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Out of the Education Desert: How Limited Local College Options are Associated with Inequity in Postsecondary Opportunities

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Abstract: The United States has a stratified hierarchy of colleges and universities. The consequences of this stratification include large disparities in the returns to higher education between the levels of postsecondary institutions, and gaps by race and income in terms of where students enroll that, together, have the potential to reproduce longstanding social inequality. We study one potential cause associated with enrollment disparities, the uneven geographic distribution of colleges around the United States. Specifically, we examine the college application and enrollment decisions of students who live in education deserts—geographic areas where students either do not have access to a broad-access, public college option (access deserts), or where they do not have access to a college that is academically matched to their academic credentials (match deserts). We find that the students in access deserts are more likely to apply to and enroll in colleges farther away from home than the students who have more readily available college options. In contrast, students in match deserts are less likely to apply to and enroll in academically-matched institutions. We discuss the equity implications of these findings and make recommendations for policy and future research.

Keywords: college choice; geography of opportunity; education desert; inequality; college application; college enrollment

1. Introduction

In the United States, as in the rest of the world, the returns to a postsecondary degree are high. College completion is associated with a range of lifetime benefits, from higher earnings to better health practices, to higher rates of civic participation (Ma et al. 2016). As a result, a postsecondary degree is seen by policymakers and the public at large as an important driver of individual mobility and positive social change. However, the U.S. higher education system is also characterized by a high degree of stratification, with a large number of broad-access two- and four-year colleges forming the foundation of the system, and fewer, more selective four-year colleges at its peak (Labaree 2017). One consequence of this stratification is a high degree of variation in the benefits that accrue from college attainment; a growing body of research shows that the benefits of a college degree are greater for students who graduate from more selective colleges (Black and Smith 2004; Dale and Krueger 2011; Hoekstra 2009; Long 2008). Thus, it matters where a student goes to college. Yet traditionally under-represented racial minority and lower-income students consistently enroll at less selective colleges than white and higher-income students (Alon and Tienda 2007; Astin and Oseguera 2004; Baker et al. 2018; Bastedo and Jaquette 2011; Engberg 2012; Posselt et al. 2012), setting up the potential for a reproduction of the existing income gaps.

Findings such as these have opened-up a new area of education research and policy concerning students' specific college choices—not just whether students enroll in college, but where they enroll in college. These new concerns are reflected in recent attention in the United States to students who are academically 'undermatched' with colleges where they enroll, a term used to describe student decisions to enroll in colleges that are less selective than expected, given the student's academic credentials (Bowen et al. 2009; Roderick et al. 2008). This phenomenon, again, tends to be more common among students from lower socioeconomic backgrounds, or students who belong to traditionally underrepresented racial minority groups (Bowen et al. 2009; Roderick et al. 2008; Smith et al. 2013). Because of the higher returns to attending more selective colleges, policymakers and researchers worry that students who undermatch may face a wide variety of long-term consequences, including a lower likelihood of graduating with a degree, as well as difficulty repaying student loans and finding a job that compensates students at a rate appropriate for their education (Hoxby 2009; Ovink et al. 2018).

Although there are many reasons for these disparities in college enrollment choices, one leading factor may be students' tendency to enroll in a college close to home (Long 2004; Niu and Tienda 2007; Rouse 1995; Turley 2009; Skinner 2018). The preference to remain close to home may produce uneven outcomes, because some geographic areas are not lucky enough to play host to a choice of public two-year colleges, let alone a four-year university (Hillman 2016). Although scholars have documented disparities in who lives in these 'education deserts' based on family background (Hillman 2016), we know nothing about how living in an education desert is related to college application and enrollment decisions. We address this gap in knowledge by answering the following three primary research questions:

(1) What are the characteristics of students who intend to go to college and live in education deserts?
(2) What is the relationship between living in an education desert and where a student applies to and enrolls in college?
(3) Do these relationships vary for students with different backgrounds?

In answering these questions, we are interested in describing the characteristics of students from two distinct types of education deserts. Firstly, given policymakers' desire for students to have access to inexpensive, open-access postsecondary education options, we studied 'access deserts', like those described by Hillman and Weichman (2016). Access deserts represent areas of the country that do not host the basic types of public postsecondary institutions we would want students to have nearby. Secondly, given a separate desire for students to have local access to an academically-matched institution, we studied a new type of desert that we called 'match deserts'. That is, a location where there is no nearby institution that is a reasonable academic match for a student's academic credentials. We estimate that 12% of U.S. high school students live in access deserts, while 15% live in match deserts.[1]

This work contributes to literature on college choice and the geography of opportunity, as well as the literature on postsecondary undermatching. The findings about each of these desert types is important, because they have distinct implications for policy and for how scholars understand how students make choices about whether and where to go to college, as well as about the sources of and solutions to persistent inequities in postsecondary enrollment.

2. Background

Hillman (2016) was the first to describe the geography of opportunity for higher education in the United States in depth. He described the distribution of colleges and universities in socially and economically connected collections of counties, referred to as commuting zones. He found that, much like food deserts, where it is difficult to easily access healthy food options (see, for example, Walker et al. 2010), education deserts are characterized largely along race and class lines (Hillman 2016).

1 Based on authors' calculations using data from the Education Longitudinal Study of 2002.

For example, the higher the proportion of Hispanic families in a commuting zone, the fewer four-year colleges and more two-year colleges there are likely to be (Hillman 2016). Likewise, commuting zones with lower rates of education attainment among their residents are similarly less likely to host four-year colleges and more likely to host two-year colleges (Hillman 2016). In contrast, more highly-educated and white communities tend to have the most local college options (Hillman 2016). Figure 1 provides a visual representation of the distribution of Hillman's access deserts.

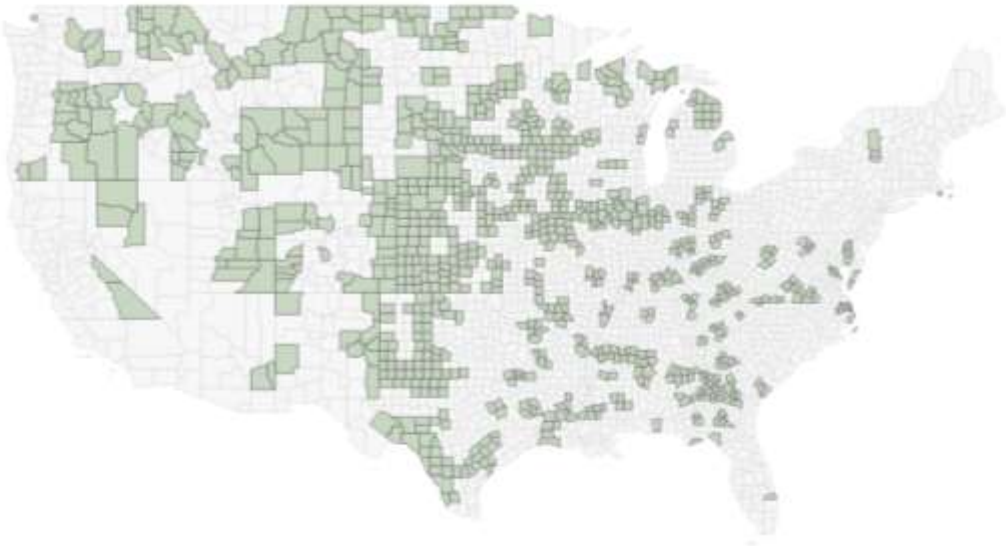

Figure 1. Access deserts in the United States (source: Hillman and Weichman 2016).

These geographic differences are important because, although transportation costs have gone down, making movement across the country much easier (Hoxby 2009), geography may still shape students' opportunity structures by constraining the set of accessible colleges. However, we do not yet know how living in an area with fewer college options shapes a prospective college student's college enrollment choice (Hillman 2016).

With the increased availability of online course options, one postsecondary alternative for students who live in education deserts is to enroll in online degree programs. However, two-thirds of access deserts also have limited access to broadband internet, preventing easy access to online education options (Rosenboom and Blagg 2018). Even if these students could access online options, online courses are still less preferable than traditional, in-person options. The students who are the least prepared for college perform worse in online courses than in face-to-face formats (Alpert et al. 2016; Bettinger and Loeb 2017). Additionally, employers markedly prefer degrees from traditional institutions to online, typically for-profit, colleges (Deming et al. 2016).

2.1. Geography and College Choice

There are several reasons to expect that the geography of higher education opportunities would have an impact on the choices students make about where to apply to and enroll in college. From the perspective of human capital models, students make decisions about whether to attend a college by comparing the discounted lifetime earnings they expect to receive if they attend that college, to the direct (e.g., tuition) and indirect costs (e.g., foregone earnings) associated with attending that college. If the benefits associated with attendance outweigh the costs, students will enroll in the college with the highest returns, provided there is at least one college whose benefits outweigh the costs (Becker 1962; Manski 1993).

In making these personal calculations of costs and benefits, lower-income students may be particularly sensitive to the cost–benefit valuation associated with certain kinds of college choices. For instance, the psychological benefits of staying close to family and of fulfilling potential family obligations, may result in students placing a premium on colleges close to home and discounting the value of attending an even more selective college, farther away. This is not necessarily a concern limited to low-income students. A survey of a sample of high school seniors from rural areas found that students overwhelmingly felt that it was important to stay close to parents or relatives (Johnson et al. 2005). Lower-income students may be more sensitive to the costs associated with geographic mobility, whether related to travel or housing. In contrast, there are many benefits for students to stay at home when they enroll in college, be they lower housing and food costs, or greater access to their social and cultural capital (Turley 2009). Perhaps as a result of these benefits, we see that low-income students are less likely to cross state lines to attend college (Hsing and Mixon 1996).

The decisions that students make about college enrollment can also only be as good as the information about college and the admissions process that students have to make that decision. Such information can come from students' cultural knowledge, from their social networks, or through the organizational environment of their high school—referred to as students' cultural capital (Bourdieu 1986), social capital (Coleman 1988), and 'organizational habitus', respectively (McDonough 1997). If students' information about colleges is limited to the colleges that are geographically proximate, or if students who live in education deserts have less access to valuable sources of social and cultural capital that might expand their knowledge of available school options, then living in education deserts may limit students' application and enrollment choices.

2.2. Preference for Proximity

If movement to college were costless, and information about college options were generally well known by students, it would not matter if students lived in geographic areas with fewer postsecondary opportunities. This, however, is not the case. There is a wide body of research that documents both the student preferences to enroll in colleges close to home and what factors persuade students to move away or stay close. While the research broadly agrees that students assess the cost of traveling to enroll in college, there is very little agreement on what geographic distance a student must travel before they are no longer considered, for research purposes, attending a school 'close to home'.

In the most expansive geographic characterization of mobility, Baryla and Dotterweich (2001) studied student migration across four, Census-defined regions of the United States, finding that students will move between regions to attend college in order to move toward a better college quality or potentially better employment prospects. However, most research looking at the mobility to college focuses on the decision to attend college in or out of a student's home state. For example, students tend to weigh factors like such as tuition costs, selectivity, academic quality, rurality, population age, and natural amenities to determine whether they should enroll in- or out-of-state (Cooke and Boyle 2011; Mixon 1992; Niu 2015). Students whose parents have more education are more likely to cross state lines to attend college, as are white students (Niu 2015), but low-income students are less likely (Hsing and Mixon 1996). Hispanic students are the least likely race/ethnicity group to be mobile across state lines, particularly if they already live in a state with high concentrations of Hispanic students (Niu 2015).

Other research has focused on intra-state migration to college, or the decisions students make whether to move within state or to move out-of-state. Much of this research tends to focus on specific states. For example, in Georgia, the proximity to a state college or two-year college is associated with a higher likelihood that a student will enroll in any Georgia public institution (Alm and Winters 2009). Conditional on deciding to enroll, Georgia students tend to enroll in whatever type of college is closest to them (state university, state college, or two-year college) (Alm and Winters 2009). In Texas, similar to the findings about students crossing state lines (Niu 2015), Hispanic students are more sensitive to the distance to the state's comprehensive universities than their white peers when it comes to in-state enrollment decisions (Jones and Kauffman 1994).

Other scholars ignore state lines, but instead think about nearby colleges purely in terms of distance-based measures, and find that, in general, the closer a college is to a student's home, the more likely the student is to enroll in that college (Long 2004; Niu and Tienda 2007; Skinner 2018). The link between distance and college attendance is strong enough that many scholars use the distance to a student's nearest college to predict whether they attend college at all (e.g., Card 1995; Rouse 1995). Students are also more likely to attend college at all—particularly four-year colleges—the more colleges they have nearby, and the tendency to apply to and enroll in nearby colleges is particularly strong for students from lower-income families (Turley 2009).

In a study that considered the consequences of enrolling in a nearby college, as well as enrolling out-of-state, González Canché (2018) used definitions of nearby colleges that included up to the 20 closest four-year colleges to a student. Although he also tested distance-based definitions, this nearest-college definition allowed him to accommodate the idea that students who live in less densely developed areas may be more willing to travel farther to college.

Taken together, this research demonstrates that, although there is disagreement about how to define it, attending college close to home matters for many students when they are making their college enrollment decisions.

2.3. The Challenges of Geography: Defining Education Deserts

There are clear strengths and weaknesses to the many approaches that scholars have used to describe the relationship between students and the geography of their college opportunities. The in-/out-of-state research is easy to execute and understand, but necessarily obscures that some student can travel a great distance from home to attend college and still stay in the same state if they are from, for example, California or Texas, but in-state (and out-of-state) college attendance is much less costly if a student is from Connecticut or Rhode Island. Distance-based measures avoid this drawback, but then also must look past the fact that crossing state lines often has important implications for the tuition a student pays, and sometimes may make overly-fine distinctions between colleges that are a few miles farther away from a given student. In research that looks at the number of colleges within a certain radius of a student, there is no conceptually well-defined radius that scholars use. For example, Turley (2009) based her 'commuting radius' on the median distance a student was from their stated first-choice college, but acknowledges that students in cities might have different concepts of easily-traveled distances, and so she sets separate radii for the city and non-city students. González Canché (2018) notes that the average city commute to work is 18.8 miles, and so rounds up and looks for 'nearby' colleges within a 20-mile radius of the students in cities; he doubles that distance for students outside of cities. Furthermore, González Canché's 'nearest college' approach has the nice feature of recognizing that a student's search might be wider where colleges are less-densely established, but it is not clear whether distinctions between the 5th and 6th or 20th and 21st colleges away from a student are meaningful to that student in their search.

For these reasons, we prefer to follow Hillman (2016) choice to characterize our education deserts within students' commuting zones. Commuting zones are collections of counties that are linked via transportation infrastructure and local labor markets. Because they are constructed to represent "the local economy where people live and work", commuting zones are likely to intuitively capture the region around home a student might feel it is reasonable to travel to go to college. (U.S. Department of Agriculture n.d.). Although, like states, they also vary quite widely in size (for example, one covers nearly all of the southern half of the state of Nevada), this size is roughly proportional to the density of the development in the area, thus capturing the urban/rural distinctions integral to the approaches of Turley (2009) and González Canché (2018).

We use commuting zones as our geographic unit of analysis and assess them based on whether they are one of two types of education deserts, each with their own equity goals and policy implications. We refer to these two types as 'access deserts' and 'match deserts'.

2.3.1. Access Deserts

If one of the concerns of food deserts is basic access to affordable, healthy food (Walker et al. 2010), then the analogous concern of an education desert would be that students have local access to affordable postsecondary education, to which there are few admissions barriers. Not everyone would have to have access to an elite institution like Stanford or Harvard, but rather, some place they could easily enroll and earn a reputable postsecondary degree. Because they are typically much less expensive than private colleges, we would want students to have nearby access to a public college option. To give students full access to the option of earning a Bachelor's degree, we would want a commuting zone to have a four-year college that is generally non-selective. Alternatively, two-year colleges are generally open to anyone who wants to enroll, and can be a gateway to a four-year degree (Rouse 1995; Doyle 2009). Broad-access, public institutions are also an important focus for determining education deserts, as those colleges are generally administered in a way that serves the needs of the local community, unlike perhaps more selective private colleges that might have a more tailored audience in mind (Hillman and Weichman 2016). Thus, we define access deserts, analogously to Hillman and Weichman (2016), as any commuting zone that does not contain at least one public, four-year college that admits over 75 percent of its applicants, or two public two-year colleges.

2.3.2. Match Deserts

Above and beyond whether students have access to any affordable postsecondary education is the concern that colleges are geographically distributed in a way such that students have access to a nearby college that will allow them to attend classes next to similarly academically-prepared students. Students who enroll in colleges that are less selective than would otherwise be expected, given their academic qualifications, are said to have 'undermatched'. There is debate about whether scholars should consider an academic match as the most important criteria for assessing students' college choices (Ovink et al. 2018). However, separate from normative judgements about whether students should enroll in academically-matched colleges, there is ample evidence that students benefit from enrolling in the most selective college that they can. For example, a growing body of research demonstrates that the economic benefits of college attendance do not accrue to students equally across all levels of the postsecondary hierarchy. Students who attend more selective colleges—particularly in the top tier—see higher returns to their degree than students of similar academic ability who attend less selective colleges (Black and Smith 2004; Hoekstra 2009; Long 2008). These heterogenous returns could have equity-enhancing benefits, because they accrue disproportionately both to traditionally under-represented racial and ethnic minority (black and Hispanic) students and to students who have less-educated parents (Dale and Krueger 2011). Attendance at more selective colleges is also associated with larger tuition subsidies, and greater attention from faculty (Hoxby 2009; Hoxby and Avery 2012).

It is not just among the top tier of colleges where there are benefits to students to enroll in more selective colleges. Specifically, the likelihood that students will graduate appears to be positively related with college quality at many points in the selectivity spectrum (Cohodes and Goodman 2014; Goodman et al. 2017). Thus, undermatching is a concern for scholars and policymakers, to the extent that it is a signal that students are not enrolling in the most selective college that they can. Indeed, undermatching is associated with a lower likelihood of graduation, worse employment outcomes, and lower early-career earnings (Ovink et al. 2018); however, the reasons that students undermatch is not well understood.

2.4. College Choice from a Desert

We conceptually separated match deserts from access deserts. We did this, in part, to emphasize the different concerns for the lives of the students in each. For students in access deserts, we were concerned primarily with whether they have basic access to an affordable college they can get be admitted to. For students in match deserts, in contrast, we were concerned with whether there is any college near a student that is academically appropriate for the student's demonstrated abilities. This is a higher order concern. We also separated the two desert ideas because an access desert is something that is experienced equally by every student in a given commuting zone, while a match desert is a function of both the colleges in a commuting zone, and a student's individual academic qualifications.

This means that while a commuting zone can be both an access desert and a match desert, it will not necessarily be both for all students in that commuting zone. For these reasons, our analysis focuses on student's college application and enrollment behavior separately for access and match deserts as distinct phenomena.

We also consider students application and enrollment decisions separately. These too represent conceptually different variables of interest. The students' enrollment decisions are important because they are most directly implicated in the students' later life outcomes. Examining application behavior separately from enrollment behavior is important because not every application that a student submits will result in admission to a given college, nor can a student enroll in every place that they have been admitted. In this way, where a student applies to college reveals where a student has considered enrolling. Thus, we can make additional conclusions about students' enrollment from an access or match desert by also making claims about whether they considered enrolling outside of an access desert or in an academically-matched college.

Ultimately, we are unable to judge whether leaving a commuting zone is the appropriate outcome for any given student living in an access or match desert—that determination would require weighing the benefits of being able to enroll in an accessible, public college, or an academically-matched college against the individual preferences of a student and the various costs of moving away from home. However, such our research will help direct future policy and research efforts to help students make the most of their college options, given where they live.

3. Data

Our primary data is sourced from the Education Longitudinal Study of 2002 (ELS). ELS is a nationally representative longitudinal survey of U.S. students who were in the tenth grade in 2002 and the twelfth grade in 2004. In this analysis, we used data from the 2002, 2004, and 2006 administrations of the ELS, which includes data on student demographics and family background, as well as key variables for our analysis, such as where the students lived in each survey round, and where students had applied to and enrolled in college as of 2006. Although there are more recent longitudinal surveys of high-school-to-college transitions, ELS is the most recent to include the full list of where students reported applying to college. We limit the analysis to the 9300 students who indicated applying to any college. In a landscape where nearly all students aspire to college enrollment (Goyette 2008; Klasik 2012; Roderick et al. 2008), this population of students are those who have demonstrated a true intent to enroll. Although it is possible that living in an education desert is related to students' decisions whether to apply to college at all, we will leave this analysis to future research.

We use commuting zone (CZ) data from the U.S. Department of Agriculture (USDA). Commuting zones are sets of counties that are aggregated in a way that accounts for where the region's inhabitants both live and work, and so are typically connected via transportation infrastructure and shared economic characteristics. There are currently 709 commuting zones in the United States. We use zip codes to link students to counties using a crosswalk from the U.S. Department of Housing and Urban Development, and then link these counties to CZs based on the USDA classifications. In cases where a students' zip code spans county lines, the student is assigned to the county where the majority of the zip code's residential population lives.

The data on the location of all colleges in a CZ come from the Integrated Postsecondary Education Data System (IPEDS). IPEDS includes descriptive information, including location, regarding nearly every accredited postsecondary institution in the United States. Intuitions are linked to CZs via their location zip code. IPEDS data is merged with data on admissions competitiveness (selectivity) as classified by the Barron's Profile of American Colleges. The Barron's Admissions Competitiveness Index rates the selectivity of U.S. four-year colleges on a scale of 1 (most competitive) to 6 (non-competitive), based on the high school grade point averages, high school class ranks, and SAT/ACT scores of the enrolled students, as well as on the proportion of applicants that the schools admit. Because of some sparseness in the data, we collapsed the two most and the two least selective categories of institutions, resulting in four levels of selectivity for four-year colleges (see Smith et al. 2013). To these four levels we added two more, one for all two-year colleges, and one for non-degree granting, less-than-two-year colleges.

4. Method

4.1. Identification of Education Deserts

The access deserts are identified using the straightforward definition described above—they are any CZ that does not contain either at least one public, four-year college that admits at least 75% of the students who apply, or two public, two-year colleges.

The match deserts include CZs that do not contain institutions that are academically-matched to a student's academic credentials. Thus, identifying match deserts first requires that we predict that level of institution to which a student is matched to. There are many ways to determine whether students have enrolled in academically-matched institutions (Rodriguez 2015). The general strategy of our method capitalizes on data about the admissions profile of students who were admitted to colleges of differing selectivity in the ELS data (similar to Belasco and Trivette 2015; Bowen et al. 2009; Ovink et al. 2018; Roderick et al. 2008; Smith et al. 2013), and most closely aligns with the approach of Ovink et al. (2018). Firstly, we use a probit regressions to predict whether students are admitted to colleges at each of the six levels of college, based on their high school academic grade point average, their composite score on a National Center for Education Statistics assessment of math and reading, and their participation in Advanced Placement or International Baccalaureate (AP/IB) coursework. Using these predicted relationships, we then estimate the likelihood that every student in the sample will be admitted to each level of selectivity. The level to which a student is considered academically matched is the highest for which they have a greater than 90% predicted probability of admission (as in Ovink et al. 2018; Smith et al. 2013).

Because these methods are imperfect (Bastedo and Flaster 2014), we took a broad definition of a match desert and said that a student lives in a match desert if there is no college within one level of selectivity of the one we predict she has matched to. We repeated our analysis with a stricter definition, where a match desert is defined as any CZ that does not have a college that is an exact academic match for a given student. Note that, unlike for the access deserts where all of the students in the CZ are either in an access desert or not, a match desert is specific to the academic qualifications of a different student—the same CZ might be a match desert for one student, but not for another.

4.2. Descriptive and Regression Analyses

For each of these desert types, we first describe the characteristics that compare students, based on whether they live in an education desert. We then use the regression analyses to look at the relationship between living in an education desert, and both application and college enrollment behavior. Specifically, we use a linear probability model of the form, as follows:

$$Y_i = \beta_0 + \beta_1 Desert_i + X_i\beta_2 + \varepsilon_i$$

here, Y_i represents our four outcomes of interest, analyzed separately. These are whether a student (1) applied to or (2) enrolled in any college outside of their home commuting zone in the access-desert condition, or whether a student (3) applied to or (4) enrolled in an academically-matched college in the match-desert condition. β_1 is our primary coefficient of interest, capturing the relationship between living in an access desert and outcomes (1) and (2) or between living in a match desert and outcomes (3) and (4). X_i is a vector of student variables that controls for the student's race/ethnicity, family income, high school academic grade point average, whether the student ever qualified for special education services, whether the student took AP/IB coursework, whether the student lives in a single-parent household, whether the student is the first in their family to enroll in college, and their SAT score quintile (or an indicator that they did not take the SAT). The income indicators divide the data into rough quartiles and the SAT indictors reflect either the student's SAT score or their ACT score converted to the SAT scale. All of these covariates were selected based on theoretically-driven and previously-demonstrated relationships to college choice. Finally, to test whether different types of students respond in different ways to living in education deserts, we run a version of the models where we interact the $Desert_i$ indicator with each of the variables indicating race/ethnicity, category of family income, whether the student is the first in their family to enroll in college, and the student's SAT quintile indicator.

We report that the results of these regressions run as linear probability models for the ease of interpretation, but we confirm our results with logistic regressions that are more theoretically appropriate for our dichotomous outcomes.

Note that the interpretation of our outcomes is slightly different depending on the type of desert we examine. For students who live in access deserts, our primary concern is whether those students can access affordable, broad-access higher education. Because these students live in access deserts, accessing these schools necessitates leaving their CZ, so our primary outcome for the students in these deserts is whether these students are more likely than others to apply to or enroll in colleges outside of their home CZ. Academic matching is a concern beyond whether students have basic access to higher education. Thus, in match deserts, our primary concern is whether students apply to and enroll in an academically-matched institution. Because there may be other, non-match institutions that they may have access to inside their CZ, this outcome is less concerned with movement out of the CZ than our access outcomes, but for the students in match deserts applying to and enrolling in a match institution who will necessarily require looking outside of their home CZ.

Note further that living in an access desert does not necessarily force a student to apply to college out of her CZ. There may still be private or for-profit college options in their CZ, as well as more selective public colleges, however these do not necessarily represent 'access' for all students, because of their price, selectivity, and perceived quality. In fact, the average access desert experienced by students in our data is home to 3.1 colleges, of which 1.1 are public colleges, 1.3 are private colleges, and 0.75 are for-profit colleges (authors' calculations). It may then be that by submitting enough applications, a student in an access desert will apply outside of their CZ by necessity. However, this likely does not happen often. The average college applicant in our data submitted 2.6 applications, fewer than the number of colleges in an access desert.

5. Results

5.1. Who Lives in Education Deserts?

Table 1 gives the descriptive statistics for students based on whether they live in any of our classifications of education deserts. Roughly 12 percent of the students in our data who applied to college live in access deserts.[2] These students are less likely to be students of color (black, Hispanic, or Asian) and are more likely to be from a low-income family background. The students in access deserts are also more likely to be the first in their family to attend college. The students in access deserts are more likely to take the SAT, but if they take the SAT, they generally score lower than the students who do not live in access deserts.

2 Of these students in access deserts, 21% lived in access desserts with no public colleges and 12% (1.5% of the entire sample) lived in 'complete' access deserts with no degree granting colleges whatsoever. CZ—commuting zone; SD—standard deviation.

Table 1. Descriptive statistics of students by education desert type.

	Lives in Access Desert		Does Not Live in Access Desert		
Variable	**Mean**	**SD**	**Mean**		**SD**
Applied Out of CZ	0.836	(0.371)	0.619	**	(0.486)
Enrolled Out of CZ	0.684	(0.465)	0.401	**	(0.490)
Black	0.081	(0.273)	0.133	**	(0.339)
Hispanic	0.048	(0.214)	0.147	**	(0.354)
Asian	0.019	(0.138)	0.047	**	(0.212)
Other	0.051	(0.219)	0.050		(0.217)
Family Income < $35 K	0.290	(0.454)	0.280	*	(0.449)
Family Income $35–50 K	0.220	(0.415)	0.189		(0.392)
Family income $50–100 K	0.360	(0.480)	0.371		(0.483)
Family income above $100 K	0.130	(0.336)	0.160	**	(0.366)
GPA	2.939	(0.723)	2.714	**	(0.768)
Ever special education	0.064	(0.245)	0.064		(0.244)
Took AP/IB	0.305	(0.461)	0.344	**	(0.475)
Single parent family	0.189	(0.392)	0.217	*	(0.412)
First generation	0.354	(0.479)	0.338		(0.473)
No SAT score	0.199	(0.400)	0.290	**	(0.454)
Quintile 1 SAT score	0.184	(0.388)	0.145	**	(0.352)
Quintile 2 SAT score	0.187	(0.390)	0.149	**	(0.356)
Quintile 3 SAT score	0.122	(0.327)	0.129		(0.335)
Quintile 4 SAT score	0.191	(0.393)	0.152	**	(0.359)
Quintile 5 SAT score	0.117	(0.321)	0.134		(0.341)
	N = 1130		*N* = 8180		

	Lives in Match Desert		Does Not Live in Match Desert			Lives in Exact Match Desert		Does Not Live in Exact Match Desert		
Variable	**Mean**	**SD**	**Mean**		**SD**	**Mean**	**SD**	**Mean**		**SD**
Applied to match school	0.743	(0.437)	0.863	**	(0.344)	0.474	(0.500)	0.646	**	(0.478)
Enrolled in match school	0.586	(0.493)	0.702	**	(0.457)	0.258	(0.438)	0.440	**	(0.496)
Black	0.036	(0.185)	0.125	**	(0.331)	0.048	(0.213)	0.133	**	(0.340)
Hispanic	0.054	(0.226)	0.130	**	(0.336)	0.078	(0.268)	0.134	**	(0.341)
Asian	0.016	(0.125)	0.047	**	(0.211)	0.023	(0.149)	0.049	**	(0.217)
Other	0.041	(0.199)	0.047		(0.211)	0.039	(0.194)	0.048		(0.213)
Family income <$35 K	0.274	(0.447)	0.258		(0.438)	0.239	(0.427)	0.263		(0.441)
Family income $35–50 K	0.231	(0.422)	0.184	**	(0.388)	0.202	(0.401)	0.185		(0.388)
Family income $50–100 K	0.362	(0.481)	0.387		(0.487)	0.409	(0.492)	0.381		(0.486)
Family income above $100 K	0.133	(0.339)	0.170	*	(0.376)	0.151	(0.358)	0.171		(0.377)
GPA	3.364	(0.576)	2.781	**	(0.730)	3.301	(0.601)	2.723	**	(0.721)
Ever special education	0.025	(0.155)	0.060	**	(0.238)	0.035	(0.185)	0.062	**	(0.242)
Took AP/IB	0.418	(0.494)	0.365	*	(0.481)	0.498	(0.500)	0.342	**	(0.474)
Single parent family	0.175	(0.380)	0.208		(0.406)	0.175	(0.380)	0.212	**	(0.409)
First generation	0.339	(0.474)	0.314		(0.464)	0.278	(0.448)	0.323	**	(0.468)
No SAT score	0.101	(0.302)	0.244	**	(0.429)	0.102	(0.302)	0.261	**	(0.439)
Quintile 1 SAT score	0.079	(0.269)	0.153	**	(0.360)	0.083	(0.276)	0.161	**	(0.367)
Quintile 2 SAT score	0.162	(0.369)	0.161		(0.368)	0.148	(0.356)	0.164		(0.370)
Quintile 3 SAT score	0.185	(0.389)	0.135	**	(0.342)	0.163	(0.369)	0.134	**	(0.341)
Quintile 4 SAT score	0.291	(0.455)	0.164	**	(0.370)	0.275	(0.447)	0.152	**	(0.359)
Quintile 5 SAT score	0.183	(0.387)	0.143	*	(0.350)	0.229	(0.420)	0.129	**	(0.335)
	N = 510		*N* = 7850			*N* = 1380		*N* = 6980		

Note. ** $p < 0.01$, * $p < 0.05$ indicates differences from students in corresponding education desert. All calculations reflect sample weighting. Due to requirements of using restricted Education Longitudinal Study of 2002 (ELS) data, all of the sample sizes were rounded to the nearest 10 throughout. AP/IB—Advanced Placement or International Baccalaureate.

Under our broad definition of match deserts, 6% of college applicants live in a match desert. As shown in Table 1, the students who live in match deserts, like students in access deserts, are less likely to be students of color, but tend to come from families with similar income levels. Academically, students in match deserts are more likely to have a higher GPA, are more likely to take the SAT or ACT, and tend to score higher on those exams. This pattern of higher achieving students living in match deserts is confirmed in Table 2, which shows the percentage of students who live in match deserts according to the level of college to which we predicted they were an academic match. Indeed, those who are eligible for the most competitive colleges are most likely to live in a match desert (57%), presumably because highly-selective institutions are not as geographically available as open-access institutions (81% of those matched to a non-selective institution have a non-selective institution in their commuting zone).

Table 2. Percent of students who matched at each selectivity level, and the percent who match at each level who live in a match desert.

	% Students Predicted to Match	**% Students in Match Desert**	**% Students in Strict Match Desert**
Most/highly competitive	2	24	57
Very competitive	27	10	69
Competitive	22	8	81
Less/not competitive	3	0	83
Community (two-year) college	46	2	95
Less-than two-year college	1	2	81

Notes. Match desert indicates that the students commuting zone does not contain a college within ±1 level of the level at which the student was predicted to match. Strict match desert indicates that a student's commuting zone does not contain a college that exactly matches the level at which the student was predicted to match.

These differences are more extreme under our stricter definition of a match desert, in which we want students to live near a college that exactly matches the level to which we predict they are academically matched. Under this definition, over 7% of college-intending students live in a match desert.

5.2. Application and Enrollment Behavior

Table 1 also gives the percentage of students in each type of education desert that either apply/enroll outside their home CZ, or apply/enroll to an academically matched institution. Here, we see that students who live in an access desert are significantly more likely to apply to an institution outside of their commuting zone (84% apply to at least one school outside their CZ, relative to 62% for those not in an access desert). When looking at those that enroll, we find that these differences persist, 68% of those in an access desert enroll outside of their home CZ, while 40% of those in a non-access desert enroll out of their CZ.

High school students who live in a match desert are significantly less likely to apply to an institution that is an academic match (74% apply to a match school, relative to 86% for those not in a match desert). Likewise, they are less likely to enroll in a match school (59% enroll in a match, relative to 70%).

These patterns are even more stark with our strict definition of a match desert. Here, just 47% of these students from strict match deserts apply to academically-matched institutions, significantly less than the 65% of students who do not live in match deserts. Students in strict match deserts are also notably less likely to enroll in an exact academic match college—26% versus 44%.

Regression analyses demonstrate how robust these differences in application and enrollment behavior are, while taking into account the other differences in the populations of education deserts and non-deserts, as well as looking at how different populations of students respond to living in education deserts.

Table 3 gives the regression results for the application behavior of students who live in access deserts. The students who live in an access desert are 19 percentage points more likely to apply out of their commuting zone, relative to those who do not live in access deserts, even after controlling for the student's race, family background, coursework, and SAT score. Similarly, as shown in Table 4, the students in an access desert are roughly 26 percentage points more likely to enroll in a college outside of their commuting zone, even after controlling for a full set of demographic characteristics.

Table 3. Relationship between living in an access desert and applying to a college outside of home commuting zone.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is Access Desert	0.217 **	0.192 **	0.207 **	0.189 **	0.192 **	0.189 **
	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)	(0.014)
Race/ethnicity		X	X	X	X	X
Family income			X	X	X	X
GPA				X	X	X
Ever special education				X	X	X
Took AP/IB				X	X	X
Single parent family					X	X
First generation					X	X
SAT score						X
Observations	9310	9310	9310	9310	9310	9310
R-squared	0.024	0.057	0.082	0.158	0.161	0.209

Notes. Robust standard error in parentheses. Regressions include the indicated control variables. Full regression results available in Appendix A, Table A1. ** $p < 0.01$.

Table 4. Relationship between living in an access desert and enrolling in a college outside of home commuting zone.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is Access Desert	0.277 **	0.250 **	0.264 **	0.250 **	0.251 **	0.255 **
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Race/ethnicity		X	X	X	X	X
Family income			X	X	X	X
GPA				X	X	X
Ever Special education				X	X	X
Took AP/IB				X	X	X
Single parent family					X	X
First generation					X	X
SAT score						X
Observations	9310	9310	9310	9310	9310	9310
R-squared	0.036	0.062	0.083	0.134	0.136	0.162

Notes. Robust standard error in parentheses. Regressions include the indicated control variables. Full regression results available in Appendix A, Table A2. ** $p < 0.01$.

Tables 5 and 6 give the results of for the regression predicting the application and enrollment behavior according to whether students live in match deserts. Here, as with the access desert results, the estimates of the relationship between applying to and enrolling in a match school and living in a commuting zone without a match institution remains, even with the inclusion of a full array of controls. After controlling for a student's race, family income and background, coursework, GPA, and SAT/ACT score, a student living in a match desert is estimated to be 12 percentage points less likely to apply to a match school and almost 12 percentage points less likely to enroll in one.

Table 5. Relationship between living in match desert and applying to an academically-matched college.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is Match Desert	−0.120 ** (0.023)	−0.113 ** (0.024)	−0.112 ** (0.024)	−0.120 ** (0.024)	−0.119 ** (0.024)	−0.116 ** (0.023)
Race/ethnicity		X	X	X	X	X
Family income			X	X	X	X
GPA				X	X	X
Ever special education				X	X	X
Took AP/IB				X	X	X
Single parent family					X	X
First generation					X	X
SAT score						X
Observations	8350	8350	8350	8350	8350	8350
R-squared	0.007	0.011	0.011	0.017	0.017	0.028

Notes. Robust standard error in parentheses. Regressions include the indicated control variables. Full regression results available in Appendix A, Table A3. ** $p < 0.01$.

Table 6. Relationship between living in match desert and enrolling an academically-matched college.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is Match Desert	−0.120 ** (0.027)	−0.120 ** (0.027)	−0.118 ** (0.027)	−0.120 ** (0.027)	−0.119 ** (0.027)	−0.113 ** (0.026)
Race/ethnicity		X	X	X	X	X
Family income			X	X	X	X
GPA				X	X	X
Ever special education				X	X	X
Took AP/IB				X	X	X
Single parent family					X	X
First generation					X	X
SAT score						X
Observations	8351	8351	8351	8351	8351	8351
R-squared	0.004	0.006	0.006	0.010	0.010	0.036

Notes. Robust standard error in parentheses. Regressions include the indicated control variables. Full regression results available in Appendix A, Table A4. ** $p < 0.01$.

The relationship between living in a broadly defined match desert, and application and enrollment behavior is only slightly less strong than the analogous relationship for our strictly-defined match deserts. Tables 7 and 8 give the results for the application and enrollment predictions based on whether students live in a commuting zone that does not contain an exact match for their predicted academic match level. The students who do not live in the same commuting zone as the exact academic match institutions are 14 percentage points less likely to apply to an exact-match institution and 11 percentage points less likely to enroll. These results are again consistent, regardless of the set of control variables we include in our models.

Table 7. Relationship between living in match desert and applying to a strict academic-match college.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is Match Desert	−0.170 ** (0.016)	−0.168 ** (0.017)	−0.172 ** (0.017)	−0.113 ** (0.018)	−0.113 ** (0.018)	−0.107 ** (0.017)
Race/ethnicity		X	X	X	X	X
Family income			X	X	X	X
GPA				X	X	X
Ever special education				X	X	X
Took AP/IB				X	X	X
Single parent family					X	X
First generation					X	X
SAT score						X
Observations	8351	8351	8351	8351	8351	8351
R-squared	0.017	0.021	0.024	0.049	0.049	0.068

Notes. Robust standard error in parentheses. Regressions include the indicated control variables. Full regression results available in Appendix A, Table A5. ** $p < 0.01$.

Table 8. Relationship between living in match desert and enrolling in a strict academic-match college.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is Match Desert	−0.170 ** (0.016)	−0.168 ** (0.017)	−0.172 ** (0.017)	−0.113 ** (0.018)	−0.113 ** (0.018)	−0.107 ** (0.017)
Race/ethnicity		X	X	X	X	X
Family income			X	X	X	X
GPA				X	X	X
Ever special education				X	X	X
Took AP/IB				X	X	X
Single parent family					X	X
First generation					X	X
SAT score						X
Observations	8350	8350	8350	8350	8350	8350
R-squared	0.017	0.021	0.024	0.049	0.049	0.068

Notes. Robust standard error in parentheses. Regressions include the indicated control variables. Full regression results available in Appendix A, Table A6. ** $p < 0.01$.

5.3. Differences by Background and Academic Qualifications

The previous regression results indicated the application and enrollment behavior of the average student in an education desert. However, the relationship between living in an access or match desert and application behavior may be different for different sub-populations of students, particularly those for whom there are concerns about equity in U.S. higher education. Thus, we ran a series of interaction models to account for the potential differences in these relationships. In each model, we included an interaction between living in an education desert with a set of mutually-exclusive characteristics, holding all of the other covariates constant. We ran these models separately, each time including interactions for either a student's race or ethnicity, family income, whether they were the first in her family to enroll in college, and their SAT quintile (or status as not having taken the SAT).

Table 9 presents the main effects and interaction effects for each of the interaction models that we ran. All of the other control variables are included in each model, but are suppressed from the table. Although the average black student is both more likely than a white student to apply to and enroll out of their home CZ, and less likely to apply to and enroll in an academically-matched institution, the application and enrollment behavior of black students in education deserts does not differ significantly from this group. However, after controlling for other characteristics, Hispanic students who live in an access desert are more likely than other Hispanic students to apply out of their commuting zone, but no less likely to enroll in a school outside their commuting zone. Taken together, if the average white student is 17 percentage points more likely to apply out of their CZ if they live in an access desert, the average Hispanic student in an access desert is 25 percentage points more likely to do the same. In contrast, Hispanic students in strict-match deserts, however, are 23 percent less likely to apply to an exact match institution, and 31 percentage points less likely to enroll in one than a white student who does not live in a match desert.

Table 9. Heterogeneous relationships between living in access or match desert and application and enrollment behavior.

	Apply	Enroll	Apply	Enroll	Apply	Enroll
	... Out of CZ		... to Match		... to Strict Match	
Home CZ is desert	0.173 **	0.259 **	−0.110 **	−0.112 **	−0.136 **	−0.099 **
	(0.016)	(0.019)	(0.025)	(0.028)	(0.021)	(0.020)
Black	0.157 **	0.114 **	0.041 **	−0.024	−0.064 **	−0.123 **
	(0.020)	(0.021)	(0.015)	(0.021)	(0.022)	(0.023)
Black * desert	0.056	-0.026	0.080	0.169	0.108	0.047
	(0.041)	(0.060)	(0.093)	(0.117)	(0.072)	(0.063)
Hispanic	−0.106 **	−0.109 **	0.058 **	0.020	0.038+	0.007
	(0.019)	(0.017)	(0.015)	(0.021)	(0.022)	(0.023)
Hispanic * desert	0.180 **	0.026	−0.122	−0.113	−0.117 †	−0.121 *
	(0.064)	(0.070)	(0.104)	(0.106)	(0.064)	(0.054)
Asian	−0.046 *	−0.091 **	0.032 *	0.023	0.032	−0.002
	(0.019)	(0.019)	(0.014)	(0.020)	(0.022)	(0.022)
Asian * desert	0.073	−0.051	−0.020	0.006	0.006	0.032
	(0.061)	(0.088)	(0.114)	(0.112)	(0.072)	(0.065)
Other	0.017	0.024	−0.030	−0.036	−0.056	−0.077 *
	(0.028)	(0.031)	(0.028)	(0.031)	(0.035)	(0.033)
Other * desert	−0.011	−0.036	−0.050	−0.030	0.018	−0.025
	(0.061)	(0.074)	(0.135)	(0.129)	(0.088)	(0.070)
Home CZ is desert	0.025	0.094 *	−0.026	−0.029	0.035	0.066
	(0.034)	(0.042)	(0.053)	(0.067)	(0.042)	(0.046)
Family income <$35 K	−0.130 **	−0.126 **	0.033 †	0.007	0.032	0.049 †
	(0.021)	(0.022)	(0.018)	(0.023)	(0.025)	(0.025)
Family income<$35 K * desert	0.235 **	0.173 **	−0.131 †	−0.160 †	−0.176 **	−0.212 **
	(0.043)	(0.052)	(0.069)	(0.083)	(0.055)	(0.056)
Family income $35–50 K	−0.127 **	−0.133 **	0.014	0.010	0.018	0.061 *
	(0.020)	(0.022)	(0.017)	(0.022)	(0.025)	(0.025)
Family income $35–50 K * desert	0.195 **	0.207 **	−0.108	−0.110	−0.208 **	−0.227 **
	(0.045)	(0.054)	(0.073)	(0.086)	(0.058)	(0.058)
Family income $50–100 K	−0.090 **	−0.112 **	0.016	0.005	0.030	0.047 *
	(0.016)	(0.019)	(0.014)	(0.018)	(0.021)	(0.021)
Family income $50–100 K * desert	0.150 **	0.184 **	−0.083	−0.043	−0.223 **	−0.193 **
	(0.041)	(0.049)	(0.065)	(0.078)	(0.050)	(0.053)
Home CZ is desert	0.158 **	0.238 **	−0.086 **	−0.072 *	−0.121 **	−0.078 **
	(0.016)	(0.020)	(0.026)	(0.031)	(0.022)	(0.021)
First generation	−0.044 **	−0.027 †	−0.008	−0.004	0.005	0.034 *
	(0.015)	(0.014)	(0.011)	(0.015)	(0.016)	(0.017)
First generation * desert	0.089 **	0.048	−0.091 †	−0.123 *	−0.064 †	−0.105 **
	(0.030)	(0.035)	(0.051)	(0.054)	(0.039)	(0.035)
Home CZ is desert	0.122 **	0.238 **	0.012	−0.039	−0.015	0.009
	(0.017)	(0.031)	(0.023)	(0.052)	(0.037)	(0.039)
No SAT score	−0.372 **	−0.323 **	−0.088 **	−0.067 **	0.063 *	0.178 **
	(0.024)	(0.026)	(0.021)	(0.026)	(0.030)	(0.030)
No SAT score * desert	0.188 **	0.055	−0.283 **	−0.174 †	−0.258 **	−0.283 **
	(0.042)	(0.050)	(0.085)	(0.098)	(0.066)	(0.063)
Quintile 1 SAT score	−0.174 **	−0.238 **	−0.066 **	−0.098 **	0.050	0.123 **
	(0.027)	(0.028)	(0.020)	(0.027)	(0.030)	(0.031)
Quintile 1 SAT score * desert	0.102 *	0.062	−0.031	0.031	−0.168 *	−0.135 †
	(0.040)	(0.052)	(0.065)	(0.091)	(0.071)	(0.070)

Table 9. *Cont.*

	Apply	Enroll	Apply	Enroll	Apply	Enroll
	… Out of CZ		**… to Match**		**… to Strict Match**	
Quintile 2 SAT score	−0.116 **	−0.183 **	−0.109 **	−0.198 **	−0.074 *	0.004
	(0.024)	(0.027)	(0.018)	(0.024)	(0.029)	(0.029)
Quintile 2 SAT score * desert	0.043	−0.038	−0.157 *	−0.122	−0.186 **	−0.166 **
	(0.039)	(0.053)	(0.064)	(0.084)	(0.058)	(0.055)
Quintile 3 SAT score	−0.069 **	−0.137 **	−0.102 **	−0.220 **	−0.073 *	−0.037
	(0.022)	(0.026)	(0.018)	(0.024)	(0.029)	(0.028)
Quintile 4 SAT score * desert	0.007	0.049	−0.242 **	−0.177 *	−0.173 **	−0.175 **
	(0.041)	(0.054)	(0.067)	(0.079)	(0.057)	(0.051)
Quintile 4 SAT score	−0.011	−0.050 *	−0.067 **	−0.115 **	−0.089 **	−0.021
	(0.018)	(0.024)	(0.014)	(0.021)	(0.027)	(0.027)
Quintile 4 SAT score * desert	0.005	−0.024	−0.091 †	−0.019	−0.081	−0.064
	(0.027)	(0.046)	(0.049)	(0.071)	(0.052)	(0.051)

Notes. Application and enrollment out of commuting zone predicted using indicator for home in access desert. Application and enrollment behavior in matches predicted using indicator for home in match desert. Coefficients for all other control variables suppressed. Each set of interactions calculated separately. Robust standard error in parentheses. Reference category for race/ethnicity is 'white'. Reference category for family income is '>100 K'. Reference category for SAT score is 'Quintile 5'. ** $p < 0.01$, * $p < 0.05$, † $p < 0.1$.

Relative to their peers who do not live in an access desert, the students from every income level, first-generation students, and those that did not take the SAT are more likely to apply outside of their commuting zone. However, although the students in all income groups are more likely to enroll outside their CZ relative to their non-access desert-peers, both first-generation students and students in access deserts who did not take the SAT are no more likely to do so.

There are fewer differential application and enrollment behaviors among students who live in match deserts, relative to those who do not live in match deserts. First-generation students who live in a match desert are modestly less likely to apply, and significantly less likely to enroll in, a match school relative to first-generation peers with a match school in their commuting zone (regardless of whether we use our broad or strict definition of match desert). Similarly, relative to those with similar SAT scores in the bottom three SAT quintiles, those living in a match desert are less likely to apply and enroll in a match school. Students in match deserts from families earning less than $50,000 a year are also less likely to apply to and enroll in academically-matched institutions than those who do not live in match deserts, but only when the match is strictly defined.

6. Discussion

In this article, we have demonstrated the connection between the higher education opportunities students have available to them locally and their college application and enrollment decisions. We focused on two types of areas that lack higher education opportunities—access deserts, which lack public, broad access postsecondary options, and match deserts, which lack colleges that are academically matched to a student's own credentials. Our results suggest at least three important patterns. First, the students who apply to college from access deserts are less racially diverse and tend to come from lower-income backgrounds than students who do not live in access deserts. Students from match deserts are also less diverse, but tend to be higher-performing academically and have similar family income levels to students who do not live in access deserts. Second, on average, the students from access deserts appear more willing to look for colleges outside of their home commuting zone, particularly Hispanic, lower-income, and first-generation college students. Finally, the students from match deserts are less likely to apply to and enroll in academically-matched colleges. That is, the students in access deserts appear to overcome the limitations of their local college options, while the students in match deserts do not.

6.1. Students and Access Deserts

Our findings about the demographics of students who live in education deserts appear to contradict earlier research. Hillman (2016) found, in particular, that access-like deserts tended to have higher percentages of Hispanic families, as well as lower levels of educational attainment. Although we did find that students in access deserts are more likely to be the first in their family to attend college, these students are also less likely to be Hispanic than students who do not live in education deserts. One explanation for this apparent disagreement might be population changes that happened between the 2004 data collection that we used to place students in commuting zones, and Hillman's data from 2009 to 2013. Although parts of the United States have seen shifts in population composition, a more likely explanation lies in the differences in our sample selection. While Hillman describes the overall population of commuting zones, we focus more narrowly on college-intending high school seniors—those who submitted applications to enroll in any college. Thus, the differences in our findings may not reflect a disagreement about the population of students who live in access deserts, but rather the differences between the overall population in access deserts and those who actually decide to apply to college from those deserts.

This distinction in sample populations and the resulting differences in findings suggests that the challenge for students living in access deserts may not be on the margin of whether to look outside of their commuting zone to apply and enroll, but whether to attend college at all. Furthermore, to the extent that access deserts have a chilling effect on the decision to apply to college, this effect may be stronger on lower income and racial minority populations—precisely those groups that Hillman found prevalent in access deserts, but we did not observe this in the college-applying population.

What is apparent from our findings, however, is that for those students in access deserts who do make the decision to apply to college, the boundaries of their home commuting zone are not as constraining as they are for other students—the students in access deserts more frequently look outside of their commuting zone for college options than the students who do not live in access deserts. In other words, it appears that access-desert students recognize the lack of options near home and go elsewhere to find places to enroll.

Furthermore, the populations that are usually at the losing end of higher education equity conversations—Hispanic students, lower-income students, and first-generation college students—are more likely to pursue postsecondary opportunities outside of their commuting zone if they live in an access desert, despite the tendency of those populations to be less likely to look outside of their home commuting zone overall. This differential behavior may mute whatever inequities in access to postsecondary opportunities access deserts create, at least among the population of students who submit college applications.

6.2. Students in Match Deserts

Our story is almost exactly the opposite to the students who live in match deserts than it is for students who live in access deserts. Here, we find that the students in match deserts are less likely to apply to and enroll in match institutions, and to the extent that certain populations of students make different choices when they live in match deserts, we find that groups like first-generation college students are even less likely to apply to and enroll in academically-matched institutions. In other words, while college applicants in access deserts make choices that appear to mitigate the challenges of their access to higher education opportunities, college applicants in match deserts appear to make choices that exacerbate and reproduce inequalities in postsecondary destinations. This claim is not meant to place blame on students in match deserts for their choices, but rather to highlight for scholars and policymakers that match deserts create an environment in which students may have a harder time accessing higher education opportunities than they do in access deserts.

That we find such behavior among college applicants in match deserts should not be a surprise; 'match' is a much more complex problem than 'access'. While it may be clear to a student that there are no affordable colleges nearby, as in an access desert, assessing both whether a college is an academic match and understanding the costs and benefits of not attending an academic match is a well-known challenge, particularly for the students who do not come from privileged backgrounds (see, for example, Hoxby and Avery 2012). Thus, the calculus for a student in an access desert to look farther afield for college options is easy, while a student in a match desert who might have reasonable-looking, non-academically-matched institutions nearby may face a set of calculations that are more difficult to compute.

6.3. Policy Implications

Because of the challenges that match deserts appear to create for students, the persistent gaps in the selectivity of colleges students enroll in (Baker et al. 2018), and the increasingly well-documented consequences for undermatching (Ovink et al. 2018), our findings have important consequences for policy aimed at the application and enrollment decisions of potential college students. Specifically, this paper provides evidence that college access and the choice policies can no longer remain geographically-neutral; not all students have the same college opportunities locally available to them, and not all students respond in the same way given those opportunities. By being aware of a student's local context and working to expand a student's opportunities if necessary, policy makers can work to help students overcome the challenges of limited local higher education options.

One model for such interventions might be the Expanding College Opportunities project by Hoxby and Turner (2013). In this policy experiment, high achieving low-income students were provided personally-tailored information about potentially academically matched institutions, both in the student's home state and, potentially, farther away. The students receiving this information were notably more likely to apply to and enroll in more selective institutions (Hoxby and Turner 2013). It remains to be seen whether a policy like this can be effectively implemented at a larger scale, and to a broader set of students, but it demonstrates the potential of geographically-tailored policy interventions to improve the likelihood that students will enroll in academically-matched institutions.

Although there may be arguments against policies that attempt to induce students to move away from home because of an assumption that students stay close to home when they enroll in college for good reasons, our results for students in access deserts show that this assumption may not always have been the case. Students in access deserts more than their peers with similar characteristics appear willing to move in order to enroll in college. While there is no reason to expect that it should hold for all students, it is likely that the students in match deserts may have the potential to be similarly mobile given the tools to facilitate that mobility.

6.4. Directions for Future Research

Our work also has important implications for future research on students' college choices. Although we have long known about students' preferences to stay close to home when they enroll in college, we are only starting to understand the implications of these preferences given a student's specific location. We provide the first evidence of how limited geographic opportunity is related to application and enrollment choices for college-intending students. There is still more to learn. As noted above, because of our focus on college-intending students, we do not speak to the potential for limited geographic opportunities to affect a student's decision to apply to college at all.

Additionally, although we found that students in access deserts are more likely to apply to and enroll in colleges outside of the limited options in their own commuting zone, it is an open question whether these were good moves. Although it is difficult to judge a 'good' move for students with multiple, idiosyncratic preferences for college, we do not know if these students are enrolling in institutions that are, at the very least, affordable or academic matches. It is encouraging that these students look elsewhere for college options, but it may be that they need additional help learning about farther away colleges that may not be as familiar to them.

Finally, our findings about the behavior of students in match deserts add an important new dimension to the literature on undermatching. While this literature tends to assume that undermatching happens as a result of a lack of information on the part of students (e.g., Hoxby and Turner 2013), we have shown that the geographic context may play an outsized role in undermatching as well. It may be that undermatching and information are linked—students might have the best information about local colleges—but future undermatching literature should continue to explore the role geographic context has in the undermatch phenomena.

7. Conclusions

Given ongoing disparities in where students enroll in college, and disparate returns to college based on where students enroll, it is important to understand the forces that shape whether and where students go to college, and how those decisions about college-going are then linked to broader issues of inequality and social stratification. One frontier in our understanding of these forces is that of the geography of opportunity—understanding how the inequitable distribution of colleges around the country shapes the college-going decisions of students with limited local options. This article provides new evidence for developing that understanding. More work is needed to develop increasingly sophisticated descriptions of how students interact with their local postsecondary geography, so that scholars and policymakers can, in turn, develop similarly sophisticated interventions that help students make the best college enrollment choice they can. If information is going to continue to be an important tool to help students make college decisions, that information needs to be relevant to students' local context. If we decide to move beyond providing information then it would be wise to direct policy efforts to reduce the perceived costs, or increase the perceived benefit, of enrolling in college away from home, particularly for students who do not live in an area with a local academic match. Continued work on these paths will support efforts to promote college enrollment to students in a way that reduces the inequities of access and match deserts.

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Appendix A.

Table A1. Relationship between living in an access desert and applying to a college outside of home commuting zone.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is Access Desert	0.217 **	0.192 **	0.207 **	0.189 **	0.192 **	0.189 **
	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)	(0.014)
Black		0.023	0.076 **	0.164 **	0.155 **	0.163 **
		(0.018)	(0.019)	(0.019)	(0.019)	(0.018)
Hispanic		−0.254 **	−0.201 **	−0.149 **	−0.142 **	−0.095 **
		(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Asian		−0.036 †	−0.012	−0.054 **	−0.051 **	−0.039 *
		(0.020)	(0.020)	(0.018)	(0.018)	(0.018)
Other		−0.056 *	-0.032	0.011	0.006	0.016
		(0.028)	(0.028)	(0.027)	(0.027)	(0.026)
Family Income <$35 K			−0.236 **	−0.150 **	−0.141 **	−0.100 **
			(0.018)	(0.018)	(0.020)	(0.020)
Family Income $35–50 K			−0.200 **	−0.136 **	−0.125 **	−0.103 **
			(0.019)	(0.018)	(0.019)	(0.018)
Family Income $50–100 K			−0.133 **	−0.089 **	−0.083 **	−0.073 **
			(0.016)	(0.015)	(0.016)	(0.015)

Table A1. *Cont.*

	(1)	(2)	(3)	(4)	(5)	(6)
GPA				0.131 **	0.129 **	0.052 **
				(0.009)	(0.009)	(0.010)
Ever Special Education				−0.04	−0.042 †	−0.013
				(0.025)	(0.025)	(0.025)
Took AP/IB				0.127 **	0.124 **	0.075 **
				(0.013)	(0.013)	(0.014)
Single Parent Family					0.040 **	0.038 **
					(0.015)	(0.015)
First Generation					−0.054 **	−0.032 *
					(0.014)	(0.013)
No SAT score						−0.352 **
						(0.023)
Quintile 1 SAT Score						−0.159 **
						(0.025)
Quintile 2 SAT Score						−0.111 **
						(0.021)
Quintile 3 SAT Score						−0.068 **
						(0.020)
Quintile 4 SAT Score						−0.013
						(0.016)
Constant	0.619 **	0.658 **	0.794 **	0.325 **	0.336 **	0.675 **
	(0.007)	(0.008)	(0.013)	(0.029)	(0.030)	(0.038)
Observations	9310	9310	9310	9310	9310	9310
R-squared	0.024	0.057	0.082	0.158	0.161	0.209

Notes. Academic match defined as any college within one selectivity level of where the student was predicted to have access to. Robust standard error in parentheses. Reference category for race/ethnicity is 'white'. Reference category for family income is '>100 K'. Reference category for SAT score is 'Quintile 5'. ** $p < 0.01$, * $p < 0.05$, † $p < 0.1$.

Table A2. Relationship between living in an access desert and enrolling in a college outside of home commuting zone.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is Access Desert	0.277 **	0.250 **	0.264 **	0.250 **	0.251 **	0.255 **
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Black		−0.023	0.024	0.098 **	0.092 **	0.111 **
		(0.019)	(0.020)	(0.020)	(0.020)	(0.020)
Hispanic		−0.241 **	−0.194 **	−0.152 **	−0.147 **	−0.108 **
		(0.016)	(0.017)	(0.017)	(0.017)	(0.017)
Asian		−0.086 **	−0.066 **	−0.103 **	−0.101 **	−0.094 **
		(0.020)	(0.020)	(0.019)	(0.019)	(0.019)
Other		−0.045	−0.023	0.013	0.009	0.019
		(0.029)	(0.029)	(0.028)	(0.028)	(0.028)
Family Income <$35 K			−0.227 **	−0.153 **	−0.145 **	−0.104 **
			(0.020)	(0.020)	(0.021)	(0.021)
Family Income $35–50 K			−0.195 **	−0.140 **	−0.132 **	−0.107 **
			(0.021)	(0.020)	(0.021)	(0.021)
Family Income $50–100 K			−0.147 **	−0.110 **	−0.105 **	−0.091 **
			(0.019)	(0.018)	(0.018)	(0.018)
GPA				0.107 **	0.105 **	0.042 **
				(0.009)	(0.009)	(0.010)
Ever Special Education				−0.039	−0.040 †	−0.02
				(0.024)	(0.024)	(0.023)
Took AP/IB				0.117 **	0.115 **	0.057 **
				(0.014)	(0.014)	(0.015)

Table A2. *Cont.*

	(1)	(2)	(3)	(4)	(5)	(6)
Single Parent Family					0.025	0.022
					(0.016)	(0.016)
First Generation					−0.039 **	−0.021
					(0.014)	(0.013)
No SAT score						−0.317 **
						(0.025)
Quintile 1 SAT Score						−0.228 **
						(0.026)
Quintile 2 SAT Score						−0.189 **
						(0.024)
Quintile 3 SAT Score						−0.131 **
						(0.024)
Quintile 4 SAT Score						−0.054 *
						(0.022)
Constant	0.404 **	0.448 **	0.588 **	0.199 **	0.207 **	0.538 **
	(0.007)	(0.008)	(0.016)	(0.029)	(0.030)	(0.039)
Observations	9310	9310	9310	9310	9310	9310
R-squared	0.036	0.062	0.083	0.134	0.136	0.162

Notes. Academic match defined as any college within one selectivity level of where the student was predicted to have access to. Robust standard error in parentheses. Reference category for race/ethnicity is 'white'. Reference category for family income is '>100 K'. Reference category for SAT score is 'Quintile 5'. ** $p < 0.01$, * $p < 0.05$, † $p < 0.1$.

Table A3. Relationship between living in match desert and applying to an academically-matched college.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is Match Desert	−0.120 **	−0.113 **	−0.112 **	−0.120 **	−0.119 **	−0.116 **
	(0.023)	(0.024)	(0.024)	(0.024)	(0.024)	(0.023)
Black		0.031 *	0.033 *	0.044 **	0.042 **	0.042 **
		(0.013)	(0.014)	(0.014)	(0.014)	(0.015)
Hispanic		0.042 **	0.044 **	0.047 **	0.050 **	0.054 **
		(0.014)	(0.014)	(0.015)	(0.015)	(0.015)
Asian		0.046 **	0.047 **	0.034 *	0.035 *	0.031 *
		(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Other		−0.041	−0.040	−0.035	−0.036	−0.033
		(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Family income <$35 K			−0.007	0.009	0.015	0.024
			(0.015)	(0.016)	(0.017)	(0.017)
Family income $35–50 K			−0.018	−0.006	−0.001	0.007
			(0.017)	(0.017)	(0.017)	(0.017)
Family income $50–100 K			−0.007	0.002	0.004	0.012
			(0.014)	(0.014)	(0.014)	(0.014)
GPA				0.009	0.008	−0.003
				(0.007)	(0.007)	(0.009)
Ever special education				−0.015	−0.016	−0.018
				(0.022)	(0.022)	(0.022)
Took AP/IB				0.049 **	0.048 **	0.024 †
				(0.012)	(0.012)	(0.012)
Single parent family					0.007	0.006
					(0.012)	(0.012)
First generation					−0.019 †	−0.014
					(0.011)	(0.011)
No SAT score						−0.105 **
						(0.020)

Table A3. *Cont.*

	(1)	(2)	(3)	(4)	(5)	(6)
Quintile 1 SAT score						−0.076 **
						(0.020)
Quintile 2 SAT score						−0.124 **
						(0.018)
Quintile 3 SAT score						−0.124 **
						(0.018)
Quintile 4 SAT score						−0.074 **
						(0.014)
Constant	0.863 **	0.853 **	0.861 **	0.808 **	0.812 **	0.930 **
	(0.005)	(0.006)	(0.012)	(0.025)	(0.025)	(0.035)
Observations	8350	8350	8350	8350	8350	8350
R-squared	0.007	0.011	0.011	0.017	0.017	0.028

Notes. Academic match defined as any college within one selectivity level of where the student was predicted to have access to. Robust standard error in parentheses. Reference category for race/ethnicity is 'white'. Reference category for family income is '>100 K'. Reference category for SAT score is 'Quintile 5'. ** $p < 0.01$, * $p < 0.05$, † $p < 0.1$.

Table A4. Relationship between living in match desert and enrolling an academically-matched college.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is match desert	−0.120 **	−0.120 **	−0.118 **	−0.120 **	−0.119 **	−0.113 **
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.026)
Black		−0.033 †	-0.026	−0.020	−0.021	−0.021
		(0.020)	(0.021)	(0.021)	(0.021)	(0.021)
Hispanic		0.016	0.023	0.023	0.025	0.017
		(0.019)	(0.020)	(0.020)	(0.020)	(0.020)
Asian		0.044 *	0.047 *	0.035 †	0.035 †	0.023
		(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Other		−0.048	-0.045	−0.042	−0.043	−0.038
		(0.031)	(0.031)	(0.031)	(0.031)	(0.030)
Family income <$35 K			−0.031	−0.016	−0.010	−0.004
			(0.020)	(0.021)	(0.023)	(0.022)
Family income $35–50 K			−0.024	−0.012	−0.007	0.002
			(0.021)	(0.021)	(0.022)	(0.022)
Family income $50–100 K			−0.019	-0.010	−0.008	0.003
			(0.018)	(0.018)	(0.018)	(0.018)
GPA				−0.002	−0.003	−0.000
				(0.010)	(0.010)	(0.012)
Ever special education				0.015	0.014	−0.001
				(0.027)	(0.027)	(0.027)
Took AP/IB				0.060 **	0.059 **	0.026
				(0.015)	(0.015)	(0.016)
Single parent family					0.001	0.001
					(0.017)	(0.017)
First generation					−0.016	−0.013
					(0.015)	(0.015)
No SAT score						−0.078 **
						(0.025)
Quintile 1 SAT score						−0.102 **
						(0.027)
Quintile 2 SAT score						−0.209 **
						(0.024)
Quintile 3 SAT score						−0.237 **
						(0.023)

Table A4. *Cont.*

	(1)	(2)	(3)	(4)	(5)	(6)
Quintile 4 SAT score						−0.116 **
						(0.020)
Constant	0.700 **	0.702 **	0.720 **	0.693 **	0.697 **	0.816 **
	(0.006)	(0.008)	(0.015)	(0.033)	(0.033)	(0.044)
Observations	8350	8350	8350	8350	8350	8350
R-squared	0.004	0.006	0.006	0.010	0.010	0.036

Notes. Academic match defined as any college within one selectivity level of where the student was predicted to have access to. Robust standard error in parentheses. Reference category for race/ethnicity is 'white'. Reference category for family income is '>100 K'. Reference category for SAT score is 'Quintile 5'. ** $p < 0.01$, * $p < 0.05$, † $p < 0.1$.

Table A5. Relationship between living in match desert and applying to a strict academic-match college.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is match desert	−0.170 **	−0.168 **	−0.172 **	−0.113 **	−0.113 **	−0.107 **
	(0.016)	(0.017)	(0.017)	(0.018)	(0.018)	(0.017)
Black		−0.033	−0.054 *	−0.107 **	−0.105 **	−0.121 **
		(0.021)	(0.021)	(0.022)	(0.022)	(0.022)
Hispanic		0.079 **	0.058 **	0.025	0.022	−0.007
		(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Asian		−0.005	−0.015	0.010	0.010	−0.001
		(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Other		−0.050	−0.059 †	−0.082 **	−0.081 **	−0.081 **
		(0.031)	(0.031)	(0.030)	(0.030)	(0.030)
Family income <$35 K			0.089 **	0.045 *	0.036	0.014
			(0.021)	(0.022)	(0.024)	(0.024)
Family income $35–50 K			0.071 **	0.039+	0.032	0.023
			(0.022)	(0.022)	(0.023)	(0.023)
Family income $50–100 K			0.046 *	0.022	0.018	0.017
			(0.019)	(0.019)	(0.020)	(0.019)
GPA				−0.099 **	−0.098 **	−0.060 **
				(0.011)	(0.011)	(0.012)
Ever special education				0.031	0.032	0.008
				(0.029)	(0.029)	(0.029)
Took AP/IB				−0.041 **	−0.039 **	−0.030 †
				(0.015)	(0.015)	(0.016)
Single parent family					-0.006	−0.002
					(0.018)	(0.017)
First generation					0.026 †	0.017
					(0.015)	(0.015)
No SAT score						0.129 **
						(0.028)
Quintile 1 SAT score						0.085 **
						(0.029)
Quintile 2 SAT score						−0.039
						(0.026)
Quintile 3 SAT score						−0.083 **
						(0.024)
Quintile 4 SAT score						−0.039 †
						(0.023)
Constant	0.437 **	0.433 **	0.385 **	0.706 **	0.701 **	0.587 **
	(0.007)	(0.009)	(0.017)	(0.035)	(0.035)	(0.046)
Observations	8350	8350	8350	8350	8350	8350
R-squared	0.017	0.021	0.024	0.049	0.049	0.068

Notes. Academic match defined as any college within one selectivity level of where the student was predicted to have access to. Robust standard error in parentheses. Reference category for race/ethnicity is 'white'. Reference category for family income is '>100 K'. Reference category for SAT score is 'Quintile 5'. ** $p < 0.01$, * $p < 0.05$, † $p < 0.1$.

Table A6. Relationship between living in match desert and enrolling in a strict academic-match college.

	(1)	(2)	(3)	(4)	(5)	(6)
Home CZ is match desert	−0.170 **	−0.168 **	−0.172 **	−0.113 **	−0.113 **	−0.107 **
	(0.016)	(0.017)	(0.017)	(0.018)	(0.018)	(0.017)
Black		−0.033	−0.054 *	−0.107 **	−0.105 **	−0.121 **
		(0.021)	(0.021)	(0.022)	(0.022)	(0.022)
Hispanic		0.079 **	0.058 **	0.025	0.022	-0.007
		(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Asian		−0.005	−0.015	0.010	0.010	−0.001
		(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Other		−0.050	−0.059 †	−0.082 **	−0.081 **	−0.081 **
		(0.031)	(0.031)	(0.030)	(0.030)	(0.030)
Family income <$35K			0.089 **	0.045 *	0.036	0.014
			(0.021)	(0.022)	(0.024)	(0.024)
Family income $35-50K			0.071 **	0.039+	0.032	0.023
			(0.022)	(0.022)	(0.023)	(0.023)
Family income $50-100K			0.046 *	0.022	0.018	0.017
			(0.019)	(0.019)	(0.020)	(0.019)
GPA				−0.099 **	−0.098 **	−0.060 **
				(0.011)	(0.011)	(0.012)
Ever special education				0.031	0.032	0.008
				(0.029)	(0.029)	(0.029)
Took AP/IB				−0.041 **	−0.039 **	−0.030 †
				(0.015)	(0.015)	(0.016)
Single parent family					−0.006	−0.002
					(0.018)	(0.017)
First generation					0.026 †	0.017
					(0.015)	(0.015)
No SAT score						0.129 **
						(0.028)
Quintile 1 SAT score						0.085 **
						(0.029)
Quintile 2 SAT score						−0.039
						(0.026)
Quintile 3 SAT score						−0.083 **
						(0.024)
Quintile 4 SAT score						−0.039 †
						(0.023)
Constant	0.437 **	0.433 **	0.385 **	0.706 **	0.701 **	0.587 **
	(0.007)	(0.009)	(0.017)	(0.035)	(0.035)	(0.046)
Observations	8350	8350	8350	8350	8350	8350
R-squared	0.017	0.021	0.024	0.049	0.049	0.068

Notes. Academic match defined as any college that exactly matches the selectivity level of where the student was predicted to have access to. Robust standard error in parentheses. Reference category for race/ethnicity is 'white'. Reference category for family income is '>100 K'. Reference category for SAT score is 'Quintile 5'. ** $p < 0.01$, * $p < 0.05$, † $p < 0.1$.

References

Astin, Alexander W., and Leticia Oseguera. 2004. The Declining "Equity" of American Higher Education. *The Review of Higher Education* 27: 321–41.

Alm, James, and John V. Winters. 2009. Distance and Intrastate College Student Migration. *Economics of Education Review* 28: 728–38. [CrossRef]

Alon, Sigal, and Marta M. Tienda. 2007. Diversity, Opportunity, and the Shifting Meritocracy in Higher Education. *American Sociological Review* 72: 487–511. [CrossRef]

Alpert, William T., Kenneth A. Couch, and Oskar R. Harmon. 2016. A Randomized Assessment of Online Learning. *American Economic Review* 106: 378–82. [CrossRef]

Baker, Rachel, Daniel Klasik, and Sean F. Reardon. 2018. Race and Stratification in College Enrollment over Time. *AERA Open* 4: 1–28. [CrossRef]

Baryla, Edward A., and Douglas Dotterweich. 2001. Student Migration: Do significant factors vary by region? *Education Economics* 9: 269–80. [CrossRef]

Bastedo, Michael N., and Ozan Jaquette. 2011. Running in Place: Low-Income Students and the Dynamics of Higher Education Stratification. *Educational Evaluation and Policy Analysis* 33: 318–39. [CrossRef]

Bastedo, Michael N., and Allyson Flaster. 2014. Conceptual and Methodological Problems in Research on College Undermatch. *Educational Researcher* 43: 93–99. [CrossRef]

Becker, Gary S. 1962. Investment in Human Capital: A Theoretical Analysis. *The Journal of Political Economy* 70: 9–49. [CrossRef]

Belasco, Andrew S., and Michael J. Trivette. 2015. Aiming Low: Estimating the Scope and Predictors of Postsecondary Undermatch. *The Journal of Higher Education* 86: 233–63. [CrossRef]

Bettinger, Eric, and Susanna Loeb. 2017. *Promises and Pitfalls of Online Education*. Washington, DC: Brookings Institution.

Black, Dan A., and Jeffrey Smith. 2004. How Robust is the Evidence on the Effects of College Quality? Evidence from Matching. *Journal of Econometrics* 121: 99–124. [CrossRef]

Bourdieu, Pierre. 1986. The Forms of Capital. In *Handbook of Theory of Research for the Sociology of Education*. Westport: Greenwood Press, pp. 241–58.

Bowen, William. G., Matthew M. Chingos, and Michael S. McPherson. 2009. *Crossing the Finish Line: Completing College at America's Public Universities*. Princeton: Princeton University Press.

Card, David. 1995. Using Geographic Variation in College Proximity to Estimate the Return to Schooling. In *Aspects of Labour Market Behaviour: Essays in Honor of John Venderkamp*. Toronto: University of Toronto Press, pp. 201–22.

Cohodes, Sarah, and Joshua Goodman. 2014. Merit Aid, College Quality, and College Completion: Massachusetts' Adams Scholarship as an In-Kind Subsidy. *American Economic Journal: Applied Economics* 6: 251–85. [CrossRef]

Coleman, James. S. 1988. Social Capital in the Creation of Human Capital. *American Journal of Sociology* 94: S95–S120. [CrossRef]

Cooke, Thomas J., and Paul Boyle. 2011. The Migration of High School Graduates to College. *Educational Evaluation and Policy Analysis* 33: 202–13. [CrossRef]

Dale, Stacy B., and Alan B. Krueger. 2011. *Estimating the Return to College Selectivity over the Career Using Administrative Earnings Data*. Working Paper w17159. Cambridge, MA, USA: National Bureau of Economic Research.

Deming, David J., Noam Yuchtman, Amira Abulafi, Claudia Goldin, and Lawrence F. Katz. 2016. The Value of Postsecondary Credentials in the Labor Market: An Experimental Study. *American Economic Review* 106: 778–806. [CrossRef]

Doyle, William R. 2009. The Effect of Community College Enrollment on Bachelor's Degree Completion. *Economics of Education Review* 28: 199–206. [CrossRef]

Engberg, Mark E. 2012. Pervasive Inequality in the Stratification of Four-Year College Destinations. *Equity and Excellence in Education* 45: 575–95. [CrossRef]

González Canché, Manuel S. 2018. Nearby College Enrollment and Geographical Skills Mismatch: (Re)conceptualizing Student Out-Migration in the American Higher Education System. *The Journal of Higher Education*. [CrossRef]

Goodman, Joshua, Michael Hurwitz, and Jonathan Smith. 2017. Access to 4-year Public Colleges and Degree Completion. *Journal of Labor Economics* 35: 829–67. [CrossRef]

Goyette, Kimberly A. 2008. College for Some to College for All: Social Background, Occupational Expectations, and Educational Expectations over Time. *Social Science Research* 37: 461–84. [CrossRef] [PubMed]

Hillman, Nicholas W. 2016. Geography of College Opportunity: The Case of Education Deserts. *American Educational Research Journal* 53: 987–1021. [CrossRef]

Hillman, Nicholas W., and Taylor Weichman. 2016. *Education Deserts: The Continued Significance of "Place" in the Twenty-First Century*. Washington, DC: American Council on Education.

Hoekstra, Mark. 2009. The Effect of Attending the Flagship State University on Earnings: A Discontinuity-Based Approach. *The Review of Economics and Statistics* 91: 717–24. [CrossRef]

Hoxby, Caroline. 2009. The Changing Selectivity of American Colleges. *Journal of Economic Perspectives* 23: 95–118. [CrossRef]

Hoxby, Caroline M., and Christopher Avery. 2012. The Missing "One-Offs": The Hidden Supply of High-achieving, Low Income Students. Working Paper w18586, National Bureau of Economic Research, Cambridge, MA, USA.

Hoxby, Caroline, and Sarah Turner. 2013. Expanding College Opportunities for High-Achieving Low-Income Students. Discussion Paper 12-014, Stanford Institute for Economic Policy Research, Stanford, MA, USA.

Hsing, Yu, and Franklin G. Mixon. 1996. A Regional Study of Net Migration Rates of College Students. *The Review of Regional Studies* 26: 197–209.

Johnson, Monica K., Glen H. Elder, and Michael Stern. 2005. Attachments to Family and Community in the Young Adult Transition of Rural Youth. *Journal of Research on Adolescence* 15: 99–125. [CrossRef]

Jones, Richard C., and Albert Kauffman. 1994. Accessibility to Comprehensive Higher Education in Texas. *The Social Science Journal* 31: 263–83. [CrossRef]

Klasik, Daniel. 2012. The College Application Gauntlet: A Systematic Analysis of the Steps to Four-Year College Enrollment. *Research in Higher Education* 53: 506–49. [CrossRef]

Labaree, David F. 2017. *A Perfect Mess: The Unlikely Ascendancy of American Higher Education*. Chicago: University of Chicago Press.

Long, Bridget T. 2004. How have college decisions changed over time? An application of the conditional logistic choice model. *Journal of Econometrics* 121: 271–96. [CrossRef]

Long, Mark C. 2008. College Quality and Early Adult Outcomes. *Economics of Education Review* 27: 588–602. [CrossRef]

Ma, Jennifer, Matea Pender, and Meredith Welch. 2016. *Education Pays 2016: The Benefits of Higher Education for Individuals and Society*. Princeton: College Board.

Manski, Charles. 1993. Adolescent Econometricians: How do Youth Infer the Returns to Schooling? In *Studies of Supply and Demand in Higher Education*. Chicago: University of Chicago Press, pp. 43–57.

McDonough, Patricia M. 1997. *Choosing Colleges: How Social Class and Schools Structure Opportunity*. Albany: State University of New York Press.

Mixon, Franklin G. 1992. Factors affecting college student migration across states. *International Journal of Manpower* 13: 25–32. [CrossRef]

Niu, Sunny X. 2015. Leaving Home State for College: Differences by Race/Ethnicity and Parental Education. *Research in Higher Education* 56: 325–59. [CrossRef]

Niu, Sunny X., and Marta Tienda. 2007. Choosing Colleges: Identifying and Modeling Choice Sets. *Social Science Research* 37: 416–33. [CrossRef]

Ovink, Sarah, Demetra Kalogrides, Megan Nanney, and Patrick Delaney. 2018. College Match and Undermatch: Assessing Student Preferences, College Proximity, and Inequality in Post-College Outcomes. *Research in Higher Education* 59: 553–90. [CrossRef]

Posselt, Julie R., Ozan Jaquette, Robert Bielby, and Michael N Bastedo. 2012. Access without Equity Longitudinal Analyses of Institutional Stratification by Race and Ethnicity, 1972–2004. *American Educational Research Journal* 49: 1074–111. [CrossRef]

Roderick, Melissa, Jenny Nagaoka, Vanessa Coca, and Eliza Moeller. 2008. *From High School to the Future: Potholes on the Road to College*. Chicago: Consortium on Chicago School Research at the University of Chicago.

Rosenboom, Victoria, and Kristin Blagg. 2018. *Disconnected from Higher Education. How Geography and Internet Speed Limit Access to Higher Education*. Washington, DC: The Urban Institute.

Rodriguez, Awilda. 2015. Tradeoffs and Limitations: Understanding the Estimation of College Undermatch. *Research in Higher Education* 56: 566–94. [CrossRef]

Rouse, Cecilia E. 1995. Democratization or Diversion? The Effect of Community Colleges on Educational Attainment. *Journal of Business and Economic Statistics* 13: 217–24.

Skinner, Benjamin T. 2018. Choosing College in the 2000s: An Updated Analysis Using the Conditional Logistic Choice Model. *Research in Higher Education*. [CrossRef]

Smith, Jonathan, Matea Pender, and Jessica Howell. 2013. The Full Extent of Student-College Academic Undermatch. *Economics of Education Review* 32: 247–61. [CrossRef]

Turley, Ruth N. L. 2009. College Proximity: Mapping Access to Opportunity. *Sociology of Education* 82: 126–46. [CrossRef]

U.S. Department of Agriculture. *Commuting Zones and Labor Market Areas*. Available online: https://www.ers.usda.gov/data-products/commuting-zones-and-labor-market-areas/ (accessed on 14 September 2018).

Walker, Renee E., Christopher R. Keane, and Jessica G. Burke. 2010. Disparities and Access to Healthy Food in the United States: A Review of food deserts literature. *Health and Place* 16: 876–84. [CrossRef] [PubMed]

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