	20.9%	46.7%	49.5%	53.5%	32.6%	27.2%
Four-year college, selective or highly-selective	0.6%	24.6%	16.0%	22.5%	50.5%	65.2%

Note: Columns may not sum to exactly 100% based on rounding.

For instance, the majority of students in Cluster 1 enroll at two-year colleges with a similar proportion of the cluster either not enrolling at any type of postsecondary institution or enrolling at an open or moderately-selective college. At the other end, more than half of the students with application behavior captured in Cluster 5 or Cluster 6 enroll at selective or highly-selective institutions.

As with application behavior, students' enrollment choices across the six clusters also defy a straightforward categorization of behaviors. Students in Clusters 2, 3, and 4, for example, predominately attend open or moderately-selective institutions although nearly a quarter of those students in either Cluster 2 or Cluster 4 enroll at highly selective colleges. Moreover, note that even though application choice sets in Cluster 3 contain on average 2.75 applications submitted, more than a quarter of these students ultimately enroll at a two-year college, defying conventional logic that models application behavior for two-year and four-year postsecondary institutions as distinct from one another. And while more than half of the students in Cluster 5 and Cluster 6 enroll at highly-selective four-year colleges, a noteworthy proportion (16.9% and 7.5%, respectively) of these students enroll at a two-year postsecondary institution or none at all. This variation across application behaviors and enrollment choices thus merits the use of multinomial logit models to explore the extent to which, if at all, application behaviors defined by the cluster analysis predict enrollment outcomes in a multivariate framework.

The results from the multinomial logit model (Table 3-5) complement the observed patterns across the application behaviors and enrollment choices presented in the preceding cross-tabulations (Table 3-4), where clear relationships emerge between clusters and enrollment choices. However, the interpretation of this model's coefficients requires careful analysis since both the dependent variable (enrollment outcome) and the key independent variable (cluster) are categorical which means that the interpretation of each requires reference categories. To illustrate this point, consider the coefficients for Cluster 1 relative to the odds of three distinct enrollment choices: no college enrollment, two-year enrollment, or enrollment at a selective or highly-selective four-year institution. From Table 3-5 the coefficient for Cluster 1 illustrates a nearly six-fold higher odds of no postsecondary enrollment compared to the likelihood of enrolling at an open or moderately-

selective postsecondary institution. The 593.6% greater odds of no postsecondary enrollment for Cluster 1 is relative to both the enrollment reference category (enrollment at an open or moderately-selective four-year college) and the cluster reference category (Cluster 4) used in the analysis.

TABLE 3-5: PREDICTIVE RELATIONSHIPS BETWEEN ENROLLMENT CHOICE AND DEMOGRAPHICS, ACADEMIC ACHIEVEMENT, AND SIX TYPES OF APPLICATION BEHAVIOR
(Reference categories: Enrollment outcomes – Enrollment at an open or moderately-selective four-year college; Clusters – Cluster 4)

	No Postsecondary Enrollment			Two-Year Postsecondary			Selective or Highly-Selective Four-Year Postsecondary		
	Est.	OR	95% CI	Est.	OR	95% CI	Est.	OR	95% CI
URM	-0.041	0.959	0.750-1.228	-0.076	0.927	0.731-1.174	-0.373	0.688	0.542-0.874
SES	-0.860	0.423	0.306-0.585	-0.455	0.634	0.626-0.642	0.586	1.796	1.076-2.997
GPA	-0.147	0.863	0.686-1.086	-0.095	0.909	0.901-0.917	0.122	1.130	0.820-1.558
Counselor	0.021	1.021	0.945-1.120	0.063	1.065	0.488-0.497	0.211	1.235	0.849-1.571
Cluster 1	1.963	6.936	3.996-12.03	1.559	4.756	4.350-5.201	-1.392	0.248	0.209-0.296
Cluster 2	0.277	1.320	0.880-1.980	-1.952	0.142	0.140-0.144	0.534	1.706	1.106-2.631
Cluster 3	-0.034	0.967	0.646-1.447	-0.902	0.406	0.267-0.616	0.579	1.786	1.190-2.679
Cluster 5	0.128	1.137	0.875-1.479	-0.854	0.426	0.390-0.465	1.576	4.838	4.230-5.533
Cluster 6	0.084	1.088	0.910-1.300	-0.501	0.606	0.522-0.703	1.662	5.271	4.082-6.805

Such complexity warrants a more interpretable approach. Mirroring the technique outlined previously for interpreting the multinomial model which regressed cluster assignment on socioeconomic status, race, and control variables, I again extract the multinomial logit's results to

simulate probabilities for each of the four enrollment categories given a student's application behavior falling into one of the six clusters. The goal of the simulation is again twofold: to visualize non-linear relationships between socioeconomic status and enrollment probabilities across clusters, and to determine the extent to which race is associated with a higher or lower probability of an enrollment category given a type of application behavior.

Based on the practical limitations of visualizing four enrollment categories across six clusters (which would generate 24 predicted probability plots) I limit the visualization in Figure 3-3 to Cluster 1, Cluster 3, and Cluster 6. I choose Cluster 1 and Cluster 6 because these clusters represent two extremes in both application behavior (e.g. number of applications submitted, average admit rate) and socioeconomic status (-0.08 and 0.67, respectively). I visualize Cluster 3 because this cluster, like Cluster 1, represents a type of application behavior that has potential policy implications worth considering (discussed in the next section). That is, for Cluster 1 and Cluster 3, students submit applications to low-tuition, close-to-home postsecondary institutions that are almost exclusively public. The primary difference between Cluster 1 and Cluster 3 is that students in Cluster 3 have slightly higher levels of academic achievement that likely increase, to a modest extent, the number of applications submitted and the selectivity of the postsecondary institutions to which they apply.

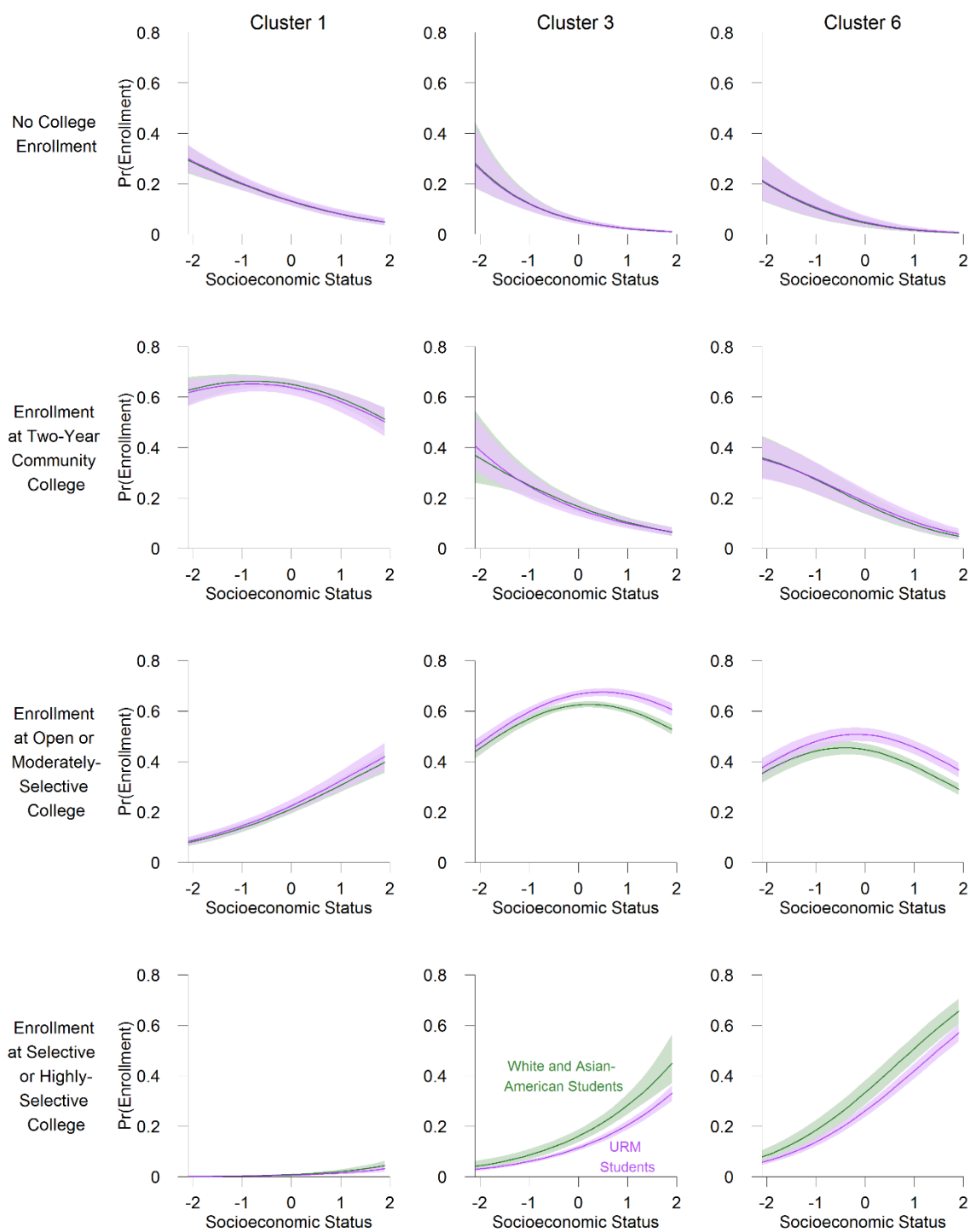
Two characteristics of application behavior relative to enrollment probabilities become readily apparent with the visualization portrayed in Figure 3-3. First, the variation in enrollment probabilities across the four categories of postsecondary enrollment, combined with the relatively narrow confidence interval bands, provide evidence that cluster assignment meaningfully predicts enrollment across different types of postsecondary institutions. Consider a student with application behavior represented as Cluster 1 with baseline socioeconomic status (i.e. equal to zero); this

student would have around a 20% chance of no enrollment or enrollment at an open or moderately-selective institution, a 60% chance of enrollment at a two-year community college, and virtually no chance of enrolling at a selective or highly-selective institution.²⁶

The second notable characteristic regarding the relationship between application behavior and enrollment probabilities is how enrollment probabilities vary by race across different clusters. The observable differences in enrollment probabilities for students with Cluster 1 application behavior are indistinguishable between White/Asian-American students and underrepresented minority students (Column 1, Figure 3-3). The probabilities for enrollment at four-year institutions (Rows 3 and 4, Figure 3-3), however, for Clusters 3 and 6 vary by race across socioeconomic status. Students from underrepresented minority backgrounds with application choice sets represented by either Cluster 3 or Cluster 6 are more likely than their white peers to enroll at an open or moderately-selective institution (Row 3, Figure 3-3). Underrepresented minority status has the opposite predictive effect on enrollment at a selective or highly-selective institutions for students in Cluster 3 and Cluster 6. In these cases, as a student's socioeconomic status increases, White and Asian-American students hold the higher probability for enrollment at open or moderately-selective or selective/highly-selective postsecondary institutions (Row 4, Figure 2), compared to a African-American/Black, Hispanic, or American-Indian peer of the same socioeconomic status.

²⁶ This example also helps to illustrate how probabilities sum to 100% for any given level of socioeconomic status for a particular cluster.

FIGURE 3-3: POSTSECONDARY ENROLLMENT PROBABILITIES, CLUSTERS 1, 3, AND 6



Note: Shaded bands represent 95% confidence intervals. Plots with only one visible band represent two curves that are not observably distinct from each other.

3.6 DISCUSSION AND IMPLICATIONS

Holland (2014) observes that “only recently [have] scholars and research paid significant attention to the actual process of college applications and begun to model and examine it” (p. 1200). She also notes that the question of how “race and class intersect to affect college application behavior” remains an unanswered question in the literature (p. 1201). This study presents a step forward in building knowledge around both of these gaps such that future research may continue to disentangle the complexities and nuances of postsecondary application behavior.

The absence of a single pattern of application behavior is, ironically, the overarching pattern revealed in this chapter’s analysis. Increasing socioeconomic status is observable across clusters in terms of students from higher socioeconomic backgrounds submitting more applications to more selective, more expensive postsecondary institutions farther from home. Yet this pattern is hardly the singular model of application behavior that Holland (2014) observes is missing from the field.

Examining the six types of application behavior, plus the typical student characteristics of those who demonstrate such behavior, provides a reminder that more than half of the study sample (those in Clusters 1 and 3, comprising 28.7% and 22.9% of the sample, respectively) have application choice sets that are characterized by low-tuition, close-to-home public institutions. Specific to Cluster 1, across all levels of socioeconomic status students from underrepresented minority backgrounds are more likely than their White and Asian-American peers to demonstrate these types of application behaviors. The substantial proportion of low-SES students applying to low-tuition, close-to-home public institutions, while probably widely assumed, is not well documented empirically in much of the postsecondary choice research, which is focused on elite

colleges and universities (e.g. Bowen & Bok, 1998; Espenshade & Radford, 2009; Wechsler, 2014).

The relationship between application behavior, enrollment choice, and the intersection of race and class (Figure 3-3) presents a puzzle to be pieced together. Why do the predictive relationships among application behavior types and race vary across socioeconomic levels for some enrollment choices but not others? The probability of a particular enrollment outcome is indistinguishable by race for those students with application behavior characterized by Cluster 1. In other circumstances, such as with Cluster 3 and Cluster 6 patterns (Figure 3-3), application behavior and race intersect to leave underrepresented minority students (compared to their White and Asian-American peers) more likely to enroll at open or moderately-selective institutions but less likely to enroll at selective or highly-selective postsecondary institution.

This chapter's analysis of application behavior and how it varies by race and socioeconomic status has the potential to meaningfully inform public policy. Returning to the fact that relatively limited application behavior (i.e. those students in Cluster 1 and Cluster 3) represents more than fifty percent of those who submit college applications, I suggest as others have (Roderick, Coca, & Nagaoka, 2011) that this type of application behavior is highly relevant to, and deserves more of the attention of, policymakers focused on increasing postsecondary access and enrollment. As such, the application behavior captured in Cluster 1 and Cluster 3 may serve one of two purposes related to public policy. First, these types of application behavior could be a target for application-related policy interventions that seek to increase the rates at which students enroll in any type of postsecondary education or at a particular type of institution. Second, the application behavior seen in Cluster 1 and Cluster 3 could serve as a diagnostic tool that triggers other types of interventions focused on increasing the rates at which students enroll in

postsecondary education. By diagnostic tool I mean that a pattern of submitting few applications, such as that seen in Cluster 1 or Cluster 3, is an observable signal that a student aspires to pursue postsecondary education but may not actually enroll. By the time applications are submitted, a student has navigated six of the nine steps that Klasik (2012) identifies as part of the “college application gauntlet.” In this way, and noting that a total of 14.1% of the students in Cluster 1 and Cluster 3 enrolled at *no* postsecondary institution immediately following their senior year of high school, the act of submitting applications could “trigger” other interventions that ultimately increase the probability that a student enrolls.

Turning first to policy design, policy interventions that target the application behavior seen in Cluster 1 and Cluster 3 could ostensibly take on the characteristics of Hoxby and Turner’s (2013) suite of experimental interventions. These low-cost interventions that delivered information and application-fee waivers “caused high-achieving, low-income students to apply and be admitted to more colleges” and “enroll in college that have stronger academic records, higher graduation rates, and more generous resources” (p. 1). In the manner that Hoxby and Turner delivered information to students and their parents about the benefits of attending a more-selective college (e.g. higher graduation rates, lower net price of attendance), a similar intervention could target lower-achieving low-income students (such as those in Cluster 1 and Cluster 3) with information about the benefits of attending a four-year college over a two-year college. Given the predominance of public institutions in Cluster 1 and Cluster 3, coordination among public universities in a particular state could also lead to an across-the-board simplified fee waiver for any state resident to use during the postsecondary application process.

Such interventions nudging students toward four-year colleges and universities would be controversial. Community colleges are considered an accessible, democratizing portal to

postsecondary education and efforts to direct students away from community colleges may be seen as paternalistic and insensitive to a student's preferences and financial constraints (Goldrick-Rab, 2010; Rouse, 1995). Yet consider the mounting evidence on the extent to which community college attendance lowers the probability of bachelor's degree attainment for comparable individuals who aspire to earn such a degree. Long and Kurlaender (2009) calculate what they deem a community college "penalty" for students who begin at a community college but aspire to earn a bachelor's degree; they find the probability of a student completing a bachelor's degree decreases by 14.5 percentage points if the student begins their college education at a community college compared to a public four-year university in Ohio; for African American students, the decreased probability of bachelor's degree attainment rises to 16 percentage points (p. 42). Reynolds (2012) estimates a substantially larger effect, finding that community college enrollment decreases the probability of baccalaureate attainment by 24.5 percentage points for men and 31.5 percentage points for women conditional on aspirations to earn a bachelor's degree (p. 353).²⁷

Two factors could curtail the controversy surrounding an intervention that presents the benefits of attending a four-year college over a two-year college. First, the fact that the Hoxby and Turner (2013) interventions inform, rather than prescribe, is key to preventing claims of coercion. A similar, nonbiased delivery of information like that Hoxby and Turner (2013) used would need to objectively inform students about the characteristics of four-year colleges and two-year colleges (e.g. graduation rates, net price, etc.). Hoxby and Turner's (2013) emphasis on culturally-appropriate information delivered to non-Caucasian parents (p. 9) is also relevant given the increased probability that an underrepresented student demonstrates application behavior like that seen in Cluster 1.

²⁷ Unlike Long and Kurlaender (2009), Reynolds (2012) does not look specifically at racial differences but does use a nationally representative sample (NELS:88).

The use of a nudge to leverage a student's existing *intent* is the second factor which could curtail controversy. Many students who enroll at community colleges submit multiple postsecondary applications; I find more than half (56.1%) of the students who enroll at a two-year college submit more than two postsecondary applications, and of those students who enroll at a two-year institution and submit at least two postsecondary applications, most (84.2%) apply to at least one four-year college or university as well. Regardless of whether a student gained admission to a four-year institution, these figures signal the student's interest in attending a four-year college or university. More importantly, the submission of an application to a four-year institution signals the student's observable intent to earn a bachelor's degree. This type of observable intent is an important component to warrant the delivery of non-coercive information relevant to the choices an individual faces (Wilkinson, 2013).

How might such an intervention be implemented? Observe that students demonstrating application behaviors like those captured in Cluster 1 and Cluster 3 apply almost exclusively to public postsecondary institutions. Nearby options for postsecondary education are important to college-bound students from low-income backgrounds (Hoxby & Turner, 2013) so one simple option would be for a state to target the delivery of accessible information to low-income students about one nearby public university and one nearby community college. This informational intervention could compare and contrast some of the salient details (graduation rates, net price, and in the case of community colleges, transfer rates from the community college to public universities in the state) that Hoxby and Turner (2013) hypothesize help students make more informed application and enrollment choices.

Another possible approach would be to coordinate in a given state information provided to applicants to public universities and community colleges. An intervention like this would not shape

application behavior but instead provide information for students to consider within the context of their application choice set. An informational intervention could be triggered and sent to a student upon the student applying to both a two-year and a four-year college. “Congratulations on applying to some of the best colleges and universities in our state,” the letter from the governor would begin, “and let me take a moment to share with you some information that may help you and your family navigate the process of choosing the best college for you.” Sending a letter from the governor is an idea taken from actual legislation proposed in Washington State, modeled loosely on the Hoxby and Turner (2013) interventions.²⁸

The use of application behavior, such as that in Cluster 1 and Cluster 3, as a diagnostic tool to trigger a non-application related intervention (seeking to spur enrollment and better choice making) is the second policy implication worth considering in light of this chapter’s findings. Recall that 14.1% of the students with application behaviors in Cluster 1 and Cluster 3 enroll in no postsecondary education; unknown is the reason *why* these students did not enroll. An obvious next step after submitting college applications for many students is to apply for federal financial aid (Klasik, 2012). Again noting that students in Cluster 1 and Cluster 3 are from lower socioeconomic backgrounds and thus more likely to need financial aid assistance, a potential implementation of a non-application related policy intervention in this regard is the state-level coordinated use of application behavior to “diagnose” who needs to apply for federal (and state) financial aid. For example, a recent partnership between the U.S. Department of Education and certain states now allows high school counselors to see, updated on a weekly basis, which students

²⁸ Considered during the 2015-2016 legislative session in Washington, House Bill 1812 proposes “a personally-addressed cover letter signed by the governor and the president of each four-year institution of higher education and nonprofit baccalaureate degree-granting institution in the state” with information on college affordability and financial aid be mailed to every low-income high-achieving public high school student in the state (Washington State Legislature, 2016, p. 2). The legislation, receiving bipartisan support, ultimately languishing in committee during the present and past legislative sessions.

in their high school have completed the Free Application for Federal Student Aid (FAFSA) (e.g. WSAC, 2016). With a minimal level of coordination between public universities and community colleges reporting into a central agency, an enhanced system could alert public high school counselors to contact students who have applied to one or more public postsecondary institution in the state (e.g. those students demonstrating application behavior seen in Cluster 1) but who have failed to complete the FAFSA. More timely submission of the FAFSA and other financial aid materials could, in turn, provide a student and her family with more accurate information about the true costs of college attendance, which are generally lower than students perceive them to be.

With this potential intervention, I acknowledge that increasing the probability a student who would have otherwise *not enrolled* instead chooses *to enroll* presents a substantial policy challenge. A common finding among the recent experiments that target application behavior (e.g. Berman, Ortiz, & Bos, 2008; Hoxby & Turner, 2013) is that the interventions affect students' choices about the types of institutions to which they apply but do not increase the overall rate at which students enroll in postsecondary education. Given that a policy intervention targeting application behavior affects just one step among the nine Klasik (2012) identifies as prerequisites for postsecondary enrollment, the lesson here may be that inducing enrollment requires interventions *throughout* the process by which a student aspires, applies, and eventually enrolls in postsecondary education. A comprehensive set of behavioral policy interventions, which would likely require coordination at the state level, could 1) deliver information to inform a student's *ex ante* application choices, 2) deliver information after she has submitted applications to help her make choices within the context of an application choice set, and 3) use the application choices as a trigger for related non-interventions that increase the probability of overall postsecondary enrollment.

To summarize this chapter's overarching point, Holland (2014) observes that "conceptualizing the often messy application process" is difficult if one attempts to model application behavior in a manner that assumes all students navigate the process in a uniform way (p. 1196). The findings in this and the previous chapter ultimately demonstrate that application behavior varies widely, specifically across different types of students, and varies in the extent to which it predicts postsecondary enrollment outcomes. Likewise, such diversity in application behavior does not present one clear policy implication but rather a collection of possible interventions based on the student herself and the type of application behavior she exhibits. While not necessarily amenable to a single model of application behavior, these findings suggest that future research on postsecondary application behavior can continue to uncover the extent to which application behavior affects enrollment choices.

Chapter 4. ON THE FRONTLINES OF COLLEGE ACCESS: TO WHAT EXTENT DO HIGH SCHOOL COUNSELORS EASE THE ADMINISTRATIVE BURDEN OF APPLYING TO PUBLIC UNIVERSITIES?

Abstract

In this study I use a theoretical framework based on administrative burden to examine how public high school counselors ease the burden that students face when applying to public universities. Drawing from the extensive literature on frontline workers and street-level bureaucrats, I conceptualize public high school counselors on “the front-line of serving the public good.” I test the extent to which counselors alleviate administrative burden across a variety of application-related contexts using administrative data from Washington State and find that counselors increase application rates in two circumstances. First, a higher level of counselor FTEs increases the odds of application submission for applications that are disproportionately burdensome, such as the application for admission required by the state’s public flagship university. Second, a higher level of counselor FTEs is also associated with a higher odds of application submission for low-income and underrepresented minority students who submit applications with minimal levels of administrative burden. I also find modest evidence to suggest that lower counselor caseloads increase application submission rates. These findings, in the context of frontline workers and access to public postsecondary education, make a meaningful contribution to the development of the administrative burden framework.

4.1 INTRODUCTION

The emergent management perspective surrounding administrative burden provides a theoretical framework to analyze how application barriers shape the take-up of, and access to, public programs and policies. Moynihan, Herd, and Harvey (2015) define administrative burden, a term introduced by Burden, Canon, Mayer, and Moynihan (2012), as the “costs that individuals experience in their interactions with the state” (p. 45). Burden et al. (2012) note that administrative burden often requires “the individual to respond with what he or she sees as a high level of resources” (p. 742). Administrative burden has been studied as administrators implementing public policy (Burden et al., 2012), government’s regulation of the private sector (Arendsen et al., 2014), and citizens accessing public programs and resources (Herd, DeLeire, Harvey, & Moynihan, 2013; Heinrich & Brill, 2015; Moynihan & Herd, 2010; Moynihan, Herd, & Harvey, 2015; Moynihan, Herd, & Ribby, 2013). This study extends research in the realm of citizens accessing public programs and resources by exploring how the state may alleviate administrative burden faced by citizens in their pursuit of public postsecondary education.

I apply this new theoretical perspective to citizens’ pursuit of public postsecondary education by examining the *college application process as a case of administrative burden*. I explore how frontline college-access services delivered at public high schools, coupled with a legislatively-authorized program to enhance these services, ease the administrative burden of applying to public universities. Understanding take-up as the process through which a citizen applies, and thus gains access to, a public program or policy (Currie, 2006), I consider the submission of an application to a public university as an analog to the take-up process of other public programs and policies. Interventions to boost take-up have been carried out for a variety of programs, including Medicaid (Aizer, 2003; Moynihan, Herd, & Harvey, 2015), the State Children’s Health Insurance Program

(Wolfe & Scrivner, 2005), the Earned Income Tax Credit (Kopczuk & Pop-Eleches, 2007), and the Supplemental Nutrition Assistance Program (Schanzenbach, 2009). I contribute to this literature by analyzing the extent to which publicly-provided services and programs to support citizens in their pursuit of postsecondary education have observable impacts on how they apply to (i.e. take-up) their state's public universities.

This study makes three contributions. The first contribution is theoretical; the research question extends the emergent topic of administrative burden into a new realm, education, and likewise leverages the administrative burden perspective to inform existing education policy research on college application behavior. By conceptualizing high school counselors as frontline workers, the study also makes a contribution to the street-level bureaucrat literature by quantifying the impact of frontline workers on the take-up of a public program. Second, this study answers the call for more public administration research on education in general (Raffel, 2007) and higher education in particular (Hicklin & Meier, 2008; Lowry, 2007). Finally, reinforcing Heinrich and Lynn's (2000) argument that multilevel models have "considerable potential for governance research" (p. 134), the study's multilevel approach demonstrates this method's effectiveness at teasing out the extent to which organizational-level management variables (at Level 2) may ease individual-level administrative burden (at Level 1).

The chapter proceeds as follows. I begin with a review of the literature on administrative burden and what is known about postsecondary application behavior. I then explore how the role of a public high school counselor is akin to that of a frontline worker in other types of public agencies and, as such, merits inclusion in this study's empirical analysis of administrative burden. I also provide background on the public program of interest – "Navigation 101" in Washington State – and explain why this program and Washington State serve as an appropriate case for

studying administrative burden. The hypotheses guiding my empirical analysis follow. I then discuss the study's data and methods, present the results, and conclude with a discussion of these results and a summary of this study's novel contributions to administrative burden literature and the theoretical framework's utility in analyzing citizen-state interactions.

4.2 ADMINISTRATIVE BURDEN AND THE TAKE-UP OF PUBLIC PROGRAMS AND POLICIES

Moynihan, Herd, and Harvey (2015) bring together much of the extant literature on take-up (discussed in Chapter 1 of this dissertation) in their conceptualization of administrative burden. Specifically, the authors draw attention to three types of costs associated with administrative burden (p. 46):

1. Learning costs – a citizen must learn about the program, her eligibility for the program, and how to access the program.
2. Compliance costs – a citizen must complete an application, provide documentation, and respond to discretionary demands.
3. Psychological costs – the stigma, loss of autonomy, and increases in stress that may accompany program processes and participation, especially in an unpopular public program.

Analyzing the research on postsecondary application behavior, reviewed below, within an administrative burden framework supports an argument that those who apply to college, especially from those disadvantaged backgrounds, indeed experience learning costs, compliance costs, and psychological costs that may deter them from submitting an application.

A salient characteristic of administrative burden is opaqueness. Moynihan, Herd, and Harvey (2015) note that a burden's impact may be "only poorly understood by the public, or even most policy actors" (p. 52). Scholars may also fail to grasp the importance of administrative burden on up-take in a given area of social policy. This fact is relevant given this study's novel approach of considering application behavior and postsecondary access through the lens of administrative burden. Historically, research on postsecondary access in the United States has evaluated an individual's enrollment in college as the outcome of interest. Klasik (2012) points out that research examining disparities in college enrollment across subpopulations of students, for example, has largely embraced the notion that "the completion of applications is trivial" (p. 508). Only recently have scholars begun to systematically explore the submission of an application as a key requisite step in attending college (e.g. Bowen, Chingos, & McPherson, 2009; Hoxby & Turner, 2013; Klasik, 2012). Identifying the importance of submitting applications – what Klasik (2012) identifies as one basic step in the "college application gauntlet" (p. 506) – has in turn motivated the policy experiments (e.g. Hoxby & Turner, 2013) that seek to boost the rates at which student attend college by affecting their application behavior.

Moynihan, Herd, and Harvey (2015) similarly observe that "education is [a] policy area where burdens matter," and note that in the case of attending college, "high-achieving low-income students face learning costs that their better-advised high-income peers do not" (p. 45). They go on to briefly review recent literature demonstrating an increased probability of a student submitting

an application based on such burden-relieving interventions as assistance with applying for federal financial aid (Bettinger et al., 2012) or packets containing application-fee waivers and information about appropriate schools given the student's academic achievement and the net costs of attending college based on families' income levels (Hoxby & Turner, 2013). Building on Moynihan, Herd, and Harvey's (2015) brief review of the learning costs associated with applying to college, I review here how all three types of administrative burden costs are experienced in the college application process.

The *learning costs* associated with applying to college may involve such activities as investigating the universities to which a student might apply, visiting college campuses, researching the specifics of an institution's admissions policies, and gauging one's competitiveness for admission given an institution's level of selectivity. Learning costs for students from disadvantaged backgrounds are likely to be particularly steep given that these students often face challenges in navigating admissions processes (Holland, 2015b; Woods & Domina, 2014) and gauging their eligibility for selective colleges (McDonough, 1997). The steep costs of learning about potential colleges to attend and the college application process likely contribute to an observed phenomenon across the United States whereby college-bound students from disadvantaged backgrounds are more likely to submit applications to colleges that are less academically-competitive than those which the student is qualified to attend (Hoxby & Avery, 2013).

The submission of an application for admission is the observable behavior that represents applying to college but in reality the college application process often spans a high school student's junior and senior years (Avery & Kane, 2004). Given the duration of the process, the compliance costs of applying to college are significant. Completing an application, one of the key general tasks

associated with compliance costs identified by Moynihan, Herd, and Harvey (2015) in the context of applying to college, typically starts with paying for and taking standardized tests (either the SAT or ACT) in the student's junior year (Klasik, 2012).²⁹ High school students in their junior year must also organize lists of colleges and universities to which they will apply since applications are due in the early part of their senior year (Kirst & Bracco, 2004). The submission of a college application involves filling out extensive forms, submitted on paper or online, writing essays, sending standardized test scores and high school transcripts to colleges, and paying application fees, all of which can represent substantial compliance costs to manage. At more selective institutions, even more compliance costs may emerge when letters of recommendation and in-person interviews are encouraged or required as part of an application.

The psychological costs related to administrative burden, and in particular the stigma of applying to an unpopular program, are a well-researched area of the take-up, implementation, and program evaluation literature (Currie, 2006; Lipsky, 1980/2010; Moffit, 1983; Soss, 1999). Scholars have also recently identified potential stigmas that pervade the college application process. Holland (2015a) documents the stigma attached to applying to and attending a community college, especially for disadvantaged students who attend affluent high schools. The focus on elite, Ivy League universities at affluent high schools leave academically less-prepared students feeling ambivalent about community college even though this type of institution likely presents a potential option for such students who aspire to earn a postsecondary credential.

²⁹ Soares (2014) argues that eliminating standardized tests (e.g. the SAT or ACT) as an admissions requirement removes a substantial barrier that nonwhite and low-socioeconomic students face in applying to college; Belasco, Rosinger, & Hern (2014), on the other hand, observe that "Despite the clear relationship between privilege and standardized test performance, the adoption of test-optional admissions policies does not seem an adequate solution to providing educational opportunity for low-income and minority students" (p. 13).

4.2.1 *Washington State: High school counselors and Navigation 101*

Washington State serves as a qualitatively “typical” case to study frontline workers and the administrative burden associated with applying to public universities.³⁰ Washington State is a typical case in that the state’s characteristics align with national characteristics across important hypothesis-related dimensions. The K-12 public school student-to-counselor ratio in Washington in 2010, for example, was 510 to 1 compared to a national average of 471 to 1 (NACAC, 2012).³¹ The proportion of students aspiring to earn a bachelor’s degree or higher in 2010 in Washington also mirrors the proportion of students nationwide with similar postsecondary aspirations (73.7% and 74.8%, respectively).³² Finally, the distribution of public postsecondary universities in the state also offers a typical range of options in that Washington State has one selective flagship university, one moderately selective land grant university, and three regional comprehensive universities of varying selectivity. This mix of public postsecondary institutions in the state, and the characteristics of the applications students must submit to such institutions to enroll (discussed below), provides variation to analyze how frontline workers may ease administrative burden across organizational contexts (Table 1).

³⁰ A “typical” case is one in which the characteristics are assumed to represent some broader topic of interest (McNabb, 2010; Seawright & Gerring, 2008).

³¹ National figures for student-to-counselor ratios specific to public high schools are sparse but Hurwitz and Howell (2014) estimate that in 2008 (the most recent year of data they use in their study) the public high school student-to-counselor ratio nationwide was 319 to 1 (p. 318); I calculate Washington State’s public high school student-to-counselor ratio to average 342 to 1 between 2006 to 2010. Hurwitz and Howell (2014) observe that public high school student-to-counselor ratio in the United States ranged from a high of approximately 400 to 1 in Arkansas to, at the low end, the general vicinity of 200 to 1 in New England states (p. 318).

³² Aspirations alone do not lead to postsecondary enrollment and degree attainment (Ross & Kena, 2012) but this measure provides insight into the general degree-seeking attitudes of high school seniors in the state. These data capturing postsecondary aspirations, available upon request from the author, are derived for students in Washington State from the U.S. Department of Education’s nationally-representative High School Longitudinal Study of 2009.

TABLE 4-1: INSTITUTIONAL CHARACTERISTICS OF PUBLIC UNIVERSITIES IN WASHINGTON, 2010³³

	Undergrad Enrollment	Percent Low-Income	Percent Black, Hispanic, and Native American	Setting	Admit Rate
Flagship					
Univ. of Washington	29,307	22%	10%	Urban City	58%
Land Grant					
Washington State Univ.	21,796	24%	13%	Rural Town	70%
Regional Comprehensives					
Western Washington Univ.	13,809	19%	13%	Suburban City	74%
Central Washington Univ.	11,052	29%	17%	Rural Town	81%
Eastern Washington Univ.	10,218	34%	18%	Suburban Town	82%

The administrative burden individuals face in their pursuit of postsecondary education is not unique to public universities. What is unique is the relationship, both political (Cohen & Noll, 1998; Hicklin & Meier, 2008; Lowry, 2007; McLendon, 2003) and administrative (Coates, Humphreys, & Vachris, 2004; Moos & Rourke, 1959; Rabovsky, 2014; Volkwein & Malik, 1997), *between the state and the public university*. In this manner, the present study's focus on application submitted to public universities does not capture the entirety of Washington's postsecondary marketplace. Rather, like other public management and public administration studies that examine either public schools (e.g. Barrows et al., 2016; Destler, 2016; Weiss & Piderit, 1999) or public universities (e.g. Fryar & Hawes, 2011; Hicklin & Meier, 2008; Long, 2007; Rabovsky, 2014) as the public entity of interest, this chapter conceptualizes public high schools, a public program

³³ These institutional characteristics are based on data from the U.S. Department of Education's Integrated Postsecondary Education Data System. The "setting" of each university is a Carnegie classification for postsecondary institutions in the United States. For public universities with multiple branch campuses I include in this study only the main campus (e.g. University of Washington-Seattle and Washington State University-Pullman).

instituted by the Superintendent of Public Instruction, and public universities within a broad system of governance to explore the phenomenon of administrative burden.

Washington presents a unique opportunity to evaluate a school-level program designed to “help students make clear, careful, and creative choices for college and career readiness” (Newell, Hubert, & Ackelson, 2012) through enhanced frontline services. The program, Navigation 101, was authorized and funded by the state legislature in 2006 as a series of grants awarded to high schools throughout Washington State by the Superintendent for Public Instruction. Grants were awarded to particular high schools between 2006 and 2010; the program was expanded statewide in 2011.³⁴

Based on the fact that high-risk and high-achieving students often receive the bulk of attention from school counselors (Newell, Hubert, & Ackelson, 2012), Navigation 101 comprised five components in an attempt to reach all students at grant-recipient high schools (Newell, Hubert, & Ackelson, 2012, p. 6):

1. Regularly-scheduled semi-annual advisory periods for all students to develop relationships with counselors and teachers in order to “develop career and college readiness skills.”
2. Support for each student to develop a “planning portfolio” that contains a four-year plan with postsecondary preparation action items.

³⁴ The Office of the Superintendent for Public Instruction (OSPI) awarded grants to public high schools through one of two mechanisms. In most cases, school districts applied for and received Navigation 101 grants; districts receiving grants in turn awarded grants to high schools of their choice. Public high schools were also allowed to apply directly to OSPI for a Navigation 101 grant. A total of \$7.2 million was awarded to 139 public high schools between 2006 and 2010.

3. Student-led conferences at least once a year where a student, with her parents and a counselor or teacher, communicates her career and college readiness knowledge and shares her academic achievements, aspirations, and plans for the year ahead.
4. Course offerings based on projected student demand, which allow schools to respond to students' college aspirations by scheduling more college preparatory courses.
5. Implementation support provided by the state's Office of Superintendent for Public Instruction for the state's Comprehensive Guidance and Counseling Program, a guidance curriculum with aligned American School Counselor Association (ASCA) National Standards for Students.

The Navigation 101 authorization and budgetary appropriation in 2006 accompanied a state law passed the same year providing guidelines for comprehensive guidance and planning programs at public high schools. Pertinent to this study is Section 2(a) of the law stating that a comprehensive guidance and planning program in Washington State contain a curriculum including such topics as “postsecondary options and how to access them” (RCW 28A.600.045, 2006, p. 210). The statute notes that public high school counselors, in partnership with principals, were expected to implement these comprehensive guidance and planning programs set forth in RCW 28A.600.045.

Easing administrative burden, through counselors at a public high school and the presence of the Navigation 101 program, can thus be assessed via dimensions of both the quantity and quality of frontline workers. In other words, a higher physical count of counselors (a measure of quantity) or a counselor with a lower caseload may spread social capital resources more broadly

to students at a given public high school. Since the number of counselors at a high school relative to the school's enrollment varies because principals in Washington have discretion in setting counselor levels at high schools (Senate Ways and Means Committee, Washington State Legislature, 2011), I am able to leverage this variation to study the extent to which counselors and their caseloads are associated with particular types of application behavior. The receipt of the Navigation 101 program, alternatively, potentially enhances the *capability* of counselors to serve students at a public high school given a fixed number of such frontline staff. The hypotheses that follow test each of these suppositions.

4.2.2 *Hypotheses*

An analysis of administrative burden requires an empirical focus on the application stage of the process through which a citizen accesses a public program or policy. Yet this empirical focus on submitting an application does not make the application an outcome in and of itself relative to the broader context of the program's logic. Outcomes are the benefits, either short-term or long-term, that result from program participation (Poister, 2010). But since other factors in the environment influence outcomes, program managers and street-level bureaucrats are in a position to primarily affect outputs (McDavid, Huse, & Hawthorn, 2013).

Poister (2010) suggests that "in terms of program logic, outputs have little inherent value because they do not constitute direct benefits," even though outputs are "essential because they lead directly to...the causal sequence of changes that lead to the desired results" (p. 38). Poister's assertion about outputs and outcomes is particularly salient in identifying why administrative burden matters. The submission of an application is, by definition, an activity in the logic of taking

up a given social program or policy; application submission typically does not represent, in and of itself, the benefit around which a public program or policy is designed. Through the lens of administrative burden, however, application submission becomes not just one activity along a causal sequence that leads to an output and, subsequently, a desired outcome. Rather, the submission of an application becomes the necessary condition on which all subsequent activities, outputs, outcomes, and impacts³⁵ depend.

With application behavior defined as the consequential juncture in the logic of taking up public postsecondary education, Hypotheses #1 and #2 use public postsecondary application rates broadly to test if public high school counselors and Navigation 101 decrease administrative burden:

H1: Higher levels of counseling resources increase the odds of application submission by easing the administrative burden of applying to college.

H2: Receipt of the Navigation 101 grant increases the odds of application submission by easing the administrative burden of applying to college.

Boyne (2002, 2003) proposes that beyond measuring a quantity of outputs, performance can also be manifest as equity, with equity defined as the fairness of distributed benefits across groups. Given the established role that counselors seek to play in augmenting the social capital of students from low socioeconomic status (low-SES) and underrepresented minority (URM) backgrounds

³⁵ Riccio, Bloom, and Heinrich (2000) describe outcomes as individual-level benefits of a policy or program and impacts as “a valid estimate of the organization’s effects.” This distinction between outcomes and impacts is important in a multilevel framework because the organization and the organization’s effects (modeled at Level 2 or higher) is often of primary interest in public management and governance research (Heinrich, 2002).

(Freeman, 2005; Holland, 2015b; McDonough, 1997; O’Conner, 2000), the importance of this equity dimension yields Hypotheses #3 and #4:

H3: Higher levels of counseling resources increase the odds of application submission by easing the administrative burden of applying to college for students with disproportionately low levels of social capital (i.e. low-income students and students from underrepresented minority backgrounds).³⁶

H4: Receipt of the Navigation 101 grant focuses more school resources on students with disproportionately low levels of social capital thus increasing the odds of application submission by easing the administrative burden of applying to college.

Gill (2008, 2011) documents political circumstances where public organizations are held accountable for outputs and elected officials are held accountable for outcomes (as cited in McDavid, Huse, & Hawthorn, 2013, p. 66). This distinction provides an insightful way to think about these hypotheses relative to administrative burden, outputs, outcomes, and impacts. Measuring application rates as a consequential activity is plausible given a frontline worker’s direct contact with this particular administrative step. And as noted earlier, elected officials are

³⁶ The relationships among race, income levels, and social capital are complex but scholars have identified ways in which race and family income serve as observable proxies for lower levels of social capital. Freeman (2005), for example, observes that African American students who have lower levels of “[social] capital tend to perceive that the school can and should provide them the necessary guidance to steer them toward college” (p. 66). Likewise, McDonough (1997) observes that low-income students who lack social capital are “dependent upon the sponsorship of the guidance counselor to help them receive information and marshal the organizational resources that back their college applications” (p. 101). Hypotheses 3 and 4 thus follow this approach of inferring lower levels of social capital for low-income and underrepresented minority students compared to their more affluent and White/Asian-American peers, respectively.

rarely interested in the nuances and specifics of application processes (Moynihan, Herd, & Harvey, 2015).

Taking Gill's (2008, 2011) distinction between accountability for outputs and outcomes a step further and relating it directly to this study, the hypotheses tested here connect high school counselors and Navigation 101 to the one specific *activity* related to easing administrative burden: the submission of an application to one or more public universities in the state. Counselors deliver services (potentially enhanced by Navigation 101) to students to ease the administrative burden of applying to college and thus application behavior emerges as a salient activity to measure in the logic of pursuing postsecondary education. For this reason, the present study focuses on application submission alone to cultivate evidence on the extent to which frontline workers may ease administrative burden.

Moynihan, Herd, and Ribgy (2016) note that the characteristics of applications themselves (e.g. length, required documents that must be submitted with applications, etc.) are crucial to an analysis of administrative burden because an application is the gateway through which the citizen accesses a public program or policy. As application characteristics, and the level of administrative burden inherent in a given application, may vary across postsecondary institutions and thus may have a bearing on the hypotheses presented above, I evaluate applications similarly to Moynihan, Herd, and Ribgy (2016) in order to systematically assess administrative burden in a manner that contextualizes this study's empirical analysis and findings.

To carry out this theoretical evaluation of applications I adopt a qualitative document analysis protocol similar to that Moynihan, Herd, and Ribgy (2016) use to assess the inherent

burden of Medicaid applications.³⁷ This analysis of applications (Table 2) provides two types of indicators to gauge an application's potential burden:

1. Magnitude, measured by the length of the application (in pages and words) and the number of questions a hypothetical applicant would need to answer to complete the application.
2. Reporting burden, which measures the extent or range of information an applicant must provide information during the application process.

TABLE 4-2: PUBLIC UNIVERSITIES' APPLICATION CHARACTERISTICS, 2010

	Application Magnitude			Application Reporting Burden ³⁸			
	Length of Application ³⁹		Number of Questions	Academics	Socio-economics	Personal	Residency
	Pages	Words					
Univ. of Washington	20	10,969	232	5	2	4	3
Washington State Univ.	4	1,325	96	5	3	2	3
Western Washington Univ.	6	2,717	138	5	3	4	3
Central Washington Univ.	4	1,050	63	5	3	0	3
Eastern Washington Univ.	6	1,234	89	5	3	4	3

Interrater reliability⁴⁰ for reporting burden levels, 0.957 (p<0.001)

³⁷ The coding protocol mirrors Moynihan, Herd, and Ribgy's (2013) approach to the greatest extent possible. A full description of the process along with the instrument used for qualitative document analysis can be found in Appendix A.

³⁸ For the measures of application reporting burden, scores ranged from "0" if no information was requested in this area of the application to "6" in cases where "Information was required and proof/verification was required; applicant provides information in an open-ended format." Appendix A contains a detailed explanation of the instrument used for this coding process.

³⁹ Paper applications are coded because no public university archived its online application. I assume that the paper application mirrors the online application.

⁴⁰ I use Cohen's weighted kappa (Cohen, 1968) because of the ordinal nature of the administrative burden scale; see Appendix A for more details.

Whereas Moynihan, Herd, and Ribgy (2016) incorporate these burden measures into their quantitative analysis, I use these figures primarily to contextualize the statistical analysis evaluating relationships between frontline workers and application submission. Yet, independent from the statistical analysis, a cursory glance of Table 4-2 reveals important variation across public universities in application burden. First, all five public universities have equivalent levels of reporting burden for academics and residency, and nearly uniform burden relative to a student's reporting of her socioeconomic circumstances; the area of personal reporting burden (which includes such factors as extracurricular activities, nonacademic involvements, and hardships the student has experienced) is the only category that appears to vary meaningfully. The second observation that is readily apparent in Table 4-2 is the significant magnitude of the University of Washington's application compared to those of the other four public universities. Note that the page length and number of words comprising the University of Washington application is more than three times that of the next largest application, that of Western Washington University. I return to these figures from Table 2 in the discussion section of this study.

4.3 PUBLIC HIGH SCHOOL COUNSELORS AS FRONTLINE WORKERS

This study conceptualizes public high school counselors as street-level bureaucrats. Smith (2011) notes in passing that the contemporary role of American high school counselors has much in common with Lipsky's (1980/2010) classic conception of street-level bureaucrats. Lipsky (2010) himself notes, in the preface to the updated edition of his seminal 1980 publication, that "high school counselors" are on the front lines in a manner that is structurally similar to "judges,

police offices, and social workers” such that one could easily “compare these [frontline] work settings with each other” (xii). Beyond these brief references, however, no study has yet applied the broader street-level bureaucrat literature to public high school counselors in an empirical manner that measures how the number of frontline workers in a given public high school potentially supports and shapes the experience of students in pursuit of postsecondary education.

The theoretical intersection of the ideas of administrative burden and street-level bureaucrats is a natural one given that each represents an aspect of a citizen’s relationship with the state. As noted earlier, Moynihan, Herd, and Harvey (2015) define administrative burden as the costs that individuals experience in their interactions with the state. Lipsky (1980/2010) likewise positions street-level bureaucrats as the intermediary between citizen and state in noting that “street-level bureaucrats implicitly mediate aspects of the constitutional relationship of citizens to the state” (p. 4).

Reflecting on the research that has developed over the past three decades on street-level bureaucrats, Meyers and Vorsanger (2007) point out an important contradiction in that frontline workers are cast in one of three ways across the literature: as passive implementers largely beholden to bureaucratic and political decision makers; as individualistic bureaucrats whose discretion and autonomy can thwart higher-level officials; and as loyal public servants who pursue the public good even when it means bending agency regulations (Meyers & Vorsanger, 2007, p. 153). Reconciling these characteristics of street-level bureaucrats in the literature with extant scholarship on public high school counselors places these frontline workers squarely in the realm of public servants in pursuit of the public good. Indeed, in a review of contemporary research on high school counselors, Smith (2011) posits that an extensive literature confirms a supposition that school counselors “are at the front-line of serving the public good” (p. 801). This is not to say that

the role of the high school counselor has been static across time; the high school counselor's role has evolved from a generalist overseeing all non-instructional duties (Brewer, 1922) to a gatekeeper reinforcing social class (Cicourel & Kitsuse, 1963; Erickson & Schultz, 1982) to an advocate (Hart & Gray, 1992) to a full-fledged "intermediary, one who negotiates, mediates, brokers, and acts," to "distribute information and provide guidance" in a manner that shapes "students' aspirations and plans for achieving them" (Smith, 2011, p. 800).

Maynard-Moody and Portillo (2010) identify five general characteristics of street-level bureaucrats. These five characteristics provide a scaffolding to both make sense of how high school counselors operate as frontline workers in general and, in particular, how these frontline workers may alleviate the administrative burden that citizens face in applying to college. The first characteristic is the worker's "frontline" status itself, that is, who they are and their organizational status. For this question of status it is useful to consider the counselor as akin to a teacher within the organizational setting of a public high school; the counselor and the teacher are prototypical examples of street-level bureaucrats (Lipsky, 1980/2010) in that they reside at the lower levels of an organization's hierarchy and do not typically aspire to higher level positions, e.g. schoolwide administrator or principal.

The second characteristic of street-level bureaucrats is direct contact with citizens, what Maynard-Moody and Portillo, among others (e.g. Prottas, 1979) call "people processing." People processing is the daily duty to deliver services to individuals based on the tasks for which the frontline worker is responsible. In the case of high school counselor these tasks are wide-ranging. An inventory of guidance-related tasks for which counselors are responsible include daily meetings with students to advise on curricular choices and post-high school planning; coordinating students' activities related to the college application process; and serving as an "on call" resource

for students from disadvantaged backgrounds and their parents (Blume, 2014a; Dixon, Jeffers-Coly, & Smith, 2014; Huerta, 2014; Smith, 2011).⁴¹ Each of these tasks involves direct contact with students and their families. Particularly important to alleviating administrative burden, this “people processing” role means counselors witness firsthand students’ encounters with the learning costs and compliance costs involved in submitting college applications.

Workplace responsibilities involving discretion that, in turn, shape citizens’ experiences are the third characteristic that defines frontline workers. The discretion that counselors exercise in advising students has been a longstanding focus of the research on high school counselors (Smith, 2011). Early studies focused on the ways in which counselors served as gatekeepers and perpetuated inequitable access to higher education (Cicourel & Kitsuse, 1963; Erickson & Schultz, 1982). This literature gave way to contemporary scholarship that finds counselors exercise discretion oriented toward social justice in general (Dahir & Stone, 2009; McDonough, 2005; Singh et al., 2010) and creating educational opportunities for disadvantaged students in particular (Bemuk & Chung, 2005). Regardless of a general orientation toward equity, however, counselors have no rigid set of criteria for how to advise a student as she navigates the high school experience and plans for college or entry into the workforce. Thus, a counselor’s discretion becomes a critical driver in determining how to effectively and efficiently work with students.

Maynard-Moody and Portillo’s (2010) remaining two characteristics of street-level bureaucrats relate to autonomy. The fourth shared trait among front-line workers is that they have autonomy from higher-level authorities. In a public school setting this autonomy sets teachers and counselors apart from principals. Teachers and counselors are the school’s staff who interact

⁴¹ These guidance-related tasks are only one part of what McDonough (2005) calls a high school counselor’s “multiple personalities” (p. 17). Discipline, course registration, and the administration of standardized tests are but a few of the responsibilities that also compete for a counselor’s limited time and attention (House & Hayes, 2002; Lee & Ekstrom, 1987; McDonough, 2005).

directly with students throughout the school day; while responsible for the school and its operation, the principal does not directly supervise these teachers and counselors. Maynard-Moody and Portillo (2010) point out that this autonomy has its drawbacks. Frontline workers are largely autonomous actors but they are also largely removed from resource allocation decisions. This again parallels the experience of school counselors. Research has long documented the fact that counselors are expected to perform a host of duties with few resources, either financial or organizational, at their disposal (Lee & Ekstrom, 1987; McDonough, 2005; Woods & Domina, 2014).

The final characteristic that defines front-line workers is their policymaking capacity, which is derived from the discretion and autonomy afforded to their position in an organization. This is the essence of Lipsky's (1980/2010) underlying hypothesis that, through implementing policy, frontline workers in fact create policy. The most salient example of counselors as street-level bureaucrats is perhaps the *de facto* implementation and policymaking responsibilities assigned to counselors in the era of No Child Left Behind (Dollarhide & Lemberger, 2006; Sink, 2009). Various accountability measures that became a hallmark of No Child Left Behind almost always fell to counselors as the school staff responsible for administering the host of standardized tests on which accountability measures were based. Although beyond the scope of this study, counselors' roles as implementers of No Child Left Behind presents clear evidence to solidify their role as frontline workers in American public high schools.

Having established this conceptualization of the high school counselor as a frontline worker, I turn to the extant empirical literature on high school counselors to review what is known about their effects on students' postsecondary choice making. Research on high school counselors related to this topic takes on one of two themes. The first theme revolves around the general impact

that counselors have on students' college application and enrollment rates. This research is primarily quantitative and demonstrates a positive relationship between the level of counseling resources in a given high school and a particular postsecondary enrollment choice. Belasco (2013) finds that more one-on-one interactions between the high school student and counselor increase the odds of a student enrolling at a four-year university. Hurwitz and Howell (2013) similarly find that the addition of one full-time equivalent (FTE) counselor at a high school leads to a ten percentage-point increase in the proportion of the senior class attending a four-year college or university.

The second theme present in the counselor literature focuses on how counselors support students from disadvantaged backgrounds in their pursuits of postsecondary education. This literature, generally qualitative, demonstrates that counselors play an active role in students' college application process especially across first-generation, low-income (Holland, 2015b; McDonough, 1997), and underrepresented racial/ethnic groups (Gonzalez, Stoner, & Jovel, 2003; McKillip et al., 2012; Muhammad, 2008). The varying multiple roles of the counselor in this context is one of providing emotional (McDonough, 1997), guidance (McKillip et al., 2012), and technical (Belasco, 2013) support to these disadvantaged students as they navigate the barriers associated with college enrollment.

The empirical literature on high school counselors can be extended in a straightforward manner to the learning costs and compliance costs that comprise administrative burden. To apply this literature to administrative burden, however, a brief discussion to connect social capital theory and administrative burden is worthwhile since much of the literature on counselors draws from this social capital framework.

4.3.1 *Frontline workers as a source of social capital*

Assuming that social capital constitutes the social structure that actors leverage to achieve their interests, Coleman (1988) observes that social capital flows through three types of resources: information channels, support, and social norms. Coleman posits that an individual's level of social capital is the product of this network of forms of social infrastructure; low levels of social capital are attributable to restricted access to information, support, and the inculcation of relevant norms, while high levels of social capital are the result of unfettered access to these three resources.

I present this background on social capital theory to make the case that information channels and support, two conduits for social capital, map onto administrative burden's learning costs and compliance costs, respectively. Administrative burden's high learning costs are synonymous with limited access to information. Likewise, the potential high compliance costs of submitting an application and navigation of complex application processes without help are akin to the lack of support that inhibits the flow of social capital. Identifying these connections between learning costs and information (within social capital theory), and compliance costs and support (within the administrative burden framework), thus explain the underlying logic of how and why high school counselors alleviate administrative burden: a rich literature on counselors demonstrates that counselors seek to "backfill" the low levels of social capital that disadvantaged students need in order to learn about and navigate an application process that may otherwise be too burdensome to surmount.

In following a group of students through their senior year, for example, McDonough (1997) explains how counselors help low-income students explore their options for college, organize their college search processes, and gauge their competitiveness in terms of admission requirements.

These are all learning costs of the college application process that a counselor can reduce. Drawing from March and Simon's (1958) work on how organizations support individuals' decision making processes, McDonough presents counselors in a social capital framework where counselors deliver information through "handbooks, the array of college representatives they invite to the school, the information packets they keep on hand to pass out to students, and the collective seminars and individual advising sessions" in which they engage daily (p. 108). In a similar study on how counselors serve students from varying socioeconomic backgrounds, Holland (2015b) argues that counselors provide critical information that directly facilitates college attendance. Holland also finds that counselors consider providing information about the college application process a central part of their job.

In terms of compliance costs, counselors are essential frontline actors in helping students navigate the technical complexities of filling out and submitting college applications (McKillip et al., 2012; Perna et al., 2008). Conceptualizing student-counselor interactions as a type of social capital transaction that allows counselors to assist students with the college application process, Bryan and colleagues (2011) find that a higher number of counselors in a high school, coupled with more frequent interactions between students and counselors, modestly increase the odds that a student will submit at least two college applications. Bryan et al. (2011) hypothesize that more frequent interactions afford counselors an opportunity to provide support specifically to disadvantaged students, such as those with parents who did not attend college, in an effort to make up for low baseline levels of social capital.

4.4 METHODS

This chapter estimates a series of hierarchical generalized linear models (HGLMs) since the citizen-level behavior of interest (i.e. the act of submitting an application) is nested within public organizations (high schools). The HGLM approach extends a conventional generalized linear model in that modeled intercepts and slopes can vary randomly at the group level. A strong theoretical case for the use of multilevel models has been made in the management literature (Lynn, Heinrich, & Hill, 2000; Heinrich & Hill, 2010; Heinrich & Lynn, 2001; Hicklin, 2010). Multilevel modeling is common in education research (Garson, 2013; Raudenbush & Byrk, 2001) but the versatility of the method has also led to its use in a diverse array of public policy and management topics ranging from the effects of antidiscrimination policies on earnings by sexual orientation (Klawitter, 2011) to the extent that collaborative governance improves environmental outcomes (Scott, 2015). Echoing May & Winter (2007), this study employs multilevel models as a “conceptually and statistically superior” (p. 461) approach to detect “theoretically relevant cross-level interactions and main effects” given a focus on organization-level variables.

HGLMs allow for greater statistical precision compared to ordinary least squares estimates by accounting for school-level Level 2 effects on Level 1 (student-level) outcomes of interest (Garson, 2013; Raudenbush & Byrk, 2001). Specifically, Level 1 [Eq. 1] models for student i at public high school j the log odds of application submission, controlling for student i 's GPA at graduation, the number of AP courses completed during high school, and if the student ever took calculus. I also include the student's gender, membership in an underrepresented racial/ethnic group (URM), receipt of free or reduced price lunch (FRPL), and interactions of these variables:

$$\begin{aligned} \eta_{ij} = & \beta_{0j} + \beta_{1j}(\text{GPA}_i) + \beta_{2j}(\text{AP}_i) + \beta_{3j}(\text{Calculus}_i) + \\ & \beta_{4j}(\text{Gender}_i) + \beta_{5j}(\text{URM}_i) + \beta_{6j}(\text{FRPL}_i) + \\ & \beta_{7j}(\text{FRPL}_i \times \text{URM}_i) + \beta_{8j}(\text{FRPL}_i \times \text{URM}_i \times \text{Gender}_i) \end{aligned} \quad [\text{Eq. 1}]$$

where η_{ij} is a logit link function generating the log odds of the outcome i.e. $\log(\varphi_{ij}/1 - \varphi_{ij})$ where φ_{ij} is the probability of application submission for student i at high school j . The nature of the HGLM model is such that the intercept at Level 1, β_{0j} , randomly varies and is modeled at Level 2 by school-level characteristics, management variables, and school-student cross-level effects;

$$\begin{aligned} \beta_{0j} = & \gamma_{00} + \gamma_{01}(\text{ENROLL}_j) + \gamma_{02}(\overline{\text{FRPL}}_j) + \gamma_{03}(\text{DIST}_j) + \\ & \gamma_{04}(\text{CounselorFTE}_j) + \gamma_{05}(\text{Nav101}_j) + \\ & \gamma_{06}(\text{CounselorFTE}_j \times \text{Nav101}_j) + \\ & \gamma_{07}(\text{CounselorFTE}_j \times \text{URM}_i) + \gamma_{08}(\text{CounselorFTE}_j \times \text{FRPL}_i) + \\ & \gamma_{09}(\text{Nav101}_j \times \text{URM}_i) + \gamma_{10}(\text{Nav101}_j \times \text{FRPL}_i) + r_{0j} \end{aligned} \quad [\text{Eq. 2.1}]$$

That is, for each high school j , Level 2 includes the enrollment of the school (ENROLL_j) and the percentage of students at the school eligible for free and reduced-price lunch ($\overline{\text{FRPL}}_j$). When applicable, the model also contains the distance (DIST_j , in drive-time minutes) between the public high school and the in-state postsecondary institution for which the application probability is calculated.

Level 2 contains the two key variables to test this study's hypotheses pertaining to alleviating administrative burden: CounselorFTE_j represents an average number of counselors (as a full-time equivalent, FTE, count) at high school j , between 2006 to 2010, and Nav101_j indicates

whether high school j was a grant recipient of the Navigation 101 program during the same period. Additionally, an interaction between these two terms ($CounselorFTE_j \times Nav101_j$) tests the extent that receipt of the Navigation 101 grant amplified the effect of counseling levels.⁴²

The consideration of counselor *caseloads* presents an alternative approach to examine the extent to which counselors alleviate the administrative burden of submitting postsecondary applications. To empirically model caseloads I replace the $CounselorFTE_j$ variable with the counselor-to-student ratio for school j ($CounselorRATIO_j$):

$$\begin{aligned} \beta_{0j} = & \gamma_{00} + \gamma_{01}(ENROLL_j) + \gamma_{02}(\overline{FRPL}_j) + \gamma_{03}(DIST_j) + \\ & \gamma_{04}(CounselorRATIO_j) + \gamma_{05}(Nav101_j) + & \text{[Eq. 2.2]} \\ & \gamma_{06}(CounselorRATIO_j \times Nav101_j) + \\ & \gamma_{07}(CounselorRATIO_j \times URM_i) + \\ & \gamma_{08}(CounselorRATIO_j \times FRPL_i) + \\ & \gamma_{09}(Nav101_j \times URM_i) + \gamma_{10}(Nav101_j \times FRPL_i) + r_{0j} \end{aligned}$$

I consider the counselor caseload variable in a manner similar to other studies that have hypothesized that all else equal, lower caseloads increase the frontline worker's effectiveness (Hill, 2006) and higher caseload levels present a barrier between client and frontline staff (Brintnall, 1981; Garrow & Grusky, 2012; Jewell & Glaser, 2006; Rice, 2012; Weissert, 1994).

⁴² The inclusion of an interaction term can be problematic in a logit model. The nonlinear nature of the logit can lead to the inconsistent estimation of the magnitude, direction, and statistical significance of the interaction's effect (Ai & Norton, 2003). Two characteristics of the HGLMs I use in this study, however, remedy the potential problems that arise with interaction terms in conventional logit models. First, recall that the random intercept I model at Level 2 is based on school-level characteristics and the interaction terms of interest (e.g. $CounselorFTE_j \times Nav101_j$). The nature of a HGLM is such that random intercepts are the result of ordinary-least squares (OLS) regression at higher levels (Snijders & Bosker, 2012). Relative to including an interaction term in a nonlinear logit model, this means in the context of an HGLM that the interaction is actually a component of the linear, OLS model at Level 2. Second, I intentionally use odds ratios for interpretation because the odds ratio, as a multiplicative effect, accounts for the nonlinear nature of the model (Buis, 2010). The use of odds ratios introduces a modest amount of complexity when interpreting the overall odds of application submission, a point I return to later in the findings section of this chapter.

A series of four interactions at Level 2 (Equation 2.1 and 2.2) leverage the multilevel model's ability to examine across the hierarchical structure of the data how a school-variable in conjunction with a Level 1 student characteristic may affect the odds of application submission. Smith (2006) observes that multilevel models are well-suited when hypotheses seek to test to what level of the hierarchy variation in individual outcomes are attributable (p. 82). Specifically, I interact the level of counseling resources at school j (*CounselorFTE* or *CounselorCASELOAD*) and school j 's receipt of Navigation 101 (*Nav101*) with student-level characteristics (receipt of free or reduced price lunch, FRPL, and being from an underrepresented minority group, URM) that are known to predict disadvantage in the pursuit of postsecondary education (Perna, 2000; McDonough, 2005; Klasik, 2012). These interactions, known as cross-level effects in the multilevel modeling literature, thus illustrate how specific subpopulations of students may be differentially affected by school-level factors.

Finally, to account for variation in district-level resources, Level 2's random intercept is modeled as a function of district-level expenditures per student. Specifically,

$$\gamma_{00} = \pi_{000} + \pi_{00j}(\text{EXPENDITURES}) + u_{00j} \quad [\text{Eq. 3}]$$

Ideally per-student expenditures would be included at the school level but these school-level budget data have only become available in Washington since 2013. As such, the model leverages the budget data available for the relevant years, which exist only at the district level (Level 3).

Multilevel models are warranted when outcomes are significantly correlated at the group level. This level of correlation, expressed as the intraclass correlation coefficient, represents what Snijders and Bosker (2012) call "the degree of resemblance between micro-units belonging to the same macro-unit" (p. 17). Following the Snijders and Bosker (2012) formula to calculate an

intraclass correlation coefficient for a logistic distribution, namely $p = \frac{\tau_0^2}{\tau_0^2 + \pi^2/3}$ where τ_0^2 is the intercept's variance and $\pi^2/3$ is the variance for the logistic distribution of Level 1 residuals, I find a substantial level of within-group correlation across the application outcomes modeled in this study (Table 4-3).

TABLE 4-3: INTRAClass CORRELATION COEFFICIENTS FOR APPLICATION SUBMISSION BY UNIVERSITY

Application submission	<i>p</i>
All publics	0.21
Flagship	0.26
Land Grant	0.12
Comprehensives	0.13

A general rule of thumb for interpreting intraclass correlation coefficients is that any value greater than 0.05 suggests that within-group correlation will bias standard errors and, accordingly, a multilevel model is warranted to address such bias (O'Connell, Goldstein, Rogers, & Peng, 2008).

A broad consensus in the multilevel modeling literature affirms a need to transform continuous variables in hierarchical models (Garson, 2013; Gelman & Hill, 2006; Raudenbush & Byrk, 2001; Snijders & Bosker, 2012) for interpretability and model convergence. The convention is to center and standardize the variable. Hence all continuous variables in the models that follow are centered and standardized with the exception of the logged AP variable. The AP variable is logged assuming that an incremental increase in AP courses at the lower end, say from two AP classes to three AP classes, is more impactful in predicting application behavior than is an increase from a student's 8th to 9th AP class (Long, Conger, & Iatarola, 2012).

I fit three separate GLMMs to examine application submission to the state's flagship university, application submission to the state's land grant university, and application submission

to one of the state's three regional comprehensive universities. I use separate models based on empirical and theoretical considerations. Empirically, I use three models because application submission is not mutually exclusive. A student may choose to apply to the state's flagship university and the state's land grant university, thus making a single model (e.g. a multilevel multinomial logit) inappropriate. Theoretically, I assume that the potential for counselors' and Navigation 101 to alleviate administrative burden will vary across the three types of institutions to which students apply. I contend here, based on the discussion earlier of varying application burden levels across institutions, that institutional heterogeneity and varying levels of application burden makes application behavior distinct based on the institution and the characteristics of each institution's application.⁴³

For each outcome of interest, I fit the model with baseline student characteristics and two versions of the full model (Equation 2.1 and 2.2) with Level 2 characteristics and the Level 3 control for district-level per-student expenditures. I fit multiple versions of the models for two reasons. First, a comparison of the two models provides insight into the extent to which school and district-level characteristics change the direction and magnitude of student-level coefficients. Second, since the baseline student-level model is nested in the full model, I use model selection criteria, such as the Akaike Information Criterion and the Bayesian Information Criterion (AIC and BIC, respectively), to verify the empirical value of including Level 2 variables.

Finally, to ease interpretation of the logit coefficients I exponentiate the coefficients to calculate odds ratios. I exponentiate the coefficients so that they can be interpreted as having a

⁴³ The error terms of these three models are likely correlated and therefore produce unbiased, but inefficient, estimates. Noting that in this situation the estimation of models in "seemingly unrelated regressions" would yield efficient estimates, Long (2004, p. 328) uses semiparametric generalized least squares to estimate such a system. The implementation of this approach relative to multilevel modeling, however, presents a technical challenge beyond the scope of this study and, as such, I proceed with the use of three distinct equations with an acknowledgment of their inefficiency.

multiplicative effect on the baseline odds for a given outcome.⁴⁴ I also present 95% confidence intervals for each odds ratio. Since odds ratios are generally interpreted relative to their effect on the baseline odds of a given outcome (Agresti, 2007; Buis, 2012) I am careful to interpret the key odds ratios of interest this way in the results section that follows.

4.5 DATA

This study leverages an extensive administrative data set to analyze the extent that frontline workers ease for public high school students the administrative burden of applying to college. The core of these data is the universe of students who graduated from Washington public high schools in 2010 (n= 50,582), which was the year before Navigation 101 was expanded statewide. Provided by the state's Office of Superintendent for Public Instruction (OSPI), these data contain each student's demographic characteristics and academic records. Table 2 contains a summary of student-level characteristics.

⁴⁴ Additionally, recall that odds ratios remedy the problems that may otherwise arise with interacted terms in a logit model (Buis, 2010).

TABLE 4-4: DESCRIPTIVE CHARACTERISTICS OF STUDENT POPULATION⁴⁵
(n=50,582)

	Mean (SD)	Median	Proportion
Academic			
Grade point average	2.92 (0.68)	2.98	-
Number of AP courses	1.28 (2.81)	0	-
Number of IB courses	0.33 (2.11)	0	-
Completed an AP course at any point in high school	-	-	0.29
Completed an IB course at any point in high school	-	-	0.04
Took calculus at any point in high school	-	-	0.12
Demographic			
Male	-	-	0.49
Eligible for federal free or reduced-price lunch	-	-	0.28
From an underrepresented minority background	-	-	0.19

I merged application data from each of the state’s five public universities to these baseline student-level data. The application data contain records for Washington resident high school graduates who applied for admission to the state’s public universities for fall quarter of 2010. From these application data, I constructed three dichotomous variables to serve as dependent variables: application submission to the state’s flagship university, application submission to the state’s land grant university, and application submission to one of the state’s three regional comprehensive universities.⁴⁶

⁴⁵ The nature of this cohort – that is, public high school students who persist to graduation – requires an acknowledgement that some of these descriptive characteristics would be much different for the *entire* student population of the state’s public high schools. For example, consider that in the 2009-2010 academic year approximately 7.3% of the state’s 12th graders dropped out, with a disproportionate number of these students being low income and of African-American, Hispanic/Latino, or American Indian backgrounds (Ireland, 2011).

⁴⁶ The state’s flagship university is the University of Washington located in Seattle. Washington State University, the state’s land grant university, is located in Pullman. The state’s three regional comprehensive universities are Western Washington University (Bellingham), Central Washington University (Ellensburg), and Eastern Washington University (Cheney). Since I am interested in how application behavior varies across institutional type I refer to these institutions generically (e.g. using the term “flagship university” instead of “UW”) throughout the study.

I also merged additional school-level and district-level characteristics to each student record. School and district characteristics were collected from multiple sources. The U.S. Department of Education's National Center for Education Statistics Common Core of Data (NCES-CCD) provided school characteristics such as school-wide enrollment and percentage of students receiving free or reduced-price lunch. Using a geographic package for the statistical software R with a built-in application program interface (Kahle & Wickham, 2016), I created a code loop to cycle through each Washington high school's latitude and longitude coordinates to query Google Maps and collect the drive time (in minutes) between every public high school and every public university in the state. I gathered district-level expenditures-per-student from financial data housed at the state's Office of Superintendent for Public Instruction's division of public finance. Each of these school-level and district-level variables were included in the data set as controls based on existing research suggesting an association between the variable and postsecondary application or enrollment behavior (Table 4-5).

TABLE 4-5: DESCRIPTIVE CHARACTERISTICS OF PUBLIC HIGH SCHOOLS AND DISTRICTS
(Schools, n = 295; Districts, n = 183)

Variable	Mean (sd.)	Median	Data source
Total public high school enrollment	882.3 (551.1)	741	NCES
Proportion eligible for federal free or reduced-price lunch	0.42 (0.17)	0.38	NCES
Public high school counselor FTE (Full Time Equivalents)	2.51 (1.52)	2	OSPI
Public high school student-to-counselor ratio	340 to 1 (103.4)	341	OSPI
Distance between high school and flagship university (minutes)	84.1 (73.1)	58.5	Google Maps
Distance between high school and land grant university (minutes)	216.9 (75.8)	248.1	Google Maps
District expenditures-per-student	\$12,470 (3,170)	\$12,060	OSPI

The Office of the Superintendent for Public Instruction provided two additional school-level variables central to this study's hypotheses connecting public services and resources to easing administrative burden. First, state administrative personnel records provided the average counselor full-time equivalents (FTEs) for each of the state's high schools from 2006 to 2010. Second, Navigation 101 implementation records from OSPI's Office of Comprehensive Guidance and Counseling captured the extent to which a high school received Navigation 101 grant funding between 2006 and 2010.

4.6 RESULTS

In this section I focus on two conceptualizations of frontline workers, the public high school counselor full-time equivalent count (FTE) and the counselor caseload, measured as a ratio of students to counselors in a given public high school. I also discuss the extent to which the receipt of a Navigation 101 grant is associated with a higher odds of application submission. I find general evidence that *higher* numbers of counselors and *lower* counselor caseloads increase the odds of application submission but this relationship is not uniform across postsecondary institution types. I also find that in the case of submitting applications to the flagship university or the regional comprehensive university, the frontline worker variables do not affect the overall population of high school students but have a statistically-significant effect on the odds of application submission for low-income and nonwhite students.⁴⁷ I find no association between Navigation 101 and the odds of application submission except in the case of regional comprehensive universities; the combined receipt of a Navigation 101 grant *and* a lower counselor caseload increase the odds of application submission at this postsecondary institution type.

The results presented here focus on the school-level covariates hypothesized to ease administrative burden – namely, counselors as frontline workers and a school’s receipt of Navigation 101 grants, and the cross-level effects of interacting these variables with student demographic characteristics – and require an appropriate interpretation of the multilevel models’ coefficients. For example, the interpretation of how a higher number of counselors affects the odds that a low-income student submits an application requires consideration of three coefficients: the

⁴⁷ In this section of the chapter I will use the term “effect” to describe a particular variable’s effect on the baseline odds. I make this distinction to acknowledge I am not implying a causal relationship in a manner that “effect” is often used (Konisky & Reenock, 2013).

student-level (Level 1) free and reduced-price lunch coefficient, the organization-level (Level 2) counselor FTE coefficient, and the cross-level interaction between school-level counselor FTE and student-level free and reduced-price lunch variable. In this example, the odds ratio is ultimately:

$$e^{(\beta_{6j}(\text{FRPL}=1) + \gamma_{04}(\text{CounselorFTE}=1) + \gamma_{08}(\text{CounselorFTE}=1 \times \text{FRPL}_i=1))}$$

This example is useful not only to illustrate the complexity of simultaneously interpreting multiple coefficients in the model but also demonstrates the utility gained from standardizing and centering the model's continuous variables. The interpretation of this particular combination of variables assumes that all other variables in the model are held at their mean while the counselor FTE variable is increased one standard deviation (in this case, $\sigma = 1.52$) above the mean.⁴⁸

With this in mind I begin by analyzing application submission to the state's public flagship university. Table 4-6 reports the results of the Level-1 model and the Level-1 model with the key counselor and Navigation 101 variables of interest. These coefficients provide a starting point to interpret the effect of the counselor FTE and the counselor caseload odds ratios on the baseline odds of application submission. Consider the odds ratio for increasing counselor FTE by one standard deviation, which is 1.282 or a 28.2% increase ($1.0 - 1.282 = 0.282$) relative to the baseline odds of application submission, 0.021, which is interpreted as a 2.06% chance (i.e. $0.021/(0.021+1) = 0.02056$) that a public high school student in Washington will submit an application to the state's flagship university. The multiplicative effect of increasing the count of counselors by one standard deviation on the baseline odds yields a new overall odds of application submission of 0.027 to 1 odds converts to a 2.63% probability. This example demonstrates Buis's (2012) observation that

⁴⁸ In Washington State the number of counselors as any given high school is measured as an FTE but is not constrained as whole numbers, e.g. a high school principal could set the counselor FTE at a school as 0.2, 1.74, or 5.0 if she so chose.

when interpreting odds ratios, a “baseline value can play an important role in evaluating how large an effect is” (p. 167).

The interpretation of the counselor caseload odds ratios merits special attention since the nature of a caseload is such that a *lower* caseload is hypothesized to ease the barriers a frontline worker faces in service delivery (Brintnall, 1981; Heinrich, 2002; Riccio, Bloom, & Hill, 2000; Rice, 2013; Woods & Domina, 2014). The interpretation of the caseload odds ratio also warrants an explanation since this variable is a ratio; following Woods and Domina (2014) I standardized the caseload variable and interpret here how a *lighter* counselor caseload may affect the overall baseline odds of application submission. Returning to Table 4-6, on the surface the odds ratio for the counselor caseload is 0.911, which means a one-unit increase in the caseload decreases the odds of application submission by 8.9% ($1 - 0.911 = 0.089$). But the interpretation of the caseload’s effect on the baseline odds can also be considered as a one-unit *decrease* in the counselor caseload. In other words, a counselor’s decreased caseload by one standard deviation (i.e. from an average of 340 students down to 237 students to every one counselor) is associated with an 8.9% increase in the odds of application submission to the flagship university.

Examining the Level 1 odds ratios of the full multilevel models for application submission to the flagship university (Table 4-7) reveals largely unsurprising results.⁴⁹ A higher GPA, more AP classes, and taking calculus sometime in high school all increase the odds of submitting an application to the state’s flagship university. Males and students from underrepresented backgrounds also have higher odds of application submission compared to females and White/Asian-American students, respectively. But while students who are both low-income and

⁴⁹ Table 4-7, 4-9, and 4-11 contain two versions of the full multilevel model. The model in the first column contains the counselor FTE variable while the second column’s model contains the counselor caseload variable. A benefit of the multilevel model in this circumstance is that the use of two different counselor-related variables leads to minimal changes to the Level 1 coefficients.

from underrepresented background have no higher odds of application submission compared to their nonwhite, non-low-income peers, note the odds of application submission to the state's flagship university for a male student who is poor and from an underrepresented racial/ethnic background are 34% lower when compared to all other students in the state.

TABLE 4-6: APPLICATION SUBMISSION TO FLAGSHIP UNIVERSITY, BASELINE MODEL

	Student-Level Model		Student-Level Model with Counselor = FTE, Nav101		Student-Level Model with Counselor = CASELOAD, Nav101	
	Est. (s.e.)	Odds Ratio (95% CI)	Est. (s.e.)	Odds Ratio (95% CI)	Est. (s.e.)	Odds Ratio (95% CI)
Intercept	-3.310 (0.035)	0.017 (0.014 - 0.020)	-3.883 (0.105)	0.021 (0.017 - 0.25)	-4.015 (0.103)	0.018 (0.015 - 0.022)
GPA	1.239*** (0.021)	3.451 (3.307 - 3.603)	1.719*** (0.029)	5.582 (5.273 - 5.908)	1.718*** (0.027)	5.578 (5.274 - 5.904)
Number of AP classes (log)	0.755*** (0.018)	2.129 (2.052 - 2.209)	0.738*** (0.027)	2.091 (1.984 - 2.204)	0.743*** (0.027)	2.103 (1.995 - 2.216)
Ever took calculus	0.443*** (0.038)	1.558 (1.445 - 1.679)	0.422*** (0.039)	1.526 (1.402 - 1.661)	0.419*** (0.043)	1.521 (1.397 - 1.655)
Free/Reduced Price Lunch (FRPL)	-0.309*** (0.045)	0.734 (0.671 - 0.802)	-0.032 (0.061)	0.969 (0.876 - 1.072)	-0.033 (0.051)	0.968 (0.875 - 1.071)
Underrepresented Minority (URM)	0.184*** (0.055)	1.203 (1.078 - 1.340)	0.302*** (0.061)	1.352 (1.199 - 1.525)	0.303*** (0.061)	1.353 (1.200 - 1.526)
Male	0.307*** (0.030)	1.359 (1.280 - 1.443)	0.373*** (0.033)	1.452 (1.361 - 1.549)	0.374*** (0.033)	1.453 (1.362 - 1.550)
FRPL x URM	0.056 (0.102)	1.058 (0.865 - 1.292)	0.147 (0.111)	1.158 (0.931 - 1.440)	0.143 (0.111)	1.153 (0.927 - 1.434)
FRPL x URM x Male	-0.421** (0.129)	0.656 (0.508 - 0.843)	-0.455** (0.136)	0.635 (0.486 - 0.828)	-0.455*** (0.136)	0.635 (0.486 - 0.828)
Counselor FTE			0.249*** (0.058)	1.282 (1.145 - 1.436)		
Counselor CASELOAD					-0.093* (0.050)	0.911 (0.825 - 1.006)
Navigation 101 (ever received grant)			-0.128 (0.123)	0.880 (0.691 - 1.120)	-0.145 (0.123)	0.865 (0.679 - 1.101)
AIC		27,864.5		27,599.3		27,575.1
BIC		27,917.7		27,674.6		27,690.4

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE 4-7: APPLICATION SUBMISSION TO FLAGSHIP UNIVERSITY, FULL MODEL

	Full Multilevel Model with Counselor = FTE		Full Multilevel Model with Counselor = CASELOAD	
	Est. (s.e.)	Odds Ratio (95% CI)	Est. (s.e.)	Odds Ratio (95% CI)
Intercept	-3.797*** (0.086)	0.022 (0.019 – 0.027)	-3.795*** (0.085)	0.022 (0.019 – 0.027)
GPA	1.717*** (0.029)	5.573 (5.263 - 5.901)	1.178*** (0.029)	5.573 (5.263 - 5.901)
Number of AP classes (log)	0.721*** (0.027)	2.056 (1.950 - 2.168)	0.723*** (0.027)	2.061 (1.955 - 2.173)
Ever took calculus	0.441*** (0.044)	1.554 (1.426 - 1.694)	0.438*** (0.044)	1.550 (1.422 - 1.689)
Free/Reduced Price Lunch (FRPL)	0.019 (0.064)	1.019 (0.900 - 1.155)	0.004 (0.063)	1.004 (0.888 - 1.136)
Underrepresented Minority (URM)	0.286*** (0.073)	1.330 (1.154 - 1.534)	0.226** (0.072)	1.305 (1.134 - 1.503)
Male	0.367*** (0.033)	1.445 (1.353 - 1.542)	0.368*** (0.033)	1.443 (1.353 - 1.543)
FRPL x URM	0.106 (0.113)	1.113 (0.891 - 1.389)	0.251 (0.218)	1.131 (0.907 - 1.411)
FRPL x URM x Male	-0.421** (0.137)	0.656 (0.501 - 0.859)	-0.421** (0.137)	0.657 (0.502 - 0.859)
High school enrollment	-0.282*** (0.054)	0.882 (0.820 - 0.948)	-0.187*** (0.038)	0.829 (0.749 - 0.918)
Proportion of FRPL in school	-0.126*** (0.037)	0.754 (0.679 - 0.838)	-0.097* (0.021)	0.908 (0.820 - 1.005)
Distance between school and college	-0.542*** (0.063)	0.581 (0.513 - 0.659)	-0.541*** (0.064)	0.582 (0.514 - 0.659)
District-level per-student expenditures	0.255*** (0.024)	1.252 (1.195 – 1.313)	0.239*** (0.048)	1.270 (1.155 – 1.396)
Counselors	0.124** (0.039)	1.132 (1.049 - 1.222)	-0.114 (0.082)	0.893 (0.760 - 1.048)
Navigation 101 (ever received grant)	0.181*** (0.052)	1.198 (1.082 - 1.327)	0.144** (0.066)	1.155 (1.015 - 1.314)
Counselors x Navigation 101	0.111 (0.962)	1.124 (0.931 - 1.358)	-0.245 (0.218)	0.782 (0.510 - 1.200)
Counselors x FRPL	0.197*** (0.050)	1.218 (1.104 - 1.343)	0.035 (0.065)	1.035 (0.936 - 1.146)
Counselors x URM	-0.078 (0.056)	0.924 (0.828 - 1.031)	0.004 (0.055)	1.004 (0.902 - 1.119)
Navigation 101 x FRPL	0.141 (0.094)	1.151 (0.957 - 1.385)	-0.094 (0.094)	0.910 (0.757 - 1.095)
Navigation 101 x URM	0.065 (0.103)	1.067 (0.872 - 1.307)	0.077 (0.104)	1.080 (0.881 - 1.324)
AIC		26,784.8		26,782.6
BIC		26,979.1		26,976.8

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

School and district-level characteristics likewise follow an intuitive pattern for application submission to the state's flagship university. Considering the full model with counselor FTE as the frontline worker measure, for instance, shows an increase in the level of poverty⁵⁰ in a public high school by one standard deviation ($\sigma = 17\%$) above the average level of poverty ($\bar{x} = 42\%$), holding all other school level characteristics at their mean, is associated with students at this higher-poverty public high school having a 24.6% lower odds of application submission. This relationship between poverty and application behavior also holds in the caseload model (Table 4-7, Column 2) although the magnitude of the effect on the baseline odds is smaller at 9.2%. The distance between a high school and the flagship university also decrease the odds of application submission. Students at larger public high schools, holding all else equal, are less likely to submit applications. District level expenditures are also positively associated with a higher odds of application submission.

Independent of all other school and district characteristics, increasing counselor FTEs by one standard deviation above the average ($\bar{x} = 2.51$, $\sigma = 1.5$) increases the odds of application submission to the state's flagship university by 13.2%. A school's receipt of Navigation 101 also increases the odds of application submission by 19.8%. However, the interaction between counseling levels and Navigation 101 is insignificant. The cross-level effect⁵¹ between counselors and low-income students is significant, however, requiring the interpretation of three variables:

$$e^{(0(\text{FRPL}=1)+0.124(\text{CounselorFTE}=1)+0.197(\text{CounselorFTE}=1 \times \text{FRPL}_i=1))}$$

This cross-level effect yield an increase in the odds of application submission by 37.9%.⁵²

Estimating the model with the counselor caseload variable reveals neither a significant relationship

⁵⁰ I use the percent of students eligible for free or reduced-price lunch as the proxy for school-wide poverty.

⁵¹ Recall a cross-level effect is an interaction among variables between levels, i.e. the counselor variable at Level 2 and the student low-income indicator at Level 1.

⁵² In this calculation I set FRPL equal to zero because the coefficient is indistinguishable from zero.

between the counselor's caseload and the odds of application submission nor the counselor's caseload and the odds of a low-income student submitting an application. In this counselor caseload model, however, the positive effect of Navigation 101 on the baseline odds of application submission remains statistically-significant compared to the model in which counselors are represented by FTE.

The effects of counselors, as an FTE count and in terms of their caseload size, have a modest effect on the baseline odds of application submission to the state's land grant university when included with a model containing only Level-1 student variables (Table 4-8). Similar to the magnitude and direction of the effects for the comparable flagship university models, a one-standard deviation increase in the number of counselors corresponds to a 12.7% increase in the odds of application submission to the state's land grant university. Likewise, a decrease in the counselor caseload by one-standard deviation increases the odds of application submission by 5%. The relativity of the baseline odds is again worthwhile to consider since the baseline odds of application submission to the state's land grant university is around 0.07 to 0.08, compared to the 0.01 to 0.02 baseline odds of application submission to the state's flagship university.

The effects of counselors and Navigation 101 are largely absent from the application submission rates at the state's land grant institution when considering the full multilevel models (Table 4-9). The odds of submitting an application to the state's land grant university increase only modestly, by 8.2%, given a one standard deviation increase in counselor FTE. There is no observable association with Navigation 101 and application submission to the land grant university, nor is there an association among the odds of application submission and counselors, Navigation 101, a student's race/ethnicity or family income. Likewise, the counselor caseload coefficient is insignificant relative to the odds of land grant university application submission.

Turning to the odds of application submission at a regional comprehensive university, the model with only student covariates, Navigation 101, and counselor-related variables (Table 4-10) continues to follow a general pattern; an increase in the number of counselors or a decrease in a counselor's caseload is associated with an increased odds of application submission (by 12.7% and 5%, respectively) to regional comprehensive universities. For the complete multilevel models (Table 4-11) an effect of counselors or Navigation 101 on the baseline odds of application submission is unobservable at regional comprehensive universities. And while the interaction between counselor FTE and a student's low-income status is positive and significant, as is also the interacted term representing counselor FTE and underrepresented minority status, this is again a scenario where all the related coefficients must be accounted for in calculating an appropriate odds of application submission. In the case of a student eligible for free or reduced price lunch, where

$$e^{(-0.515(\text{FRPL}=1)+0(\text{CounselorFTE}=1)+0.078(\text{CounselorFTE}=1 \times \text{FRPL}_i=1))} = 0.655$$

the odds of application submission improve only marginally given an increase of one-standard deviation in counselor FTE. Put another way, the odds of application submission to a regional comprehensive university are already 39.4% lower for a student eligible for free or reduced price lunch ($1 - 0.606 = 0.394$); for this same student when considering an increase in counselors at the high school by one standard deviation, the odds ratio changes only marginally to a 34.5% lower odds of application submission ($1.0 - 0.655 = 0.345$). Accounting for this multi-coefficient odds ratio's multiplicative effect on the baseline odds illustrates how the baseline 0.174 odds that a public high school student in Washington submits an application to a regional comprehensive drops to a 0.104 odds for a low-income student ($0.174 \times 0.606 = 0.104$) but increases one-percentage point to a 0.114 odds ($0.174 \times 0.655 = 0.114$) given a one standard deviation increase in counselor FTE.

The association between being Black, Hispanic, or Native American and the odds of application submission to a regional comprehensive university is indistinguishable from zero. The increase in the odds of application submission to a regional comprehensive university for this minority student population given an increase in counselors by one standard deviation, however, is a modest 8.1%.⁵³ This means a baseline 0.174 odds of submitting an application to a regional comprehensive increases to a 18.8% chance ($0.174 \times 1.081 = 0.188$) for underrepresented students given an increase in counselor FTE. The association between counselor caseload size and the odds of application submission to a regional comprehensive university presents a noteworthy distinction between measuring frontline staff *as a count* and in terms of their *caseloads*. From Table 4-11, note the counselor caseload and the interaction between the counselor caseload and Navigation 101 are both significantly different from zero. This association means a decrease in the counselor's caseload by one standard deviation increases the odds of application submission by 8.6% ($1.0 - 0.914 = 0.086$) but at Navigation 101 schools this effect on the baseline odds is actually larger; $e^{(-0.090(\text{CounselorCASELOAD}=1) + -0.171(\text{CounselorCASELOAD}=1 \ \& \ \text{NAV101}=1) + 0(\text{NAV101}=1))}$ yielding 0.770 as the odds ratio resulting from summing and exponentiating these three variables (counselor caseload, Navigation 101, and the interaction between counselor caseload and Navigation 101).⁵⁴ This odds ratio is interpreted as a lower caseload by one standard deviation *at Navigation 101 public high schools* corresponding with a 23.0% increase ($1.0 - 0.770 = 0.230$) in the odds of application submission; relative to the baseline odds this means an overall 0.175 odds of submitting an application to a regional comprehensive university increases to a 0.215 odds of application submission ($0.175 \times 1.230 = 0.215$).

⁵³ The evidence for this particular association is weaker than previously-discussed examples given this figure is significant at the 90% confidence level.

⁵⁴ The statistical insignificance of the Navigation 101 coefficient in this circumstance means the coefficient is set to zero when calculating the odds ratio for these three variables.

TABLE 4-8: APPLICATION SUBMISSION TO LAND GRANT UNIVERSITY, BASELINE MODEL

	Student-Level Model		Student-Level Model with Counselor = FTE, Nav101		Student-Level Model with Counselor = CASELOAD, Nav101	
	Est. (s.e.)	Odds Ratio (95% CI)	Est. (s.e.)	Odds Ratio (95% CI)	Est. (s.e.)	Odds Ratio (95% CI)
Intercept	-2.571 (0.046)	0.076 (0.070 - 0.084)	-2.563 (0.060)	0.077 (0.069 - 0.087)	-2.605 (0.056)	0.074 (0.66 - 0.083)
GPA	0.729*** (0.021)	2.074 (1.990 - 2.161)	0.729*** (0.021)	2.074 (1.990 - 2.161)	0.729*** (0.021)	2.072 (1.989 - 2.160)
Number of AP classes (log)	0.275*** (0.025)	1.316 (1.254 - 1.381)	0.269*** (0.025)	1.308 (1.246 - 1.373)	0.274*** (0.025)	1.315 (1.253 - 1.380)
Ever took calculus	-0.001 (0.045)	0.999 (0.916 - 1.090)	0.003 (0.045)	1.003 (0.919 - 1.095)	-0.000 (0.045)	1.000 (0.916 - 1.091)
Free/Reduced Price Lunch (FRPL)	-0.507*** (0.050)	0.602 (0.546 - 0.665)	-0.503*** (0.050)	0.604 (0.548 - 0.667)	-0.505*** (0.050)	0.603 (0.547 - 0.666)
Underrepresented Minority (URM)	0.094* (0.055)	1.098 (0.985 - 1.224)	0.095* (0.055)	1.099 (0.986 - 1.226)	0.095* (0.055)	1.100 (0.987 - 1.226)
Male	0.135*** (0.110)	1.145 (1.078 - 1.216)	0.135*** (0.031)	1.145 (1.078 - 1.216)	0.135*** (0.031)	1.145 (1.078 - 1.216)
FRPL x URM	0.409*** (0.102)	1.506 (1.234 - 1.838)	0.412*** (0.102)	1.510 (1.237 - 1.844)	0.409*** (0.102)	1.505 (1.233 - 1.837)
FRPL x URM x Male	0.016 (0.110)	1.016 (0.819 - 1.262)	0.015 (0.110)	1.016 (0.818 - 1.261)	0.017 (0.110)	1.017 (0.819 - 1.263)
Counselor FTE			0.119*** (0.036)	1.127 (1.051 - 1.208)		
Counselor CASELOAD					-0.051* (0.031)	0.950 (0.895 - 1.010)
Navigation 101 (ever received grant)			0.097 (0.072)	1.102 (0.956 - 1.269)	0.083 (0.071)	1.086 (0.946 - 1.248)
AIC		33,279.2		33,270.2		33,279.2
BIC		33,376.8		33,385.5		33,394.6

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE 4-9: APPLICATION SUBMISSION TO LAND GRANT UNIVERSITY, FULL MODEL

	Full Multilevel Model with Counselor = FTE		Full Multilevel Model with Counselor = CASELOAD	
	Est. (s.e.)	Odds Ratio (95% CI)	Est. (s.e.)	Odds Ratio (95% CI)
Intercept	-2.529*** (0.059)	0.080 (0.071 - 0.089)	-2.536*** (0.058)	0.079 (0.071 - 0.089)
GPA	0.722*** (0.021)	2.058 (1.974 - 2.146)	0.721*** (0.021)	2.057 (1.973 - 2.145)
Number of AP classes (log)	0.252*** (0.025)	1.287 (1.224 - 1.353)	0.253*** (0.025)	1.287 (1.225 - 1.353)
Ever took calculus	-0.011 (0.046)	0.989 (0.904 - 1.081)	-0.012 (0.046)	0.988 (0.904 - 1.081)
Free/Reduced Price Lunch (FRPL)	-0.501*** (0.065)	0.606 (0.534 - 0.688)	-0.500*** (0.064)	0.606 (0.534 - 0.688)
Underrepresented Minority (URM)	0.129* (0.067)	1.138 (0.999 - 1.297)	0.139** (0.066)	1.150 (1.011 - 1.308)
Male	0.120*** (0.031)	1.128 (1.061 - 1.199)	0.121*** (0.031)	1.128 (1.061 - 1.199)
FRPL x URM	0.413*** (0.113)	1.511 (1.234 - 1.851)	0.408*** (0.103)	1.504 (1.228 - 1.841)
FRPL x URM x Male	-0.026 (0.112)	1.026 (0.824 - 1.278)	0.025 (0.112)	1.025 (0.823 - 1.277)
High school enrollment	0.163** (0.083)	1.177 (1.000 - 1.384)	0.136*** (0.037)	1.146 (1.064 - 1.233)
Proportion of FRPL in school	-0.046 (0.037)	0.955 (0.889 - 1.027)	-0.048 (0.037)	0.953 (0.886 - 1.025)
Distance between school and college	-0.150*** (0.037)	0.861 (0.800 - 0.927)	-0.145*** (0.037)	0.865 (0.804 - 0.930)
District-level per-student expenditures	0.055* (0.033)	1.056 (0.990 - 1.127)	0.057* (0.033)	1.059 (0.992 - 1.130)
Counselors	0.079** (0.030)	1.082 (1.020 - 1.148)	-0.044 (0.044)	0.957 (0.878 - 1.043)
Navigation 101 (ever received grant)	0.101 (0.080)	1.106 (0.946 - 1.294)	0.114 (0.077)	1.121 (0.965 - 1.302)
Counselors x Navigation 101	-0.054 (0.066)	0.947 (0.832 - 1.078)	-0.074 (0.064)	0.929 (0.819 - 1.053)
Counselors x FRPL	0.000 (0.044)	1.000 (0.917 - 1.091)	0.001 (0.047)	1.001 (0.913 - 1.096)
Counselors x URM	0.053 (0.048)	1.054 (0.959 - 1.160)	0.018 (0.048)	1.018 (0.926 - 1.119)
Navigation 101 x FRPL	0.015 (0.087)	1.015 (0.856 - 1.204)	0.013 (0.087)	1.013 (0.855 - 1.201)
Navigation 101 x URM	-0.050 (0.092)	0.952 (0.794 - 1.140)	-0.056 (0.092)	0.945 (0.789 - 1.132)
AIC	32,054.1		32,054.5	
BIC	32,248.4		32,248.8	

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE 4-10: APPLICATION SUBMISSION TO COMPREHENSIVE UNIVERSITY, BASELINE MODEL

	Student-Level Model		Student-Level Model with Counselor = FTE, Nav101		Student-Level Model with Counselor = CASELOAD, Nav101	
	Est. (s.e.)	Odds Ratio (95% CI)	Est. (s.e.)	Odds Ratio (95% CI)	Est. (s.e.)	Odds Ratio (95% CI)
Intercept	-1.789*** (0.043)	0.186 (0.178 - 0.194)	-1.774*** (0.058)	0.170 (0.151 - 0.190)	-1.808*** (0.054)	0.164 (0.147 - 0.182)
GPA	0.698*** (0.017)	2.041 (1.977 - 2.108)	0.697*** (0.017)	2.008 (1.945 - 2.074)	0.697*** (0.017)	2.008 (1.942 - 2.076)
Number of AP classes (log)	0.345*** (0.021)	1.366 (1.321 - 1.413)	0.343*** (0.021)	1.409 (1.361 - 1.458)	0.345*** (0.021)	1.412 (1.355 - 1.471)
Ever took calculus	-0.393*** (0.040)	0.726 (0.673 - 0.782)	-0.391*** (0.040)	0.676 (0.627 - 0.729)	-0.393*** (0.040)	0.675 (0.625 - 0.730)
Free/Reduced Price Lunch (FRPL)	-0.530*** (0.040)	0.559 (0.519 - 0.604)	-0.529*** (0.040)	0.589 (0.546 - 0.636)	-0.529*** (0.040)	0.589 (0.545 - 0.637)
Underrepresented Minority (URM)	-0.029 (0.047)	0.971 (0.888 - 1.062)	-0.029 (0.047)	0.972 (0.889 - 1.063)	-0.028 (0.047)	0.973 (0.887 - 1.067)
Male	-0.091*** (0.026)	0.924 (0.879 - 0.971)	-0.091*** (0.026)	0.913 (0.869 - 0.959)	-0.091*** (0.026)	0.913 (0.868 - 0.960)
FRPL x URM	0.441*** (0.082)	1.629 (1.393 - 1.904)	0.442*** (0.082)	1.555 (1.330 - 1.819)	0.440*** (0.082)	1.553 (1.322 - 1.825)
FRPL x URM x Male	-0.041 (0.092)	0.931 (0.778 - 1.114)	-0.041 (0.092)	0.960 (0.803 - 1.149)	-0.040 (0.092)	0.961 (0.802 - 1.151)
Counselor FTE			0.075** (0.034)	1.078 (1.051 - 1.105)		
Counselor CASELOAD					0.042 (0.029)	1.042 (0.986 - 1.102)
Navigation 101 (ever received grant)			0.058 (0.069)	1.060 (0.926 - 1.214)	0.052 (0.069)	1.053 (0.921 - 1.205)
AIC		44,114.4		44,112.9		44,115.8
BIC		44,212.1		44,228.3		44,231.1

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE 4-11: APPLICATION SUBMISSION TO COMPREHENSIVE UNIVERSITY, FULL MODEL

	Full Multilevel Model with Counselor = FTE		Full Multilevel Model with Counselor = CASELOAD	
	Est. (s.e.)	Odds Ratio (95% CI)	Est. (s.e.)	Odds Ratio (95% CI)
Intercept	-1.748 ^{***} (0.071)	0.174 (0.156 - 0.195)	-1.742 ^{***} (0.056)	0.175 (0.157 - 0.196)
GPA	0.700 ^{***} (0.017)	2.015 (1.947 - 2.084)	0.700 ^{***} (0.017)	2.014 (1.947 - 2.083)
Number of AP classes (log)	0.342 ^{***} (0.022)	1.408 (1.350 - 1.469)	0.343 ^{***} (0.022)	1.409 (1.351 - 1.470)
Ever took calculus	-0.381 ^{***} (0.040)	0.683 (0.631 - 0.739)	-0.381 ^{***} (0.040)	0.683 (0.631 - 0.739)
Free/Reduced Price Lunch (FRPL)	-0.515 ^{***} (0.051)	0.597 (0.540 - 0.660)	-0.519 ^{***} (0.051)	0.595 (0.538 - 0.657)
Underrepresented Minority (URM)	-0.062 (0.057)	0.940 (0.841 - 1.050)	-0.045 (0.056)	0.956 (0.856 - 1.067)
Male	-0.092 ^{***} (0.026)	0.913 (0.867 - 0.961)	-0.091 ^{***} (0.026)	0.913 (0.867 - 0.961)
FRPL x URM	0.479 ^{***} (0.084)	1.614 (1.370 - 1.903)	0.468 ^{***} (0.084)	1.596 (1.355 - 1.880)
FRPL x URM x Male	-0.039 (0.094)	0.962 (0.801 - 1.156)	-0.041 (0.094)	0.960 (0.799 - 1.153)
High school enrollment	0.125 (0.079)	1.133 (0.971 - 1.323)	0.060 [*] (0.033)	1.062 (0.993 - 1.136)
Proportion of FRPL in school	-0.026 (0.033)	0.974 (0.914 - 1.038)	-0.025 (0.033)	0.975 (0.915 - 1.040)
District-level per-student expenditures	0.085 ^{***} (0.030)	1.089 (1.026 - 1.156)	0.092 ^{***} (0.031)	1.096 (1.032 - 1.165)
Counselors	0.041 (0.084)	1.133 (0.971 - 1.323)	-0.090 ^{**} (0.039)	0.914 (0.847 - 0.986)
Navigation 101 (ever received grant)	0.076 (0.076)	1.079 (0.930 - 1.251)	0.057 (0.071)	1.059 (0.921 - 1.217)
Counselors x Navigation 101	0.035 (0.060)	0.966 (0.858 - 1.087)	-0.171 ^{***} (0.057)	0.843 (0.754 - 0.943)
Counselors x FRPL	0.078 ^{**} (0.035)	1.081 (1.008 - 1.159)	0.016 (0.037)	1.016 (0.944 - 1.094)
Counselors x URM	0.074 [*] (0.040)	1.077 (0.995 - 1.165)	-0.004 (0.041)	0.996 (0.920 - 1.079)
Navigation 101 x FRPL	-0.018 (0.070)	0.983 (0.856 - 1.128)	-0.005 (0.070)	0.995 (0.867 - 1.142)
Navigation 101 x URM	0.030 (0.077)	1.030 (0.886 - 1.198)	0.011 (0.077)	1.011 (0.869 - 1.142)
AIC		42,697.6		42,694.1
BIC		42,883.1		42,879.6

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

4.7 DISCUSSION

Returning to the hypotheses guiding this study, evidence supporting Hypothesis 1, that higher levels of counseling resources increase the odds of application submission by easing administrative burden, is relatively weak in aggregate but compelling in specific circumstances e.g. application submission to the state's flagship university, and to a lesser extent, to the state's land grant university and the state's regional comprehensive universities. The evidence that an FTE increase in frontline workers at a public high school is associated with an increase in the odds of application submission to the state's flagship university is made more plausible by the fact that this application is considerably more burdensome, at least in length, compared to other applications students may submit to public universities in the state (Table 4-2).

Yet the evidence for Hypothesis 1 is overshadowed by the fact that the FTE level of counselors is associated with an increased odds of application submission in some cases while in other circumstances, counselor caseload is the variable which bears a statistically-significant relationship to the odds of application submission. In fact, specific to the full multilevel models, there are no modeled odds of application submission where both the counselor FTE *and* the counselor caseload variable are statistically significant.

The extant frontline worker literature on caseloads helps to make sense of this apparent inconsistency between an FTE measure of frontline staff and the measurement of caseloads. Hill (2006) notes that often a count of organizational staff (such as FTE) is a more straightforward measure of frontline workers compared to the "caseload size variable" because organizational "aspect[s] operate *through* the caseload variable" (p. 279, emphasis added).⁵⁵ These organizational

⁵⁵ Hill (2006) is careful to note, however, that a count of frontline staff is also be open to interpretative meaning in that a higher number of frontline staff in and of itself may represent an organization's "structural complexity" that is unobservable with a variable that simply counts frontline staff (Scott, 1998, as cited in Hill, 2006, p. 274).

aspects, largely intangible, include such factors as an organization's efficiency or capacity. In other words, certain organizations may have an inherent culture, a particular manager, or a relevant technology that allows frontline workers to better cope with larger caseloads. For this reason, Hill (2006) considers a caseload variable specifically in a multilevel model to represent a broad level of resources available to the organization.

On the other hand, Weissert (1994) suggests that a caseload variable may be susceptible to "measurement error" because the "caseload variable might *not* be an accurate portrayal of [an organization] ... since it does *not* take into account differences in efficiency and style" (p. 239, emphasis added). Weissert's point appears to oppose Hill's (2006) opinion of the caseload variable because Weissert argues that a caseload variable is assumed to incorporate efficiency and style but may not accurately capture the variation of such organizational characteristics. Put succinctly, Hill (2006) sees the caseload variable as more than just a ratio of clients to frontline workers; Weissert (1994) observes that measurement error may arise by attributing too much meaning to the caseload variable.

These perspectives on modeling frontline workers demonstrate that a count variable and a caseload variable are two sides of the same coin. Weissert (1994) contends that the caseload variable has merit but cautions against its over-interpretation; Hill (2006) acknowledges the caseload variable's merit plus she interprets the variable's meaning in a broader organizational context. In this study I err on the side of Weissert and assume a lower caseload, holding all else equal, improves a counselor's ability to deliver services. The fact that a higher count of counselors is associated with an increased odds of application submission in some cases while in other cases, a lower counselor caseload increases the odds application submission is therefore not problematic because these findings represent two distinct ways to empirically specify the contribution of

frontline workers. Since for both variables the direction of the odds ratio is consistent (i.e. a higher number of counselors or a lower counselor caseload increases the odds of application submission) I consider evidence from both variables to support Hypothesis 1.

For Hypothesis 2, which tests that receipt of the Navigation 101 grant increases the odds of application submission through enhancing the services delivered by high school counselors, evidence substantiates an association in two circumstances: between the program and application submission to the state's flagship university; and between the program, a lower counselor caseload, and application submission to the state's regional comprehensive universities. For the increased application odds to the flagship university this evidence is consistent with theory since the burden of this application is substantially greater compared to other public institutions' applications. For the regional comprehensive universities, the mechanism at work may be alleviating the administrative burden of submitting an application for students for whom this type of institution specifically represents a "good fit" (Mattern, Woo, Hossler, & Wyatt, 2010). Navigation 101 amplified the state's existing efforts to develop public high schools' comprehensive guidance and planning programs with curriculum on "postsecondary options and how to access them" (RCW 28A.600.045, 2006, p. 210); the receipt of Navigation 101 coupled with a lower counselor caseload appears to cultivate counseling services that specifically align with students accessing regional comprehensive universities.

Results supporting Hypotheses 3, testing that a higher level of frontline workers increases the odds of application submission for students with disproportionately low levels of social capital (i.e. low-income students and students from underrepresented minority backgrounds), are statistically significant for low-income students submitting applications to the flagship university and regional comprehensive universities, and also for students from underrepresented racial

backgrounds who submit applications to regional comprehensive universities. Context in this case, however, is important. For a one standard deviation increase in counselor FTE, the overall odds of a low-income student applying to the flagship university increases from 2.2% to 3.0%. Likewise, the modest benefit that more counselors offer to low-income students in applying to regional comprehensive universities (an increase in FTE is associated with a 8.1% increase in the odds of application submission) is not enough to offset the strong negative association between receipt of free or reduced-price lunch and a lower odds of application submission.

Finally, no evidence substantiates the hypotheses that receipt of the Navigation 101 grant has an observable impact on low-income or underrepresented students submitting applications to any type of public postsecondary institution in the state (Hypothesis 4).

A summary of the evidence bearing on Hypotheses 1 and 3 points to a reoccurring relationship between a higher FTE count of frontline workers and submitting an application to the state's flagship university. How might administrative burden help make sense of this pattern? One explanation is that, given the great length of the flagship university's application, the learning costs and compliance costs are higher for submitting this particular application compared to applications to other public postsecondary institutions in the state. As such, more frontline workers at a given high school would plausibly alleviate these disproportionate costs. Beyond the figures reported in Table 4-2, consider other qualitative differences between the flagship university application and the regional comprehensive universities' applications. In 2010 the flagship university, on one hand, required students to submit an application containing extensive information for all high school coursework plus essays about extracurricular activities and personal achievements. The state's regional public universities, on the other hand, generally asked students a few basic questions about high school coursework (e.g. "Did you take AP/IB courses?") and in some cases, offered

guaranteed admission if a student met minimum requirements (EWU Catalog, 2009, p. 19). The varying complexity between the flagship university application and regional comprehensive universities' applications is clearly a function of each institution's selectivity. Independent of an institution's selectivity and relevant to administrative burden, however, one application is clearly more burdensome than the other and thus presents a potential occasion for frontline workers to intercede and alleviate such burdens.

These findings converge to inform three dimensions of administrative burden's development. The first is that the nuances of citizens' application behavior are complex and deserve careful attention from researchers. Studies of administrative burden thus far have focused on the submission of an application to a single program or agency (as in a state Medicaid program e.g. Moynihan, Herd, & Harvey, 2015; Moynihan, Herd, & Ribgy, 2013; or with cash transfer programs, e.g. Heinrich & Brill, 2015). The submission of applications to public universities, alternatively, represents a domain of administrative burden in which the receivers and processors of applications are plural and heterogeneous. Another example in the public sphere that is analogous to this context includes housing applications involving some kind of public assistance. A citizen may encounter administrative burden in applying for somewhere to live, and a public intervention may seek to alleviate that burden, but the degree of the burden the citizen experiences will also depend largely on the housing providers to which applications are submitted since each particular landlord controls their application process.

The second contribution these findings make to administrative burden is the notion that an intervention outside of a public program itself may mediate administrative burden in a manner that increases the odds of successful application submission. Administrative burden thus far has been studied as an endogenous constraint within a public program, such as in the case of increasingly

complex eligibility and application rules being implemented to intentionally limit access to Medicaid (Moynihan, Herd, & Ribgy, 2013). The study of application submission to a public university presents an alternative perspective because high school counselors and Navigation 101 are exogenous to the public entity (i.e. public universities) to which applications are submitted. Since the political and practical feasibility are low for a state legislature to meddle in the details of a public university's application process, a more plausible solution may be to authorize and implement a third party that alleviates a burdensome application process and thus increases access. Looking again at an example outside of public universities, one could picture a local public housing agency alleviating administrative burden for its clients not by reforming the application rules to public housing programs but by instead funding a case manager to alleviate the learning, compliance, and psychological costs of submitting such applications.⁵⁶

The potential of a case manager to ease learning, compliance, and psychological costs related to application submission leads to the final contribution this study makes to the theoretical development of administrative burden. Frontline workers have yet to be formally incorporated into administrative burden's theoretical frame. This study provides conceptual and plausible empirical evidence that frontline workers alleviate administrative burden and do so in a manner that potentially affects certain subpopulations more than others. The fact that frontline workers are motivated to achieve positive outcomes for clients is well established in the broader literature on street level-bureaucrats (Maynard-Moody & Portillo, 2010; Meyers & Vorsanger, 2007). The findings presented here support such a claim aligned with extant literature on high school counselors and their desire to cultivate postsecondary opportunities for the students they serve

⁵⁶ Public housing authorities, of course, have frontline workers that help "public housing seekers navigate the at-times byzantine application process" but the extent to which these frontline workers ease or hamper the application process is unclear (Einstein & Glick, 2016, p. 2).

(Smith, 2011). Just as plausible, though, is a circumstance in other policy or program arenas where frontline workers with different motivations could exacerbate administrative burden with implicit or explicit mechanisms for gatekeeping. This potential duality requires in future studies a context-specific theoretical specification in modeling frontline workers and their predicted effects on administrative burden.

4.8 APPENDIX A: QUALITATIVE DOCUMENT ANALYSIS TO ASSESS AN APPLICATION'S LEVEL OF ADMINISTRATIVE BURDEN

The coding protocol that follows mirrors Moynihan, Herd, and Ribgy's (2013) approach to the greatest extent possible. I began by developing an instrument to assess the administrative burden of each university's application. Like Moynihan and colleagues, I designed the instrument around two dimensions of burden, quantifying aspects of the application and qualitatively assessing reporting requirements. Quantified aspects of the application included a question count, count of pages, and total number of words in the physical application. To assess reporting requirements, on the other hand, I used an ordinal scale with seven points representing increasing levels of burden. Moynihan, Herd, and Ribgy's (2013) use four categories in their study: state does not ask about item = 0; state asks for information but not proof = 1; state asks for information and requires proof = 2; state requires proof but does not specify what proof is = 3. Note that the requirement of proof without specifying what proof entails assumes a higher level of burden because this ambiguity increases the compliance cost experienced by the application.

I created seven burden categories to capture more of the nuance associated with information requested in a structured format or information requested in an open-ended format, assuming like Moynihan, Herd, and Ribgy's (2013) that a structured request requires less cognitive effort (and thus has a lower compliance cost) compared to an open-ended, ambiguous request for information. The seven categories are:

0 = No information was requested in this area of burden

1 = Information was requested but not required; applicant provides information in a structured format

2 = Information was requested but not required; applicant provides information in an open-

ended format

3 = Information was required but proof/verification was not required; applicant provides information in a structured format

4 = Information was required but proof/verification was not required; applicant provides information in an open-ended format

5 = Information was required and proof/verification was required; applicant provides information in a structured format

6 = Information was required and proof/verification was required; applicant provides information in an open-ended format

In their Medicaid study Moynihan, Herd, and Ribgy (2016) assess burden in three areas of Medicaid applications: income reporting, expense reporting, and residency documentation. For this instrument I structured the assessment of administrative burden around four areas of the application: academic qualifications, socioeconomic background, personal context, and residency requirements. Examples of application questions that fall within each of these categories can be found in the instrument instructions that follow.

After creating the instrument, I then formulated a hypothetical identity for the application evaluator to assume. Moynihan, Herd, and Ribgy (2016) note this is a critical step in the assessment process to ensure multiple evaluators code application burden consistently across organizational contexts. In other words, in the case of my study the evaluator assumed the identity of a Caucasian female who is a senior in high school at a public high school in Washington. It is from this vantage point that the evaluator qualitatively assesses each application's four categories of administrative burden.

With the instrument and hypothetical identity of the applicant created, I proceeded to hire

two graduate students to code each of the applications. I first undertook a pilot coding exercise with each graduate student using a public university application not included in this study. I reviewed each graduate student's scoring individually with them and discussed any questions that arose during their assessment of burden in this pilot exercise. Each graduate student was then given the five undergraduate applications for public universities in Washington State with accompanying worksheets to fill out.

Each graduate student returned their completed worksheets at which point data from the worksheets were entered into a statistical software to calculate a measure of interrater reliability. I use a weighted Cohen's kappa (Cohen, 1968) because of the ordinal nature of the ratings. A weighted kappa better accounts for the fact that along a rating spectrum with possible values of low, medium, and high, two raters may vary in their scores but are in closer agreement if both scores are low (e.g. 2 and 3) than if one rater scores low and one rater scores high (e.g. 2 and 6). In reality, however, the difference was minimal between the unweighted kappa (0.927, $p < 0.001$) and the weighted kappa (0.957, $p < 0.001$) which combined can be interpreted as a high level of interrater reliability.

4.9 APPENDIX B: INSTRUCTIONS AND WORKSHEET PROVIDED TO APPLICATION EVALUATORS

In this coding exercise you will analyze various aspects of five undergraduate college applications. For each application you will hypothetically assume you are a Caucasian female applying to college. (Additional information about your hypothetical background appears below.) You will *quantify* aspects of the application (pages, questions, and words) and also *qualitatively gauge* the application's level of burden in three areas related to information that the application requests from the applicant (socioeconomics, academics, and personal background). You will enter each of these data points in the accompanying worksheet.

Who are you?

You are a Caucasian female who is a senior in high school at a public high school in Washington. You are 17 years old and have lived in Washington State your entire life. You live with both parents and have one sibling who is 14 years old. Neither of your parents graduated from college; your mother earned an associate's degree at Highline Community College and your father has a high school diploma. Your parents' combined income for the past year was \$74,000. You are applying for admission for autumn quarter, 2010.

During high school you completed academic coursework was as follows: four years of English, four years of social studies, three years of math, three years of science, and three years of foreign language. (When filling out applications do not worry about the specific names of these courses.) You took four AP classes during high school. Your SAT scores were 580 for verbal, 620 for math, and 600 for writing. Three of the courses you completed in high school were Running Start classes (senior year English, senior year pre-calculus, and senior year American History) and for each of these classes you earned three credits (for a total of nine credits) at Green River Community College.

During high school you participated in the following activities: you worked on the yearbook staff for three years (10th to 12th grade) and served as editor your senior year; you played volleyball for three years (9th to 11th grade) and made the varsity team your junior year; you were elected junior class president during your 11th grade year; you played the violin in a community orchestra all four years of high school; during the 11th and 12th grade you worked part-time at a local restaurant as a host.

Instructions for Word Count

From the first question to the last question of the application, count each word. In this count, do not include words that are example answers to questions.

Instructions for Question Count

From the first question to the last question of the application, count each question. In this count, include all questions and subquestions, but do not consider each blank as a question in and of itself. For example, if "Address" has six blanks (e.g. street address, apartment, city, state, ZIP code, country) count this as one question, not six.

Assess the reporting requirements for each of these areas using the following criteria:

0	1	2	3	4	5	6
No information was requested in this area	Information was requested but not required; applicant provides information in a structured format	Information was requested but not required; applicant provides information in an open-ended format	Information was required but proof/verification was not required; applicant provides information in a structured format	Information was required but proof/verification was not required; applicant provides information in an open-ended format	Information was required and proof/verification was required; applicant provides information in a structured format	Information was required and proof/verification was required; applicant provides information in an open-ended format

In other words, an application would be scored “0” (i.e. minimal burden) if no information in a particular category was requested; at the other extreme an application would be scored “6” (maximum burden) if information for a particular question was required, the submission of proof/evidence was also required, and the information was requested in an unstructured, open-ended format.

Academics

These are questions/requirements such as:

- Disclosure of courses taken in high school
- Submission of transcripts (high school and/or college)
- Submission of SAT/ACT scores from the College Board

Socioeconomic

These are questions/requirements such as:

- Has the student has been in foster care in Washington?
- The applicant’s parents’ level of education
- Student’s family income
- Required submission of documents verifying tribal membership

Personal

These are questions/requirements such as:

- Extracurricular, sports, leadership, and other nonacademic activities
- The extent to which the student experienced hardship
- Details about the student’s interactions with the institution to which the student is applying

Citizenship/Residency

These are questions/requirements such as:

- Are you a resident of Washington State?
- Are you a citizen of the United States?

DATA ENTRY WORKSHEET

Your name and today's date: _____

The university's application
that you are analyzing here: _____***Quantifying application characteristics (record a number in the blank)***

Application's page count: _____

Application's word count: _____

Application's question count: _____

Gauging application burden (check one box for each area)

Academic burden:

0	1	2	3	4	5	6

Socioeconomic burden:

0	1	2	3	4	5	6

Personal burden:

0	1	2	3	4	5	6

Residency burden:

0	1	2	3	4	5	6

0	1	2	3	4	5	6
No information was requested in this area	Information was requested but not required; applicant provides information in a structured format	Information was requested but not required; applicant provides information in an open-ended format	Information was required but proof/verification was not required; applicant provides information in a structured format	Information was required but proof/verification was not required; applicant provides information in an open-ended format	Information was required and proof/verification was required; applicant provides information in a structured format	Information was required and proof/verification was required; applicant provides information in an open-ended format

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Grant Blume earned an MPA at the Evans School in 2010 and entered the school's Ph.D. program that same year. Prior to graduate school, Grant worked in college admissions counseling and as a legislative aide for a member of Congress in Washington, DC. Grant's research as a doctoral student applied both public management and public policy perspectives to the study of choice-making and postsecondary access in the United States. This line of research blended economics, public management theory, and emergent findings from behavioral economics. Grant is also interested in the empirical evaluation of public policies and programs and has served as the principal investigator on a number of evaluation projects in Washington State. As a fellow of the U.S. Department of Education's Institute of Education Sciences (IES) pre-doctoral training program at the University of Washington, Grant received extensive training in quantitative, qualitative, and mixed-methods research methods. During his tenure as a Ph.D. student, Grant published multiple co-authored journal articles and taught master's and Ph.D. courses in the Evans School and College of Education. Grant's honors and awards include being the 2015 recipient of the National Association for College Admission Counseling (NACAC) Excellence in Government Relations Award and the 2014 winner (with his adviser, Dr. Mark Long) of the Wilder Award for Social Equity and Public Policy.