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The Effects of a Dual Degree Program on Diversity in Medical School

A thesis submitted in partial satisfaction
of the requirements for the degree Master of Arts
in Education

by

Jacob Aaron Bailey

2013

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ABSTRACT OF THE THESIS

The Effects of a Dual Degree Program on Diversity in Medical School

by

Jacob Aaron Bailey

Master of Arts in Education

University of California, Los Angeles, 2013

Professor Mitchell J. Chang, Chair

A persistent underrepresentation of certain racial and ethnic minorities in American medical education contributes to health disparities and hinders physician training by mitigating the benefits of a diverse learning environment. In 2007, the University of California (UC) instituted Programs in Medical Education (PRIME) to prepare physician leaders to work in underserved communities. To determine the effect of PRIME on underrepresented minority (URM) admissions, this study examines data from UC San Diego School of Medicine by way of an interrupted time-series analysis. Results indicate the program increased the proportion of URM matriculants. It also protected the proportion of URM applicants from decreasing the year of its implementation. A year-to-year decrease in the matriculation yield of URM students from California partially explains the increase in URM students from out-of-state. Lastly, statistical modeling found no evidence of an autoregressive component; meaning one year's measures did not influence those of the subsequent time point.

The thesis of Jacob Bailey is approved.

Sylvia Hurtado

Mark Kevin Eagan

Mitchell J. Chang, Committee Chair

University of California, Los Angeles

2013

To my classmates who make me a better student.

To my mentors who make me a better colleague.

To my family who makes me a better physician.

To my wife who makes me a better person.

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Chapter 1

Introduction

When a patient lies anesthetized on the operating table, most people are less concerned about the color of the surgeon's skin than the proficiency of their hands. Whether a physician grew up with privilege or had a childhood fraught with adversity should not affect clinical acumen—should it? Current debates on diversity have withdrawn from previous discussions of parity or remediation. Instead, a sizeable amount of contemporary research attempts to substantiate powerful educational benefits from learning in diverse environments. This leaves institutions justifying race-conscious practices by pointing out positive diversity-related outcomes. For this reason, the Association of American Medical Colleges (AAMC, 2012) recently reiterated in an amicus brief for *Fisher v. University of Texas at Austin* that physicians require training in diverse environments that reflect our society. By creating diverse learning environments, medical schools not only promote excellence but also function to redress medical disparities.

If a diverse learning environment is needed for our medical education system to achieve excellence and redress disparities, then attention should be given to the racial and ethnic diversity of medical students. Medical schools do not enroll enough students from Black, Latino, Native American, or Native Hawaiian backgrounds to achieve anything close to racial or ethnic parity in the physician workforce (Castillo-Page, 2012). Less than 16% of medical students come from these underrepresented minority (URM) backgrounds, while 31% of the population identify with these backgrounds (United States Census Bureau, 2013). This discrepancy between the medical student and national populations becomes especially problematic considering that URM physicians are more likely to work in minority and impoverished communities than their majority colleagues (Saha & Shipman, 2006). Medical schools are aware of this problem and many actively recruit URM students to their campuses. These recruitment efforts often function without sufficient assessment, thereby permitting institutions to

perpetuate ineffective practices. Ineffective recruitment efforts not only tie up resources but can also be counterproductive. Institutional diversity efforts are under unusual constraints in certain states with large URM populations such as California, Michigan and Arizona, where race-based affirmative action has been outlawed in public education. Paradoxically, these states rely heavily on public institutions to train their physician workforce.

The University of California (UC) has been mindful of its responsibilities towards its state's physician workforce. In 2007, as part of a new plan for enrollment growth and diversification, UC instituted a dual degree program entitled Programs in Medical Education (PRIME) (Nation, Gerstenberger, & Bullard, 2007). This program was specifically designed to simultaneously address a 30-year stagnation in total enrollment at UC medical schools as well as California's need for physicians trained to grapple with health disparities in diverse cultural and socioeconomic communities. PRIME was to focus on aspects of underserved medicine, including populations in physician shortage areas and/or with poor health outcomes. Funding for PRIME originally came in the form of Proposition 1D, a \$200 million state bond in 2006. Severe budget cuts have subsequently left each UC medical school to maintain their respective programs, threatening the long-term existence of these programs.

Currently, each campus has maintained its PRIME cohorts. Although the program's primary objective—to train physician leaders for California's underserved—has remained unchanged, each school has adopted a unique emphasis. The Davis cohort focuses on rural communities, San Francisco on urban, Los Angeles on leadership, and Irvine on Latino communities. At UC San Diego (UCSD), the initiative is named PRIME-Health Equity (PRIME-HEq) and emphasizes social determinants of health. Similar to other cohorts, PRIME-HEq requires matriculants to meet the same admissions criteria as those to the traditional curriculum in addition to its own standards (Manetta, Stephens, Rea, & Vega, 2007). During the first two years of medical school, the curriculum is supplemented by didactic and experiential learning in health disparities, community engagement, and clinical work in underserved populations.

During their third year, all PRIME-HEq students complete their Primary Care Clerkship in an underserved community clinic. In addition, students must complete a Master's Degree, typically between their third and fourth years of medical school.

As mentioned previously, there is a strong connection between physician racial/ethnic identity and practice location, with URM physicians more likely to work in areas with high rates of poverty and racial/ethnic minorities. Thus, PRIME-HEq's capacity to achieve its mission may be interdependent on its ability to increase the enrollment of students from URM backgrounds. The purpose of this thesis is to evaluate if PRIME-HEq increases diversity at the UCSD School of Medicine. To achieve this objective, a single question is asked: Does PRIME-HEq improve the admissions of students from URM backgrounds? To address this question, admissions patterns at UCSD School of Medicine are examined using regression and interrupted time-series analysis. In order to inform the investigation, this study includes a review of how disparities in medical education contribute to health inequities, the factors that contribute to low enrollment of URM students, and how medical schools seek to increase URM enrollment. What little research published on PRIME is shared in attempts to situate it as a potential solution to the problem.

The literature reviewed in this study helps frame underrepresentation of certain racial and ethnic minority groups as a problem in both the physician workforce as well as the education sector. Problems in the workforce primarily arise through service patterns of URM physicians; these patterns are addressed, as they are directly linked to the mission of PRIME. The educational problems associated with a lack of racial/ethnic diversity typically stem from precluding the benefits of diversity. Accompanying the characterization of these two multifactorial problems is a partial explanation of a few of their causes, as well as some of the ways medical schools attempt to redress them. PRIME is included in these strategies, since the intent of this study is to determine if it indeed increases racial/ethnic diversity.

To evaluate how PRIME-HEq has affected the URM admissions, a closer examination of admissions data from 2002 to 2012 is used to help understand application and matriculation trends, including frequencies of URM applicants and matriculants, and matriculation yields. These data also help establish what trends emerged over the appointed time span. An interrupted time-series analysis is built from regression modeling of yearly proportions, using the addition of PRIME-HEq as an option on UCSD's application as the process change of interest (Huitema, 2011a; Shadish, Cook, & Campbell, 2002). Out-of-state students are used as a comparison group in order to increase the validity of this quasi-experimental method.

Although evaluating a single school's underserved medicine program can be viewed as limited in scope, there are significant reasons that such an undertaking deserves attention. From a practical sense, it provides formative information for this and similar programs. Since the minimum amount of time for a PRIME-HEq student to become a fully practicing physician is eight years—four years of medical school, one year for a Master's Degree, and a minimum three years of residency—it remains too early to follow workforce trends of program graduates. Nevertheless, this study could foreshadow potential outcomes or challenges for PRIME. Some may consider an underserved medicine program like PRIME as a sort of race-blind diversity initiative. From this standpoint, it becomes even more crucial to gauge its impact on the admissions process, since race-based affirmative action in higher education is again being challenged in the Supreme Court. The court's decision may strike down race-based affirmative action and leave institutions of higher education searching for ways to ensure diverse learning environments while adopting race-blind practices. If PRIME indeed increases URM matriculation, it could serve as an example of an academic program that does not consider race or ethnicity in the admissions process yet effectually increases their representation in the student body by appealing to applicants' preferences. Regardless of whether a school adheres to race-blind or race-based admissions policies, all medical schools "must engage in ongoing, systematic, and focused efforts to attract and retain students, faculty, staff, and others from

demographically diverse backgrounds” for accreditation from the Liaison Committee on Medical Education (AAMC & LCME, 2012). These recruiting efforts may influence student choice. Researchers studying the decision process of higher education attendance may be drawn to this study, as it may shed light on the institutional context of this choice.

Interrupted time-series analysis is not only a practical method for measuring the effects of PRIME-HEq on trends in the admissions process over time, but it also permits for tests of autocorrelation in the errors of the model. In other words, after building a suitable regression model, one can test if the residual at one time point can be predicted by the residual of the previous time point. This is one way of measuring the degree to which one data point affects the subsequent data point. Much of the current dialogue on affirmative action in *Fisher v. University of Texas at Austin* revolves around the notion of building a critical mass—a point at which ethnic/racial representation is large enough to be self-sustaining and no longer requires intervention. Testing for autocorrelation within the interrupted time-series model allows us to begin to empirically assess the assumptions of a critical mass and determine to what extent the compositional diversity of one entering class affects the subsequent year.

Chapter 2

Literature Review

Perhaps at this point, one may remain unconvinced that enrolling disproportionately low numbers of students from URM backgrounds constitutes a problem. In fact, this disparity creates two problems—one in labor and the other in education. Low enrollment of URM medical students perpetuates a substantial disparity in the number of practicing physicians from URM backgrounds (Castillo-Page, 2010). The second problem is that low enrollment of URM students, or a lack of compositional diversity, can diminish the educational benefits associated with interacting across racial and ethnic lines (Milem, Chang, & Antonio, 2005; Whitla et al., 2003). This chapter includes a review of the literature on these two problems, causes of low compositional diversity in medical education, how medical schools have attempted to address the issue, and how PRIME has been described in the literature.

The Workforce Problem

In her ethnography, Mattingly (2010) describes the borderlands that exist in urban hospitals between Black parents and their children's clinicians. She recounts how families and physicians navigate the enormous divide between the sick and "their professional healers" and notes:

In clinical encounters that cross race and class lines, worries over being misread constitute major threats. Misunderstandings are magnified to intense proportions in situations characterized by both cultural difference and high stakes. Cultural identities constructed by race, class, gender, and other potentially stigmatizing markers take on profound meaning here. (p. 11)

Although Mattingly's research focuses on the plight of African American families, the dangers associated with negotiating these borderlands are likely familiar for others who have been marginalized due to race or ethnicity. It becomes easy to imagine recently immigrated Latino patients with limited English proficiency worrying about communicating with their physician, or

Native American patients withholding that they are concurrently seeking traditional healing out of distrust of the healthcare system. These portrayals are rather simplistic and fall into stereotypes, but even the more frequent, complex variations of these stories exemplify the divide between patient and physician.

So if cultural differences based on race threaten optimal care, does racial or ethnic concordance between patients and providers improve health care? This is one question a report published by the U.S. Department of Health and Human Services (HHS; Saha & Shipman, 2006) attempts to answer. The department's systematic review of the empirical literature examines the theory that health-care workforce diversity improves public health outcomes via four hypotheses: 1) the service pattern hypothesis; 2) the concordance hypothesis; 3) the trust in health care hypothesis; and 4) the professional advocacy hypothesis. Following is an exploration of the first hypothesis as it is aligned most with the intent of this thesis. Along with a brief summary of HHS report's findings, an updated review of the literature is provided.

Service patterns of URM physicians. Since PRIME-HEq's mission is to train physician leaders in California's underserved communities, it is important to characterize these neighborhoods. According to the U.S. Census Bureau, California has the largest Hispanic population (Ennis, Ríos-Vargas, & Albert, 2011), largest Native American/Alaskan Native population (Norris, Vines, & Hoefell, 2012), and fifth largest African American population (Rastogi, Johnson, Hoefell, & Drewery, 2011) in the nation. Since these populations tend to be overly represented in impoverished communities (U.S. Department of Health and Human Services, 2012) as well as health provider shortage areas (Hoffman, Damico, & Garfield, 2011), physician practice patterns potentially hold great influence on public health.

In short, the HHS review found strong evidence that URM physicians disproportionately serve minority and/or underserved communities (Saha & Shipman, 2006). In fact, all 16 studies that tested this hypothesis found URM physicians are more likely to work in underserved

communities than majority physicians. More recent studies corroborate these findings. A cohort study of family medicine residency graduates found high school census tract data to be predictive of the type of neighborhood they practiced in after graduation (Hughes et al., 2005). Physicians who attended high school with a higher percentage of URM students were about 6.5 times more likely to practice in minority communities. The model developed by Hughes and colleagues (2005) did not find that other individual characteristics, such as race or ethnicity, were associated with this practice pattern; however, they limited their census data to demographics reported in 1990, which was unlikely to be characteristic of all cohort members.

In another study of graduates from the University of New Mexico School of Medicine, Wayne, Kalishman, Jerabek, Timm, and Cosgrove (2010) found that students who came from URM backgrounds were roughly two times more likely to work in medically underserved communities than non-URM graduates. The two other significant predictors of working in an underserved community were entering medical school at a later age and growing up in an urban area. Recent graduates also tended to work in medically underserved areas; however, this association was not significant.

Although not specifically examining URM physician practice patterns, Lupton, Vercammen-Grandjean, Forkin, Wilson, and Grumbach (2012) tracked graduates of the University of California Postbaccalaureate Program, which is designed to assist students from disadvantaged backgrounds gain acceptance to medical school. Roughly 63 percent of their participants were URM students. This was drastically different from the control group of randomly selected physicians who were matched by medical school and graduation year, which only consisted of 13 percent URM students. Alumni from the postbaccalaureate program were significantly more likely to work in high-poverty, high-Latino, and high-African American medical service study areas.

Brown, Liu, and Scheffler (2009) examined a much larger sample than had been used in previous studies when they sought to determine whether the practice patterns of Black or Latino

physicians were affected by how well represented they were in an area. This study tracked 53,606 physicians and 9,806 residents over six years. They defined representation as the difference in the proportional population of a certain racial/ethnic group from the proportion of physicians of the same race/ethnicity. A value of zero indicated no over- or under-representation occurred. Tracking the changes in practice location, they found that Black and Latino physicians were more likely than White physicians to leave an area if their respective groups were overrepresented. Likewise, if Black or Latino physicians were underrepresented in the community, they were less likely than White physicians to leave the area. Upon moving, Hispanic physicians were unlikely to relocate to an area with more or less representation than their previous area. It was statistically unlikely that Black and Hispanic residents moved to an area with greater representation upon graduation, and Black residents were found to move to areas with less representation. From these results, Brown et al. (2009) concluded that market forces influence Black and Hispanic physicians' decisions to distribute themselves in a manner that attempts to establish a form of equilibrium.

These studies further strengthen the assertion that increasing enrollment of URM students in medical school will help improve public health. They also validate using participant demographics as a predictor of future practice trends. Given the relatively short amount of time PRIME-HEq has been functional, its ability to produce physician leaders in underserved areas remains in question. Based on the literature, however, examining trends in the demographic composition of PRIME-HEq could be useful in predicting future outcomes.

The Education Problem

In *Grutter v. Bollinger* (2003), the U.S. Supreme Court ruled that student body diversity, including racial and ethnic diversity, is a compelling state interest, which has allowed race-conscious admissions policies to remain at many institutions of higher education. For medical schools, these interests include enhancing the students' educational experience and teaching integral skills required to serve a diverse population (*Fisher v. University of Texas*, 2012). The

diversity interests of medical schools necessitate that their students interact with people from differing racial and ethnic backgrounds. From this standpoint, it becomes useful to view diversity as “engagement across racial and ethnic lines” in the way described by Milem et al. (2005). This definition accounts for the way in which student body racial/ethnic composition facilitates student interactions without dictating them. Because engagement across racial and ethnic lines requires the presence of URM students on campus, it still proves useful to examine the representation of minority groups.

In order to argue that insufficient enrollment of URM medical students constitutes a problem in medical education, most literature focuses on the benefits observed with increased representation of minority groups. The proposed benefits of diversity in higher education have been categorized by Milem (2003) along four different dimensions. These sectors include the individual, the institutional, the economic and private enterprise, and societal. Some of these benefits have been observed empirically at the undergraduate level (Antonio et al., 2004; Chang, Denson, Saenz, & Misa, 2006; Chang, 2001; Denson & Chang, 2008) though they are still debated (Rothman, Lipset, & Nevitte, 2003). The following studies included here explore diversity within medical education specifically and are categorized into individual and institutional benefits according to the sectors described by Milem (2003).

Individual benefits. The benefits of diversity to individual students comprise the bulk of current medical education research in this area. By way of telephone survey, Whitla et. al (2003) quantified the frequency and type of cross-racial interactions (CRI) experienced by medical students at Harvard and UC San Francisco. They found that CRI frequency increased as students advanced in schooling. Half of respondents endorsed studying with someone from another race or ethnicity often, while the vast majority of those that did not endorse this type of CRI preferred to study alone rather than in groups. Students felt compositional diversity helped them work more effectively. They also felt it improved both classroom discussion and medical

understanding. Overall, students indicated a diverse student body was beneficial and more importantly, that regular CRI with other students influenced their learning how to treat patients.

Querying students from four southeastern medical schools, Elam, Johnson, Wiggs Messmer, Brown and Hinkley (2001) found that students' perceptions of how diversity affects learning environment, educational experiences, and future practice plans varied along both individual and institutional characteristics. Their definition of diversity was broader and included characteristics such as age, religion, sexual orientation and socioeconomic status. Their general findings were that schools with a more diverse class valued the contributions of diversity more than those that had a more homogeneous student body. Of note, African American students were significantly more likely to feel the curriculum inadequately addressed diversity and that faculty were not knowledgeable enough about diversity issues. Perhaps even more distressing, Black students were also significantly more likely to remain silent in small group discussions concerning diversity in order to avoid accusations of racism. These findings provide evidence that a lack of compositional diversity is indeed a problem and not simply an absence of benefits.

More recently, a study at three California medical schools by Guiton, Chang, and Wilkerson (2007) found supporting evidence that compositional differences in student, faculty, and patient populations influence their views on diversity. Likewise, the types of interactions students have, such as voluntary experiences with underserved populations or informal interactions with peers from dissimilar backgrounds, help shape students' views on diversity. Similar to Elam et al. (2001), they found that schools with more compositional diversity valued such diversity more than less diverse schools.

In summation, these studies on CRI and compositional diversity in medical education find empirical evidence of the individual benefits of CRI and the detriments of low compositional diversity. These conclusions support the AAMC's position that medical students require a

diverse learning environment in order to promote excellence and acquire the necessary skills to work in a diverse society.

Institutional benefits. Few studies have been carried out regarding the institutional benefits of diversity in medical education. One benefit is measured yearly. Each year the AAMC has entering first-year students fill out their Matriculating Student Questionnaire (MSQ). This survey includes a list of items asking students how much certain factors influenced them to choose the specific school to which they matriculated. In 2007, 16.5 percent of entering students stated student diversity was a very positive factor in their school selection. Another 5.9 percent stated programs for minority and/or disadvantaged students influenced their decision. When MSQ results are examined by race/ethnicity, student diversity is one of the top ten reasons for choosing a school for matriculating Latino, Black, and Asian students, but was not for entering White students. The tenth most influential factor cited by entering White students was advice of alumni at 19.2 percent. Unfortunately this same breakdown is not available for the 2012 MSQ results, however 19.0 percent of students stated student diversity was a very positive factor in deciding which school to attend. Those citing programs for minority and/or disadvantaged students also increased to 7.0 percent.

Causes of Low Compositional Diversity in Medical Education

Generally speaking, both the applicant pool and the selection process determine the composition of the medical student body. For medical schools, the selection process is heavily dictated by academic performance. One measure relied upon by these schools is the MCAT. This section reviews national data, briefly touching on how the MCAT contributes to the problem of low URM enrollment. It also overviews literature specific to compositional diversity in California higher education, including medical education.

Review of national data. Although less than 16 percent of U.S. medical school matriculants come from URM backgrounds, the acceptance rates vary with ethnicity and gender (Guiton, Chang, & Wilkerson, 2007). According to the AAMC's data, Latino students had one of

the highest acceptance rates in 2011 at 49.2 percent, with nearly equal gender representation. By contrast, Black students had some of the lowest acceptance rates at 38.3 percent, with 65.1 percent of them women. Native American/Alaskan and Native Hawaiian/Polynesian student acceptance rates were 45.5 and 25.0 percent, respectively. However, only 101 Native American/Alaskan and 84 Native Hawaiian/Polynesian students applied in 2011. As a comparison, the two largest non-URM student populations, White and Asian (over half of whom self-identified as Chinese or Asian Indian), had acceptance rates of 48.3 and 45.1 percent respectively. The ratio of Asian women to men accepted into medical school is near equal, while 54.2 percent of White students accepted are male. From a longitudinal perspective, all of these acceptance rates are greater than those reported in 2006, mainly due to an overall increase in acceptances (Castillo-Page, 2008). Considering the variation in rates of acceptance for URM applicants, this stage of the admissions process is unlikely to fully explain the lack of compositional diversity, though it may contribute to disparities for some groups such as African American students.

The AAMC data confirm that disparities exist at previous stages of the selection process (Castillo-Page, 2012). The number of total applicants increased from 33,624 in 2002-03 to 43,919 in 2011-12. In 2011, White and Asian students comprised 75 percent of all applicants, while URM students were only 15.6 percent of the total applicants. Foreign applicants as well as those who omitted their race/ethnicity, self-identified as other, or indicated more than one non-Latino race comprised the remaining 10 percent. During this period of growth, the number of Asian applicants saw the largest percent growth, with 9,818 applicants in 2011 compared to 6,500 in 2002. The largest total increase during this time was seen in White applicants, from 20,446 to 25,074, for a 22.6 percent increase. U.S. Latino applicants saw a 41.6 percent increase, from 2,433 to 3,459, while the number of Black applicants only grew 19.2 percent, from 2,858 to 3,407. There were only 95 and 139 Native Hawaiian/Polynesian applicants in 2002 and 2011 respectively, and the number of Native American/Alaskan applicants actually

dropped from 344 to 308. These figures indicate that Latino, Asian, and Hawaiian students are increasing their proportional representation within the applicant pool while White, Black, and Native American students are decreasing.

Matriculation, acceptance, and application rates only partly explain the disproportionately low number of URM medical students. Looking further down the pathway, Grbic and Garrison (2012) found a relationship between institutional type and acceptance rates based on the undergraduate school's 2005 Carnegie Classification. Acceptance rates were noticeably greater for students from R1 research institutions (51.1%) and B1 liberal arts colleges (53.3%) than from all other U.S. institution types. Over two-thirds of applicants attended an R1 institution alone or in combination during their undergraduate education. Their results also show a decrease in acceptance rates for students who attend more than one institution. Grbic and Garrison (2012) suggest academic preparedness as one possible reason for these differences. They point to a corresponding decrease in MCAT scores with an increase in the number of institutions attended. They also see a similar decrease in MCAT scores depending on institutional type, with students from R1 and B1 schools achieving higher scores. Since URM students are more likely to attend multiple institutions and are less likely to enroll at R1 schools, these results indicate more pervasive educational inequities influencing medical education.

The MCAT and compositional diversity. The utilization of the MCAT for student selection has been rationalized by multiple studies that have found correlations between test scores and performance in medical school (Julian, 2005; Koenig, Sireci, & Wiley, 1998). A survey conducted by Dunleavy, Sondheimer, Castillo-Page, and Bletzinger (2011) found that for admissions officers deciding which applicants to interview, MCAT performance was second only to grade point average. Although MCAT scores have been given such importance, Dunleavy et al. (2011) point to the multitude of factors given significant weight in the selection process.

Even if tempered by other factors, URM applicants on average score lower on the MCAT (AAMC, 2012), which potentially contributes to disparities in enrollment.

The studies used to justify the MCAT as a predictor of medical school performance are problematic, however, since they rely on licensing exam scores as an indicator of future performance. In order to become a practicing physician, all students must pass the three parts, or Steps, of the United States Medical Licensing Exam (USMLE). Not unexpectedly, studies have found that a high-stakes multiple-choice exam predicts the performance on a high-stakes multiple-choice exam. Although these studies suggest the MCAT may help medical schools identify students who might not pass licensing exams, they do not speak to the utility of these instruments in predicting future clinical skills.

White, Dey, and Fantone (2009) analyzed the academic performance of eight classes from the University of Michigan School of Medicine (n = 1,441) as measured by undergraduate GPA, MCAT scores, quiz and test grades from medical school years 1 and 2, and USMLE Step 1 score. Using the students' Internal Medicine clerkship ratings as a surrogate for clinical performance, they devised and tested a structural equation model. When this model was tested for majority students (Whites and Asians) and minority students (African-American, Hispanic, Filipino, Native American, and Pacific Islander) they found very different patterns across predictors and student groups. Although MCAT scores were found to significantly predict USMLE Step 1 scores for both majority and minority students, they only predicted the clinical performance of majority students. Grades during the second year of medical school, however, proved to be the best predictor. Similarly, USMLE step 1 scores significantly predicted clinical performance for majority students but not for minority students.

Proposition 209. In 1996, California voters approved Proposition 209, thereby prohibiting preferential treatment based on race, ethnicity, sex, color, or national origin at public institutions. The Regents of the University of California had already institutionalized the same prohibition previously through Special Policy 1. The Regents have since rescinded this policy,

but Proposition 209 still restricts certain practices (University of California Office of the President, 2010). In a brief analysis sponsored by the AAMC, Steinecke and Terrell (2008) examined the effect these policies had on the medical school enrollment of URM students. They noted a dramatic decrease in the number of URM students accepted and matriculated to California medical schools. They also point out that since 1995, over half of California students accepted into medical school now matriculate out of state. Proposition 209 did not affect only medical education, and Steinecke and Terrell (2008) do not address how much of the downward trend is attributable to Proposition 209's impact on the undergraduate students' premedical pathways.

Although not specific to premedical students, Santos, Cabrera, and Fosnacht (2010) analyzed the impact of Proposition 209 on UC application, acceptance, and enrollment rates. Using an Impact Ratio Analysis Test and the Standard Deviation Test, they found evidence of an adverse impact on URM students in the college selection process prior to Proposition 209, which worsened after its passage. Only the application phase saw modest improvements by 2002.

The effect of Proposition 209 on UC undergraduate education is important for the discussion of diversity in medical education for several reasons. As noted previously, students from R1 institutions such as the UC campuses make up the bulk of medical school applicants and are more likely to be accepted (Grbic & Garrison, 2012). In fact, UC schools make up four of the top ten schools supplying medical school applicants (Castillo-Page, 2012). UC Los Angeles provides more applicants than any other school. Berkeley, San Diego, and Davis come in at third, sixth, and tenth, respectively. Considering that California is not only the most populous but also one of the most racially and ethnically diverse states (Brewer & Suchan, 2001; Mackun & Wilson, 2011), one could expect a large number of URM applicants to come from its public institutions. Instead, only two UC campuses rank in the top ten schools in the number of Latino applicants. Even if Puerto Rican schools are removed from consideration, the

University of Florida and the University of Miami contribute nearly double the number of applicants of UC Los Angeles. These same schools almost triple the number of applicants from Berkeley, which is the next most productive UC (Castillo-Page, 2012).

How Medical Schools Approach Diversity

Two basic themes emerge in the remaining literature: studies concerning institutional practices and studies that concentrate on student values. Rumala and Cason (2007) detail an institutional approach to URM student recruitment similar to that found at many medical schools, including some PRIME cohorts, capitalizing on the involvement of current students. By creating a formal partnership with a URM student organization, the medical school both validates and facilitates student-initiated recruitment efforts. The partnership entails allocating funding and personnel to student-directed recruitment strategies. These strategies include an undergraduate mentorship program, applicant tracking and communications, and community partnerships, among others. Rumala and Cason (2007) systematically view each strategy utilized; however, they do not provide an evaluation of the partnership. Although they do provide longitudinal enrollment data, their analysis is unable to determine what impact the partnership has on student admissions due to limitations of their data.

In another paper detailing institutional practices, Vela, Kim, Tang, and Chin (2010) explore the impact curriculum has on URM student admissions. They feature the University of Chicago Pritzker School of Medicine and its decision to incorporate a health disparities course into the required first year curriculum. Through a mixed methods analysis, they found URM students were more likely than non-URM students to have known of the course prior to enrollment, and that this course significantly influenced their decision to enroll at the school. Students expressed feelings of excitement about the curriculum, stating it gave the school a reputation for emphasizing social justice. Vela et al. (2010) also note the curricular change coincided with a significant increase in URM enrollment at the medical school. However, admissions data for this study was limited to four years, two pre-adoption and two after

implementation. Likewise, they don't speak on the general constitution of the applicant pool, thereby limiting causal inference.

PRIME in the Literature

At this point in its history, little has been published on PRIME and its various cohorts. Most of the literature consists of programmatic descriptions (Manetta et al., 2007; Nation et al., 2007; Vega, 2009). This study attempts to expand upon our previous study of PRIME-HEq and admissions trends (Bailey & Willies-Jacobo, 2012). In this initial study, we analyzed three years of applicant data from UCSD to determine if students from URM backgrounds are more interested to PRIME-HEq. The results showed URM and disadvantaged students had greater odds of applying to the program than non-URM or non-disadvantaged students. The odds of applying to PRIME-HEq also increased if the applicant was female. Gender appeared to have a moderating effect on URM status, as did California residency. For disadvantaged students, having applied to UCSD previously appeared to be a moderator. Although this initial study suggests URM students are more interested in PRIME-HEq than non-URM students, it does not provide any evidence that the program has any impact on other aspects of the admissions process for these students. This study hopes to increase our understanding of programmatic effects on URM admissions and resume where this last study left off.

Chapter 3

Methodology

Introduction

The relatively short existence of PRIME at UC medical schools and the complexity of the admissions process present a challenge when trying to draw conclusions on the program's influence on admissions trends. Traditional methods, such as a *t*-test, are inappropriate due to statistical assumptions of independence (Shadish et al., 2002). The number of URM students in one class may affect the number that matriculate in subsequent years. In statistical terms, this influence of one year to the next is called autoregression. Besides autoregression, there may also be multiple factors that influence students' decisions to apply or matriculate. This may be why other studies on diversity efforts abstain from inferring causality when linking institutional programs to components of the admissions process. Alternative explanations must be ruled out in order for any of these programs to be considered the cause of admissions trends.

Previously mentioned studies try to connect diversity efforts to admissions outcomes without inferring causality. Rumala and Cason (2007) rightfully draw attention to the increase in URM admissions after implementing a student/institutional partnership for recruiting. They simultaneously explicitly refrain from drawing specific conclusions on the program's effects on URM admissions trends. Vela et al. (2010) circumvent these issues by relying on students' responses to a survey addressing their matriculation decisions. This method allowed for student input to inform the effect of a health disparities course on URM admissions trends to the University of Chicago School of Medicine. Still, Vela et al. (2010) refrain from attributing a simultaneous increase in the percent of URM matriculants to the new course. Neither study attempts to measure changes in admissions and statistically ascribe them to their programs.

The only study to date that evaluates how PRIME affects URM admissions is our previous work describing applicant trends to PRIME-HEq from 2008-2010 (Bailey & Willies-Jacobo, 2012). This work only addresses which students are more likely to apply to PRIME-

HEq by utilizing nominal data in a logistic regression model. Conclusions are limited to students' decision to apply and fail to inform us of later aspects of the admissions process. In order to better understand how PRIME impacts overall trends in URM admissions, this study attempts to answer the following question: Does PRIME increase admissions of students from URM backgrounds? For the purposes of this study, admission is exclusively treated as a process rather than an outcome because of the complexity of applying to medical school. As such, admission is broken down to three different components: 1) application via AMCAS; 2) matriculation to the school; and 3) matriculation yield of those accepted.

The underlying hypothesis is that PRIME-HEq does improve URM admissions to the school of medicine. Students from URM backgrounds are more likely to apply, which indicates a higher level of interest than that of their majority colleagues (Bailey & Willies-Jacobo, 2012). Students with greater interest in such a program may choose to apply to or attend a school that they otherwise may not have. Additionally, it is often thought that diversity is self-producing. The number of URM students in a particular component one year could help determine how many there are the next year, especially if students in the program are involved in targeted recruitment similar to those described by Rumala and Cason (2007).

The focus of this chapter is the methods used to answer the research question, and includes a discussion of the dataset sample, analytical method, and variables used in the analysis. Finally, the limitations of the study are recognized and discussed.

Sample

All American medical schools (except certain programs in Texas) receive applications via the American Medical College Application Service (AMCAS), which is run by the AAMC. This primary application, as it is often called, contains extensive biographic and academic information. Along with this information are the student's scores on the Medical College Admission Test (MCAT), which is also administered by the AAMC. Students include a personal statement as well as descriptions of their extracurricular activities, so that medical schools have

a broader picture of each person. If a student experienced difficulties or hardships that they feel disadvantaged them in any way, they are invited to explain this in a supplemental narrative. Each course and corresponding grade from every postsecondary school is itemized and later verified through official transcripts. Letters of recommendation are included in the primary application and sent with the rest of the application to those schools selected by the student.

Even with all the information provided through AMCAS, this in-depth process is only the primary application. The vast majority of schools require a supplemental or secondary application. These applications vary in length, form, deadlines, and price. Some secondary applications are extended automatically to anyone who applies through AMCAS; other schools, including UCSD, screen primaries and send secondary applications to students deemed competitive. Starting in 2008, UCSD began giving students the opportunity to apply to PRIME-HEq at this secondary application stage. Still, this secondary application does not complete the application process. After submitting both primary and secondary applications, applicants are evaluated in consideration for an interview. Just as with secondary applications, each school conducts its interviews differently.

After receiving an interview, students wait for schools to make their final admissions decision. Most programs give students until May 15th to consider multiple acceptance offers. Those individuals fortunate to have such options are asked to keep one acceptance and withdraw their application from other schools after this date. Some offers are extended after this date and students may be notified of an acceptance up to the start of the academic year.

This study utilizes data compiled from the UCSD Medical School Admissions Office database for incoming classes from 2002 to 2012. Identifying information was removed prior to the formation of the dataset. Identifying information included personal statements and letters of recommendation. Applicant characteristics as well as admissions decisions made by students as well as institutions are included in the dataset for every student who applied during these years. Admissions decisions entail offers and completion of secondary applications, offers and

completions of interviews, acceptances, as well as matriculation. Approximately 4,000 to 6,000 students apply to UCSD Medical School every year. The complete longitudinal sample contains 56,557 individual applications. The dataset is partitioned by year, and, for each year, counts are compiled for variables of interest.

Variables

In order to explore the admissions process, dependent variables for each of its four components are constructed as compound units of measure. These dependent variables include: 1) percent applied; 2) percent matriculated; and 3) matriculation yield. The dependent variables for the first two components—application and matriculation—are defined as the percent of students at that particular stage who fall within the population of interest. For example, the percent URM applied would be the number of URM applicants divided by the number of total applicants, scaled to 100. The fourth dependent variable, matriculation yield, is also a compound unit of measure but is defined as the percent of the accepted students from a population of interest who matriculated to the school. These four dependent variables are calculated for each of the four comparison groups: URM students, out-of-state students, California-resident, URM (CA-URM) students, and out-of-state, non-URM (OS-nURM) students. For this analysis, applicants who indicated their race or ethnicity as Black, Latino, Native Hawaiian, Other Pacific Islander, Native Alaskan, or Native American, alone or in combination, were considered URM students. Constructing dependent variables with compound units of measure requires fewer independent variables, since it accounts for fluctuations in the size of applicant pool, accepted pool, and incoming class. Table 3.1 presents information on the dependent variables used in this segment of the study.

Table 3.1. *Description of Dependent Variables from UCSD Admissions Data*

Variable	Model Role	Description
<i>% URM_t Applied</i>	Dependent	Calculated value: (number of URM applicants / total applicants) x 100 at time
<i>% Out-of-state_t Applied</i>	Dependent	Calculated value: (number of non-CA resident applicants / total applicants) x 100
<i>% CA-URM_t Applied</i>	Dependent	Calculated value: (number of CA resident applicants who are URM / total applicants) x 100
<i>% OS-nURM_t Applied</i>	Dependent	Calculated value: (number of non-CA resident applicants who are not URMs / total applicants) x 100
<i>% URM_t Matriculated</i>	Dependent	Calculated value: (number of matriculating URM students / total matriculants) x 100
<i>% Out-of-state_t Matriculated</i>	Dependent	Calculated value: (number of matriculating non-CA resident students / total matriculants) x 100
<i>% CA-URM_t Matriculated</i>	Dependent	Calculated value: (number of matriculating CA residents who are URM / total matriculants) x 100
<i>% OS-nURM_t Matriculated</i>	Dependent	Calculated value: (number of matriculating non-CA residents who are not URMs / total matriculants) x 100
<i>% Matriculation Yield URM_t</i>	Dependent	Calculated value: (number of matriculating URM students / number of accepted URM students) x 100
<i>% Matriculation Yield Out-of-state_t</i>	Dependent	Calculated value: (number of matriculating non-CA resident students / number of accepted non-CA resident students) x 100
<i>% Matriculation Yield CA-URM_t</i>	Dependent	Calculated value: (number of matriculating CA residents who are URM / number of accepted CA residents who are URM) x 100
<i>% Matriculation Yield OS-nURM_t</i>	Dependent	Calculated value: (number of matriculating non-CA residents who are not URMs / number of accepted non-CA residents who are not URMs) x 100

The independent variables for this study include measures of time, intervention phase, and a slope change variable. These three independent variables are used to construct models for each of the four components of the admissions process. The intervention phase and slope change variables are used to interpret how PRIME-HEq affects the model. Much of the variation between students each year is captured in the time variable. It is not assumed that the majority of unforeseen factors that influence the admissions process remain constant. Rather, the assumption is that these elements for the most part affect different comparison groups equally within each year. Variables accounting for autoregressive errors are only added to the

equations if the residuals are not independent upon inspection. Walking through the equations in the next section provides additional explanation of the method of building the regression models.

Data Analysis

In order to establish causality of an intervention, alternative explanations for the observed effect must be ruled out. Typical experimental methods such as randomized, double-blind experiments are often used for ruling out such explanations. This is achieved by controlling, or manipulating, all other variables other than the intervention. Such methods are problematic, however, when the events or characteristics of a study cannot be manipulated within the context of this study. One way to rule out alternative explanations without the manipulation of variables is the addition of a non-equivalent comparison group. To reduce alternative explanations, it should be reasonably expected that the comparison group react differently or do not react at all to the intervention, despite being conceptually related (Shadish et al., 2002). If, following the intervention, a change occurs in the target group that does not occur in the other, it becomes more reasonable to attribute that change to the intervention. Steiner, Wroblewski, and Cook (2009) discuss variations on the notion of causality and alternatives to experimental designs. One of these quasi-experimental designs, interrupted time-series, does not rely on the assumption of independence and allows for estimations of autocorrelation. In other words, a time-series analysis makes allowances for observations to be influenced by values at a previous time point (Shadish et al., 2002).

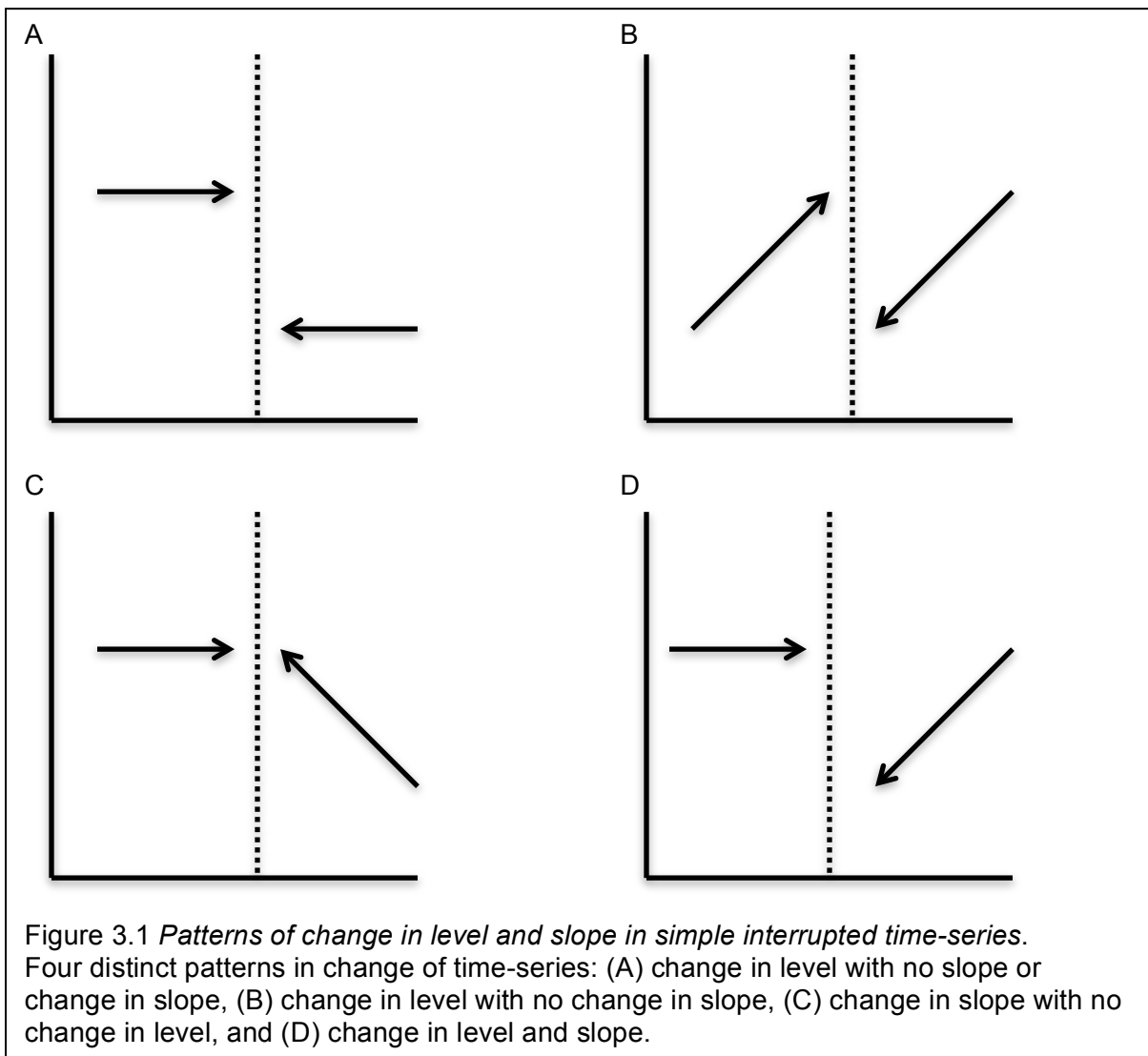
Interrupted time-series. Interrupted time-series is a two-phase design composed of repeated measures from some unit over time. In this study the unit is the institution, with measurements repeated on a yearly basis from 2002 to 2012. The interruption is the availability of PRIME-HEq through the application process. As stated previously, the inaugural class of PRIME-HEq was in 2007; however, these students were selected from already matriculated students due to the program's time of implementation. Because PRIME-HEq was not an option

on the secondary application, and was not known to applicants, 2007 is not a suitable interruption time point. The pre-PRIME phase incorporates data points from 2002 to 2007 and provides a baseline trend. The PRIME phase includes observations from 2008 to 2012 and is compared to the counterfactual projections in admissions established through the pre-PRIME phase.

Interrupted time-series describe an effect, or change between the observed and counterfactual, in terms of form, immediacy, and permanence (Shadish et al., 2002). Form describes what a trend looks like, for example, in slope or variance. Immediacy refers to how quickly or slowly a change occurs, and permanence pertains to how long the change lasts. Because of the relatively short length of time in this study, a simple interrupted time-series is constructed which makes certain assumptions of the baseline trends. It is assumed that there is not a cyclical pattern, or cyclicity, to the data, and that the baseline phase has enough observations to sufficiently estimate future patterns. Any changes are assumed to be immediate, since delayed effects may not be captured in the data. Questions of permanence are also overlooked due to the time frame. By assuming an immediate effect, an absence of cyclicity, and foregoing any measure of permanence, a linear model should adequately describe baseline trends, making it possible to use Ordinary Least Squares (OLS) regression analysis to build linear models (Bloom, 2003; Huitema, 2011a).

Under the assumptions that the data can be modeled in a linear fashion, without cyclicity, and that effects are immediate, interrupted time-series can be used to describe changes in level and slope. Figure 3.1 illustrates these types of changes. It is important to note that a level change does not constitute a change in mean. Rather it identifies a difference in the dependent variable immediately following the time of interruption. In other words, a change in level occurs when the baseline has a different intercept at the time of intervention than the trend observed after said intervention. In the context of this study, a positive level change in URM percent matriculation would mean there was a larger percentage of URM students in the class

immediately following PRIME implementation than there would have been had it not been put into place. This level change can occur in the absence of a slope, such as in Panel A of Figure 3.1, or when a slope is present as depicted in Panels B and D. Here, the x-axis denotes time, with the dotted line indicating the moment of intervention. Arrowheads are added to indicate where a level change would potentially occur, such as in Panels A, B, and D. Slope changes can also occur, such as in Panel D. A slope change is when the rate of increase or decrease is different following the intervention.



Analytical strategy. Adequately determining the effect of PRIME-HEq on URM admissions requires selection of the appropriate comparison groups and regression models to

depict trends within these groups. The first set of comparisons in this study is between URM students ($N = 7,807$ at applicant stage) and out-of-state students ($N = 18,950$ at applicant stage). Out-of-state students were selected as a comparison group for several reasons. Of the other more rigid applicant characteristics available in the dataset, residency status has the least overlap with URM status. Out-of-state URM students make up 12.6% of all non-resident applicants and 30.7% of all URM applicants. Diversity does not only encompass race and ethnicity. Non-residents also contribute diverse experiences and backgrounds to the learning environment. However, there are monetary incentives for enrolling out-of-state students, in the form of out-of-state tuition, that are not in place when based solely on race or ethnicity. Quotas do not exist for either group; thus, the amount to which they contribute to class composition varies from year to year. Still, there is some disagreement as to how applications from either group should be handled, evidenced by *Fisher v. University of Texas at Austin* and The Students First Act sponsored by California State Senator Rubio (D) (Read, n.d.). Lastly, this comparison is informed by PRIME's mission "to address the needs of California's underserved populations" (Nation et al., 2007). Based on the analysis of PRIME-HEq applications, it is assumed that interest in the program is low enough amongst out-of-state students to where its implementation had no effect on this group's admissions trends. Therefore, any changes in the baseline trend of out-of-state admissions after PRIME inception are attributed to external factors rather than to the program.

As stated previously, there are some URM students from out-of-state, which complicates the analysis. In order to compare truly non-equivalent groups, the second set of comparisons in this study is between CA-URM students ($N = 5,413$ at applicant stage) and OS-nURM students ($N = 16,556$ at applicant stage). Although a much stricter comparison, these subgroups are only intended to tease out some of the nuance from the first comparison pairing. By evaluating these subgroups, a greater amount of inference can be made regarding the population of URM students as a whole.

Statistical strategy. The strategy for selecting appropriate regression models for this study relies heavily on the steps outlined by Huitema (2011a). This strategy entails constructing two separate OLS regression models and then using a model comparison test to determine the appropriate one. The first model uses four parameters to determine changes in slope and level. The second uses only two parameters and tests for changes in level only. After choosing the appropriate model with the comparison test, an analysis of the residuals detects if the errors are independent. If the errors are not independent, then the value at one time point does in fact influence subsequent values, and autoregressive parameters are then added to the equation. Although Huitema (2011a) does an excellent job of detailing his strategy, these steps will be explained in the portion of the next section pertaining to model selection and autoregression.

Model selection. As mentioned earlier, a more detailed approach to selecting the appropriate model is explained by Huitema (2011a). The following is a shortened version of his systematic method of building and selecting linear regression models to fit the time-series data. Model 1 for each of the admissions components is as follows:

$$Y_t = \beta_0 + \beta_1 Year_t + \beta_2 PRIME_t + \beta_3 SC_t + \varepsilon_t$$

where

Y_t is the dependent variable at time t ,

β_0 is the model's intercept,

$\beta_1, \beta_2, \beta_3$ are the partial regression coefficients,

$Year_t$ is the value at time t ($t = 1, 2, 3 \dots n$),

$PRIME_t$ is a dummy variable denoting the availability of PRIME-HEq in the application process (0 = the pre-PRIME phase, 1 = the PRIME phase),

SC_t is the slope change variable (calculated as $[Year_t - (n_1 + 1)] \times PRIME_t$ where n_1 is the number of observations in the first phase,

ε_t is the error term.

In this model the errors are assumed to be independent, normally distributed, and heteroscedastic.

With all three variables, Model 1 can adequately describe the potential changes in admissions trends depicted in Figure 3.1. The partial regression coefficient β_2 is the change in the dependent variable level due to the availability of PRIME-HEq in the application process. The partial regression coefficient β_3 is the effect PRIME-HEq availability has on the dependent variable's rate of change. This rate of change is itself represented by β_1 .

Model 2 for each of the admissions components is similar but without the variables affected by time:

$$Y_t = \beta_0 + \beta_1 PRIME_t + \varepsilon_t$$

where

Y_t is the dependent variable at time t ,

β_0 is the model's intercept,

β_1 is the partial regression coefficient representing the level change,

$PRIME_t$ is a dummy variable denoting the availability of PRIME-HEq in the application process (0 = the pre-PRIME phase, 1 = the PRIME phase),

ε_t is the error term.

Again, errors are assumed to be independent, normally distributed, and heteroscedastic. Unlike the first model, however, Model 2 describes the difference in means of the two phases of the time-series. In small N studies the advantage of this model is its simplification. This requires that there is no slope in either phase, however, making partial coefficients for time and slope change unnecessary.

After the two models have been derived for each of the dependent variables, they are compared to one another in order to determine which most accurately describes the data. As

stated previously, this is dependent on β_1 and β_3 being equal to zero. To test this assumption and determine which model to use, the following model comparison test is employed:

$$F = \frac{(SS_{\text{Reg1}} - SS_{\text{Reg2}}) / 2}{MS_{\text{Res1}}}$$

where

SS_{Reg1} is the regression sum of squares from model 1.

SS_{Reg2} is the regression sum of squares from model 2.

MS_{Res1} is the residual mean square from model 1.

The value of F calculated from this equation is compared to the critical value of F based on $df = 2, N-4$ and with a liberal $\alpha = .10$. Assigning a less stringent α favors committing a type I error, thus minimizing the risk of accepting β_1 and β_3 as zero and unnecessary to the model. If the calculated F is greater than the critical value, then model 1 is preferred and the variables of $Year_t$ and SC_t are required in order to fit the observed data.

Autoregression. Before finalizing either model the assumption of independence, normality, and heteroscedasticity of errors needs to be addressed. Although normality and heteroscedasticity can be approached using typical methods for linear regression, testing for independence requires some attention at this point.

A closer inspection of the residuals for the selected regression model helps determine the independence of these errors. When errors at one time point affect those of later time points, they exhibit autocorrelation. Both positive autocorrelation and negative autocorrelation can occur, which decreases or increases the confidence intervals of change coefficients respectively (Huitema, 2011a). In this regard, autocorrelation affects the reliability of statistical tests to determine if PRIME-HEq makes a significant difference on admissions trends. Another reason for such an examination is to determine if the output value at time t is dependent on its previous value at time $t - 1$, or even earlier. Conceptually, this would indicate that admissions

components are affected by the measures of the previous year or years. If, for example, percent matriculation of URM students was dependent on that of the previous year, an increase in representation one year would lead to a greater than expected percentage the next. This concept of dependent growth is an underlying principle to building a “critical mass” (*Grutter v. Bollinger*, 2003)

To test for autocorrelation, this study utilizes the H–M test described by Huitema (2011a) rather than a bounded Durbin-Watson test. This removes some of the ambiguity that remains with the Durbin-Watson test. The H–M test only has one critical value rather than the two values provided by the Durbin-Watson test. The test statistic z_{H-M} is defined in the following manner:

$$z_{H-M} = \frac{r_1 + (P/N)}{\frac{\sqrt{(N-2)^2}}{(N-1)N^2}}$$

where

P is the number of parameters in the model,

N is the observations of time points,

e_t is the residual at time t , and

r_1 is the lag-1 autocorrelation coefficient. Here this coefficient is defined as

$$r_1 = \frac{\sum_{t=2}^N (e_t)(e_{t-1})}{\sum_{t=1}^N e_t^2}$$

The test statistic is compared to a critical value set at 1.282 for an $\alpha = .10$, which accommodates for the small N in this study. Models with a z_{H-M} score greater than the critical value are said to demonstrate autocorrelation of errors.

If autocorrelation of errors is observed, then the model must be adjusted accordingly.

This adjustment involves the addition of an autoregressive component to the model parameters

and a disturbance variable. To do this, the error term in the equation is transformed to include a lag autoregressive coefficient. When autocorrelation occurs, values from several previous time periods can theoretically affect the value at time t . As such, there can be anywhere from lag-1 to lag- p autoregressive coefficients, where p is the order of how far back the error predicts the error term ε_t . For the purposes of this study, only lag-1 autoregressive coefficients are considered, due to the small number of observations. The relationship between the error term ε_t and both the transformed error term and disturbance variable is defined as follows:

$$\varepsilon_t = \phi\varepsilon_{t-1} + \mu_t$$

where

ε_t is the error term at time t ,

ϕ is the lag-1 autoregressive coefficient,

μ_t is the disturbance.

Huitema (2011b) recommends a double bootstrap procedure for small cases such as this, and graciously provides the program for evaluating X:Y matrices for interrupted time-series using this method at <http://fisher.stat.wmich.edu/joe/TSDDB/Timeseries.html>.

Limitations

The largest threat to interrupted-time series analysis is history (Shadish et al., 2002). Over the time period of this study there are any number of potential factors that could have influenced admissions trends. The administrative process within admissions could very well have changed at any point in these 11 years. For this reason, this study relies heavily on comparison groups in order to infer any sort of relationship between PRIME-HEq and admissions trends. As mentioned previously, by comparing semi-equivalent student groups and nonequivalent subgroups, any inference is strengthened.

Although the admissions dataset includes a large number of variables concerning individual students, very little institutional information is known, including some of the finer administrative details of the admissions process. This large amount of information at the student level allows for sophisticated analysis at an individual level but limits the level to which institutional studies can be conducted. Once the individual measures become compounded by year, the number of observations becomes drastically smaller.

The small sample size resulting from compounding measures is unfortunately the greatest limitation of this study. In fact, this study challenges the minimal number of post-intervention observations recommended by Huitema (2011a). However, this is found in many other interrupted time-series (Bloom, 2003; Huitema, 2011a; Shadish et al., 2002). To compensate for this limitation, a more liberal value of $\alpha = .10$ was selected for the test of autocorrelation of errors while conserving a smaller p value of 0.05 for the level of significance required by any one parameter.

Chapter 4

Results

Introduction

The purpose of this study is to determine if PRIME-HEq has affected the admissions of URM students. Many medical schools share their programmatic efforts to recruit this group of students; however, recruitment does not always translate over to observable outcomes. When observable outcomes are available, it is often difficult to attribute sizeable statistical effects in admissions trends to these interventions (Rumala & Cason, 2007; Vela et al., 2010). This chapter describes the results of an interrupted time-series analysis using OLS regression analysis, and represents one method of measuring potential effects on admissions due to the implementation of PRIME-HEq. Multiple comparison groups were constructed in order to strengthen this analysis. An overview of the student comparison groups within each admissions component is provided at the beginning of this chapter. A section for each admissions component follows the overview, beginning with PRIME-HEq's effects on the application component. A section on matriculation trends follows the presentation of results on student applications. Finally, the relationship between PRIME-HEq implementation and matriculation yields is discussed. Each of these three sections includes a table and graph for comparisons between both groups and subgroups, in order to point out the specific admissions trends in each student population. Due to the iterative nature of this analysis, the conclusions from the findings are provided at the completion of this section.

Overview

The statistical sample for this study includes all applicants to UCSD School of Medicine from 2002–2012 ($n = 56,557$). Table 4.1 shows the number and percentage of students within each comparison group. As noted in the table, 13.8% of all applicants come from URM backgrounds, while 33.5% of applicants are from out-of-state. These two groups are not

mutually exclusive. Chi-square analysis reveals that a statistically greater proportion of URM applicants come from California (69.3%) as compared to other locations (30.7%, $p < .005$).

Table 4.1. Student Comparison Groups from 2002–2012 by Admissions Process Components

Comparison Group	Count (% within component)		Percent Matriculation Yield
	Applicants (N = 56,557)	Matriculants (N = 1,376)	
URM	7,807 (13.8)	174 (12.6)	36.7
Out-of-state	18,950 (33.5)	144 (10.5)	31.2
CA Resident URM	5,413 (9.6)	155 (11.3)	37.6
Out-of-state Non-URM	16,566 (29.3)	125 (9.1)	31.3

UCSD School of Medicine saw sizeable growth in the number of applications received from 2002–2012. The school received a total of 4,183 applications in 2002, compared to the 5,959 received in 2012. Figure 4.1 represents the total number of applications received from URM applicants and out-of-state applicants over the period of this study. Overall, there was a greater increase in out-of-state applications (87.3% growth) than URM applications (49.2% growth) during this time. This has caused the percentage of applicants from out-of-state to climb while the percentage of URM applicants has remained relatively constant.

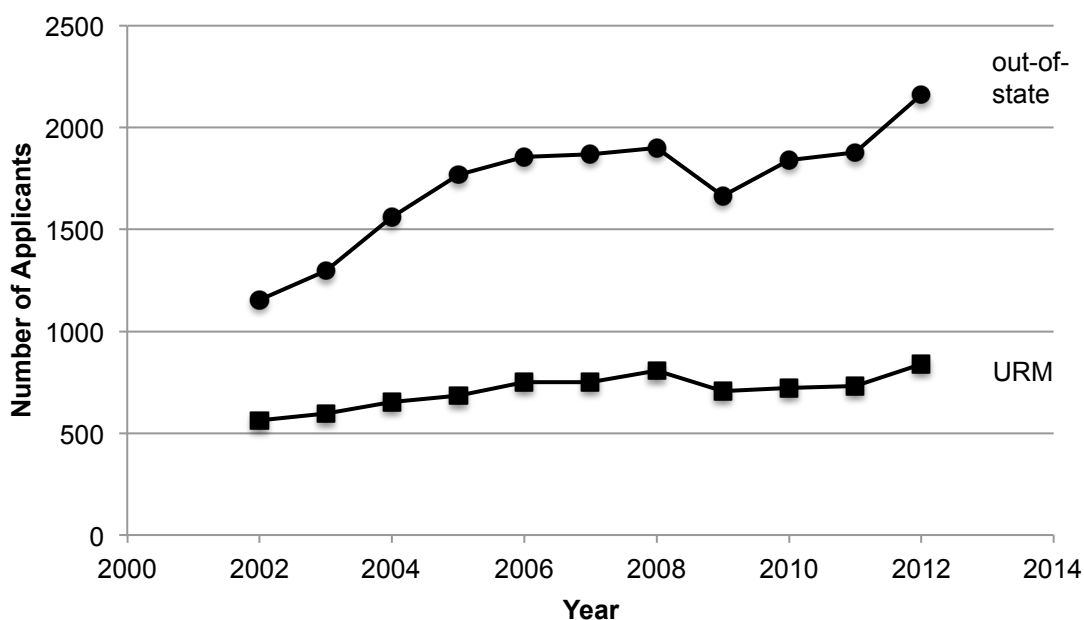


Figure 4.1. Number of applicants from comparison groups by year

Application

Interrupted time-series by OLS regression was used to understand if PRIME-HEq affects the composition of the applicant pool. Following the strategy outlined by Huitema (2011a), models were constructed for each comparison group and subgroup. In order to better compare groups, the first half of this section reports the results of the appropriate OLS regression model for URM and out-of-state trends. The second half reports the results for trends within the CA-URM subgroup and OS-nURM subgroup.

URM and out-of-state groups. Two models were constructed for each comparison group. Model 1 took into account the parameters of change over time in years, changes in this slope over time, and changes in level at the time of PRIME-HEq availability. Model 2 disregards the first two parameters when they are found to be statistically irrelevant by means of the model comparison test described earlier ($F_{critical} = 3.257$). For the time-series describing trends in the percentage of URM applicants, model two was more appropriate ($F = .672$); thus only the effect of PRIME-HEq availability was tested. When applied to the models depicting trends in the percentage of out-of-state applicants, model 1 was more suitable ($F = 8.450$). The results of the two appropriate models for these comparison groups are found in Table 4.2.

Table 4.2. Results of Interrupted Time-Series by Ordinary Least Squares Regression for Percentage of Underrepresented Minority (URM) and Out-of-State Students Applied to UCSD School of Medicine, 2002 – 2012.

Variable	URM			Out-of-State		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
Year				1.431*	.363	.006
Slope change				-.874	.602	.189
PRIME-HEq	-.017	.257	.949	-4.522*	1.838	.043
Constant	13.805*	.173	.000	27.563*	1.413	.000
R ²	.000			.740		
F (Mod. Comp.)	.672			8.450		
Z _{H-M}	-.004			.774		

Note. $F > 3.257$ indicates model 1 favored to model 2, $Z_{H-M} > 1.282$ indicates autocorrelation of errors. * = $p < .05$

As reflected in Table 4.2, there was no significant change in the percentage of URM applicants over time, nor was there any significant change in the slope after implementing PRIME-HEq. Likewise, PRIME-HEq did not appear to affect the URM composition of the applicant pool. The low coefficient of determination indicates this model does nothing to explain the variance in the percentage of URM applicants in the pool. After testing for autocorrelation of errors, there was no evidence that the value at one time point affected subsequent time points.

Unlike the percentage of URM applicants, there was a statistically significant increase from year to year in the percentage of applicants coming from out of state. The slope of this increase appears to be unaffected by PRIME-HEq; however, there was a significant decrease in level at the time of implementing its availability. In other words, the proportion of out-of-state students dropped significantly upon inclusion of PRIME-HEq to the secondary application. After this interruption, the proportion of out-of-state applicants continued to increase at the same rate, but now with a new intercept. The coefficient of determination is also substantially greater for this model. Autocorrelation of errors was not observed for these findings. Figure 4.2 depicts the time-series of both the percentage of URM and out-of-state students in the applicant pool, as well as the changes that occur to these time-series with the implementation of PRIME-HEq.

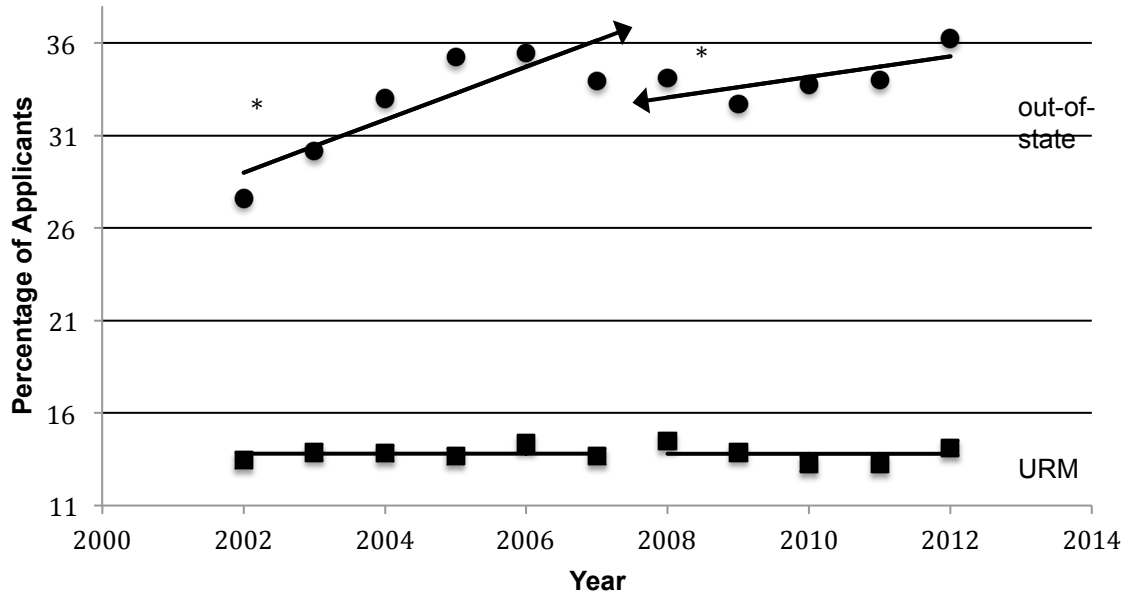


Figure 4.2. Percentage of applications from URM and out-of-state students to UCSD School of Medicine, before and after PRIME-HEq implementation. Note. * = significant slope; arrowheads = significant level change.

CA resident URM and out-of-state non-URM subgroups. These nonequivalent subgroups are derived from the combination of a student’s URM and residency status. Two models for these subgroups were constructed in the same manner as were the previous comparison groups. Table 4.3 contains the results of the appropriate OLS regression analysis for the percentage of applicants who were both CA residents and came from URM backgrounds. It also contains the results of this analysis for the percentage of students who do not come from an URM background and are from out of state. Model 1 was found to be the most suitable for CA-URM application trends as well as OS-nURM trends ($F = 6.091$ and 9.037 , respectively).

Table 4.3. Results of Interrupted Time-Series by Ordinary Least Squares Regression for Percentage of California Resident Underrepresented Minority (CA-URM), and Out-of-State Non-URM (OS-nURM) Students Applied to UCSD School of Medicine, 2002 – 2012.

Variable	CA-URM			OS-nURM		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
Year	-.177*	.061	.023	1.184*	.294	.005
Slope Change	.018	.102	.861	-.650	.488	.225
PRIME-HEq	.520	.310	.138	-4.011*	1.490	.031
Constant	10.416*	.239	.000	24.422*	1.146	.000
R ²	.736			.747		
F (Mod. Comp.)	6.091			9.037		
Z _{H-M}	-.223			.960		

Note. $F > 3.257$ indicates model 1 favored to model 2, $z_{H-M} > 1.282$ indicates autocorrelation of errors. * = $p < .05$

Both models explain a great deal of the variance in the percentage of the subgroups in the applicant pool. These subgroups demonstrated a significant change over time. The percentage of CA-URM students significantly decreased over time, despite a 28.1% growth in the number of applicants from this subgroup. The percentage growth of non-URM students from California was only slightly less at 25.0%. By contrast, the percentage of OS-nURM students significantly increased each year; its growth at 83.4% was greater than that of the applicant pool as a whole. Out-of-state URM students saw the greatest percent growth at 113.7% but also had the smallest overall representation, with only 297 applicants in 2012. Neither the CA-URM nor OS-nURM subgroup appeared to be affected by the previous year's outcomes, as evidenced by low z_{H-M} scores denoting an absence of autocorrelation of errors.

PRIME-HEq was not observed to significantly alter the rate of decline in the percentage of CA-URM applicants, nor was it found to have an effect on the year-to-year percentage point increase in the representation of OS-nURM applicants. PRIME-HEq did not significantly interrupt the declining percentage of CA-URM applicants but there was a significant level decrease in the OS-nURM subgroup. This level decrease represents a significant drop in the proportion of OS-nURM applicants upon implementation of PRIME-HEq, followed by a continuation in the year-to-year percentage point increase in representation. Figure 4.3

represents the time-series of the percentage of both subgroups in the applicant pool, and the changes seen with the implementation of PRIME-HEq.

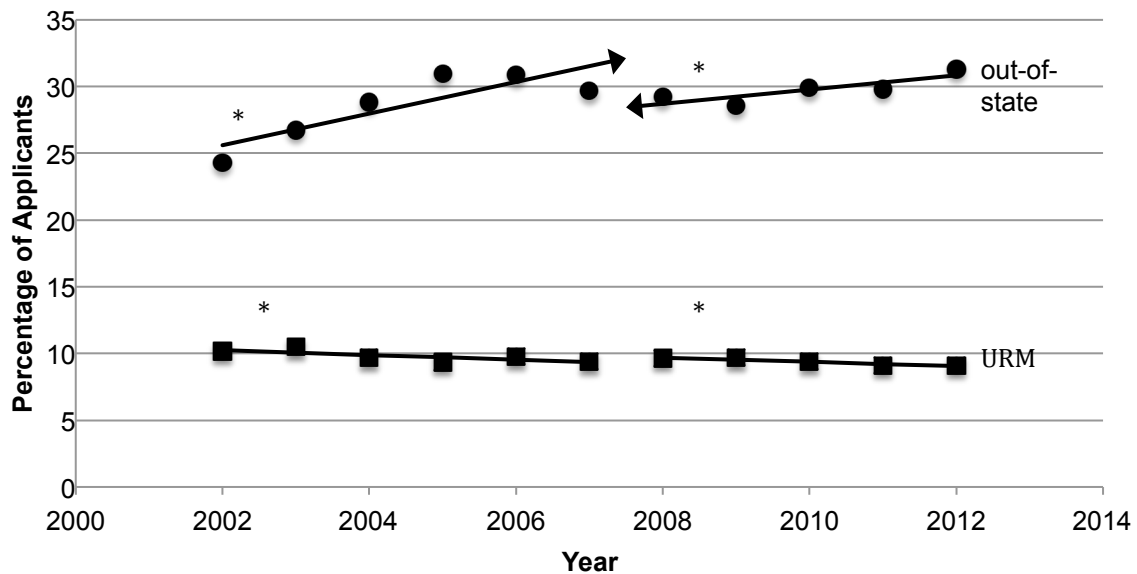


Figure 4.3. Percentage of applications from California resident URM, and out-of-state non-URM students to UCSD School of Medicine, before and after PRIME-HEq implementation. Note. * = significant slope; arrowheads = significant level change.

Matriculation

URM and out-of-state groups. Two OLS regression models were calculated for each comparison group as was done previously for evaluating PRIME-HEq’s effect on the applicant pool. Reported in this section are the models that best represent the percentage of these subgroups among matriculating students in the time-series. Table 4.4 contains coefficients, standard errors, and significance for the parameters used to construct these models.

Table 4.4. Results of Interrupted Time-Series by Ordinary Least Squares Regression for Percentage of Underrepresented Minority and Out-of-State Students Matriculated to UCSD School of Medicine, 2002 – 2012.

Variable	URM			Out-of-State		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
Year				1.052	.918	.290
Slope change				3.088	1.523	.082
PRIME-HEq	3.760*	1.528	.036	-4.968	4.653	.321
Constant	10.938*	1.030	.000	3.582	3.577	.350
R ²	.402			.758		
F (Mod. Comp.)	.766			6.463		
Z _{H-M}	.402			.475		

Note. $F > 3.257$ indicates model 1 favored to model 2, $z_{H-M} > 1.282$ indicates autocorrelation of errors. * = $p < .05$

Over the course of the time-series, the variables accounting for change over time and change in slope were unnecessary to describe the effects of PRIME-HEq on URM matriculation. This was indicated by an F score lower than the critical value. Without these variables, this simplified model still accounted for 40.2% of the variance in percentage of matriculants, as denoted by the coefficient of determination. The percentage of matriculating URM students significantly increased with the implementation of PRIME-HEq when compared to the pre-PRIME phase. In other words, no significant year-to-year changes were noted in the proportion of URM matriculants either before or after PRIME-HEq implementation. But there was an overall increase in the proportion of URM students during the PRIME-Heq phase. The z_{H-M} score for this model was .402, indicating an absence of autocorrelation of errors. Figure 4.4 illustrates the proposed model for the percentage of URM matriculants.

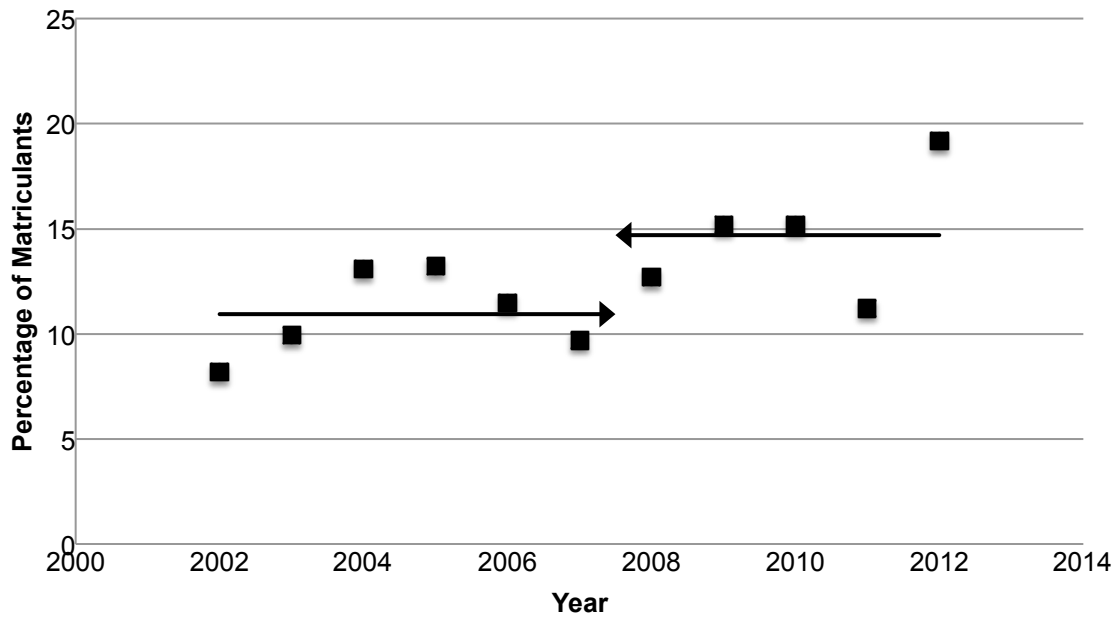


Figure 4.4. Percentage of matriculants from URM backgrounds to UCSD School of Medicine, before and after PRIME-HEq implementation.
Note. arrowheads = significant level change.

A very observable increase in the percentage of out-of-state matriculants is seen in the time-series (see Figure 4.5). Unlike the model explaining the percentage of URM matriculants in each class, the comparison test results indicate model 1 to be the more suitable regression model to explain the percentage of out-of-state matriculants. Still, no parameter was found to significantly predict the percentage of out-of-state matriculants and no autocorrelation of errors was observed.

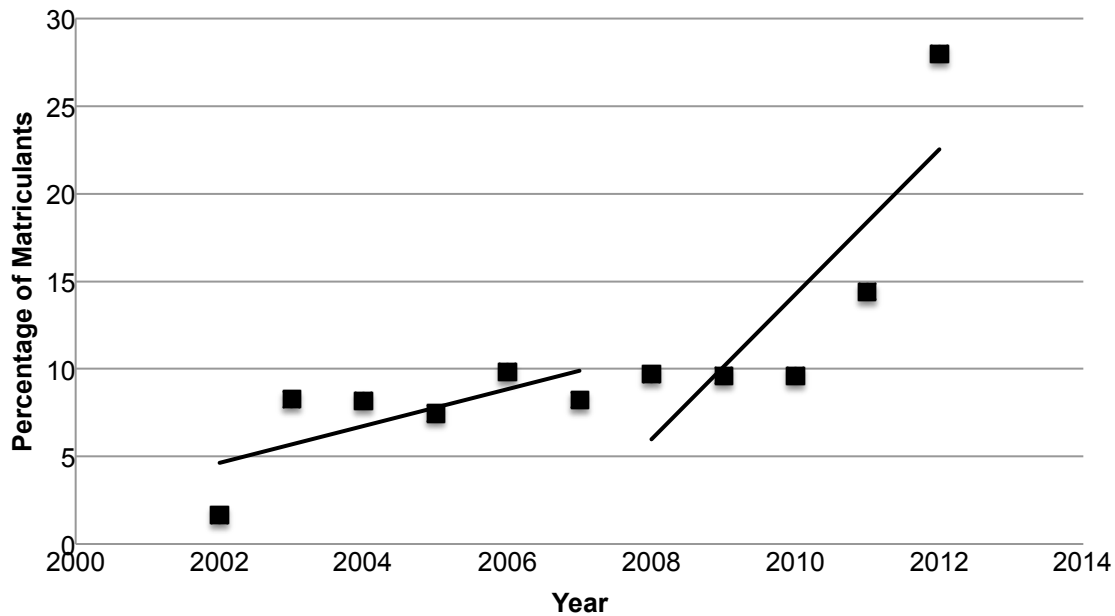


Figure 4.5. Percentage of matriculants from out of state to UCSD School of Medicine, before and after PRIME-HEq implementation.

CA resident, URM, and out-of-state non-URM subgroups. After constructing two models for both subgroups, comparison tests determined which model was most appropriate for each. Test statistics resulted in utilizing model 2 to predict the percentage of URM students from California in each year’s matriculating class. Model 1 was found to be more adequate for non-URM students from out of state. Table 4.5 contains results of these regression models.

Table 4.5. Results of Interrupted Time-Series by Ordinary Least Squares Regression for Percentage of California Resident Underrepresented Minority Students (CA-URM) and Out-of-State Non-URM (OS-nURM) Students Matriculated to UCSD School of Medicine, 2002 – 2012.

Variable	CA-URM			OS-nURM		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
Year				1.052	.757	.207
Slope Change				2.506	1.255	.086
PRIME-HEq	2.520	1.313	.087	-5.040	3.834	.230
Constant	10.118*	.885	.000	2.761	2.948	.380
R ²	.290			.771		
F (Mod. Comp.)	.286			7.281		
Z _{H-M}	-.867			.308		

Note. $F > 3.257$ indicates model 1 favored to model 2, $Z_{H-M} > 1.282$ indicates autocorrelation of errors. * = $p < .05$

Neither subgroup's dependent variable was predicted by change over time, the change in slope over time, nor the availability of PRIME-HEq in the application process. No evidence of autocorrelation of errors was detected either. The trends noted in the larger comparison groups appear to be largely driven by those seen with these two subgroups, including the observable increase in representation by out-of-state students. Figure 4.6 illustrates the models for both CA-URM and OS-nURM subgroups.

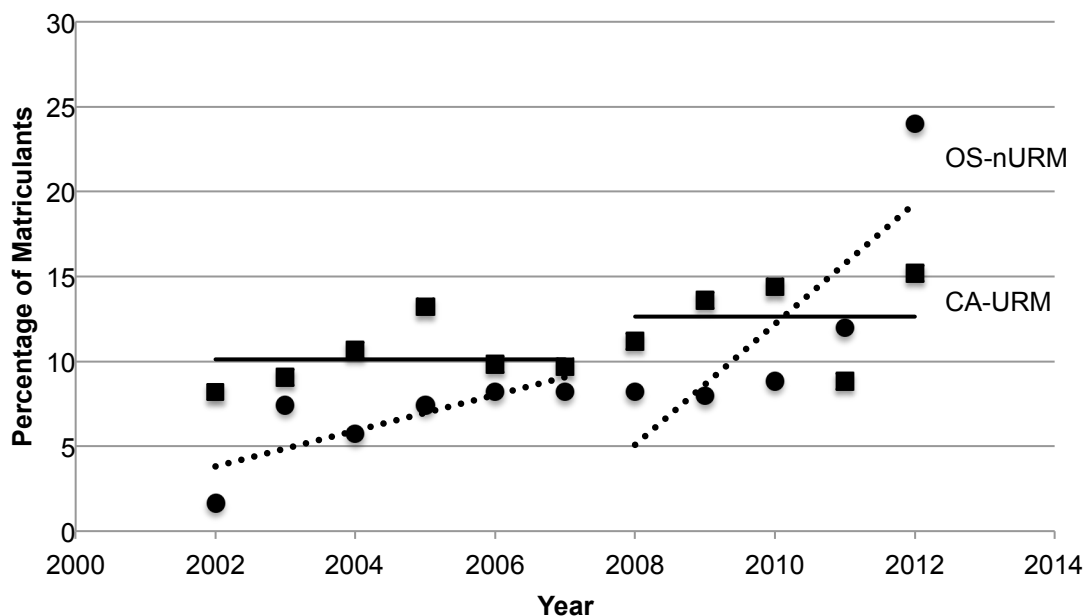


Figure 4.6. Percentage of California resident URM and out-of-state non-URM students matriculating to UCSD School of Medicine, before and after PRIME-HEq implementation.

Matriculation Yield

Up to this point, the denominators used to construct dependent variables have controlled for the size of the comparison group or subgroup at that same stage in the process. This has allowed the analysis to revolve around admissions components that rely on a student's choice to engage in the admissions process. The choice to engage in the admissions process is most apparent by a student's choice to submit an application. By analyzing the percent composition of the applicant or matriculating pool from a comparison group, the denominator restricts the

analysis to students with equal choice, and controls to some degree the institution's influence over the dependent variable. This section contains the results for percent matriculation yield of comparison groups and subgroups. Matriculation yield changes the denominator to control for the number of students accepted from each comparison group. It is derived by dividing the number of matriculants from that group by the number of accepted students from the same group. The first half of this section tackles the comparison between URM and out-of-state students. A comparison between URM in-state students and non-URM out-of-state students follows.

URM and out-of-state groups. After calculating a model comparison statistic, model 1 was found to be the most appropriate to predict the percent matriculation yield of URM students. Model 2 was found to best predict the percent matriculation yield for the out-of-state comparison group. Table 4.6 contains the results of the OLS regression analysis for both URM and out-of-state comparison groups. Of the required parameters for the URM model, only the year parameter was found to be statistically significant. This reflects a roughly 3.27% increase each year in the matriculation yield of this comparison group: the year-to-year change in the proportion of URM students who matriculate into UCSD. A negative slope change was calculated after the availability of PRIME-HEq; however, this change in slope was not significant. This model explained a large portion of the variance ($R^2 = .563$) and autocorrelation was not detected in the errors ($z_{H-M} = -.840$). The out-of-state student matriculation yield was found to be relatively stable over time, thus model 2 only accounts for potential effects of PRIME-HEq. No such effects were noted however, thus PRIME-HEq was not found to affect the matriculation yield of out-of-state students. Figure 4.7 depicts the change in URM and out-of-state matriculation yield as calculated by the unadjusted regression results. Since unadjusted values are used, the slope of the URM student model is reversed. It should be noted, however, that this slope change was not found to be significant.

Table 4.6. Results of Interrupted Time-Series by Ordinary Least Squares Regression for Matriculation Yield Percentage of Underrepresented Minority (URM) and Out-of-State Students to UCSD School of Medicine, 2002 – 2012.

Variable	URM			Out-of-State		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
Year	3.271*	1.367	.048			
Slope Change	-4.893	2.267	.068			
PRIME-HEq	-2.741	6.927	.704	7.078	5.317	.216
Constant	22.961*	5.325	.004	26.074*	3.585	.000
R ²	.563			.164		
F (Mod. Comp.)	3.264			2.566		
Z _{H-M}	-.840			-.096		

Note. $F > 3.257$ indicates model 1 favored to model 2, $Z_{H-M} > 1.282$ indicates autocorrelation of errors. * = $p < .05$

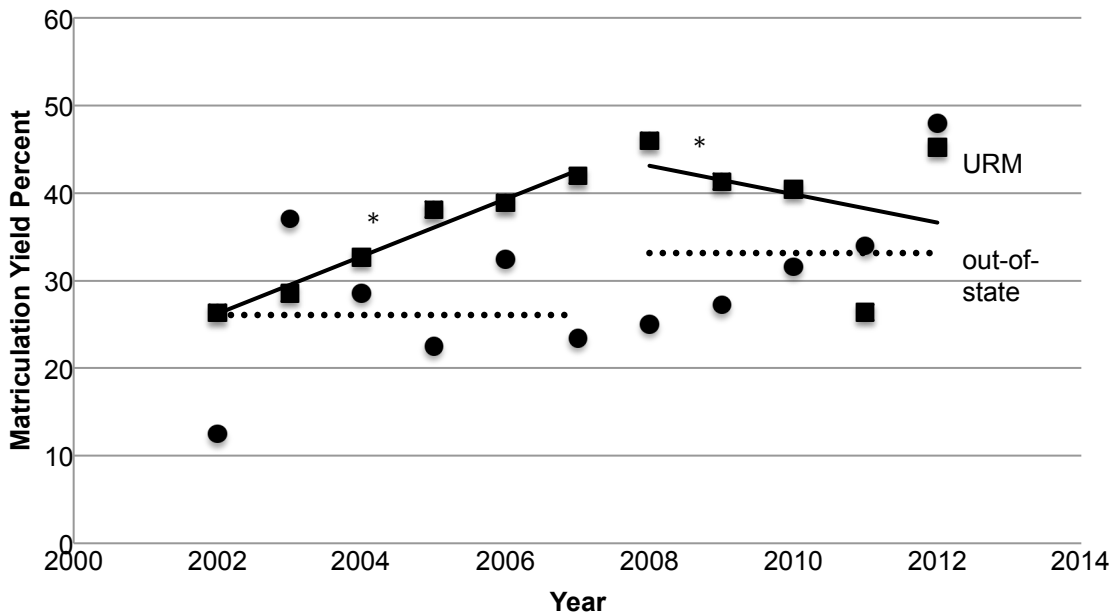


Figure 4.7. Matriculation yield of URM and out-of-state students accepted to UCSD School of Medicine, before and after PRIME-HEq implementation.

Note. * = significant slope

CA resident URM and out-of-state non-URM subgroups. The parameters of year and slope change were found to contribute to the fit of the respective OLS regression equations

for both CA-URM students as well as OS-nURM students. Model comparison tests for both subgroups resulted in an *F* statistic greater than the critical value of 3.257. Table 4.7 details the findings of the OLS regression analysis for both comparison subgroups.

Table 4.7. Results of Interrupted Time-Series by Ordinary Least Squares Regression for Matriculation Yield Percentage of California Resident Underrepresented Minority (CA-URM) and Out-of-State Non-URM (OS-nURM) Students to UCSD School of Medicine, 2002 – 2012.

Variable	CA-URM			OS-nURM		
	Coef.	S.E.	Sig.	Coef.	S.E.	Sig.
Year	3.931*	1.333	.021	.912	1.881	.642
Slope Change	-5.486*	2.211	.042	5.431	3.119	.125
PRIME-HEq	-5.489	6.754	.443	-8.715	9.527	.391
Constant	21.811*	5.192	.004	23.361*	7.324	.015
R ²	.628			.562		
<i>F</i> (Mod. Comp.)	4.736			3.368		
Z _{H-M}	-1.195			-1.120		

Note. *F* > 3.257 indicates model 1 favored to model 2; z_{H-M} > 1.282 indicates autocorrelation of errors. * = *p* < .05

Over the course of the baseline period, an increasing percentage of CA-URM applicants who were accepted to the school decided to matriculate. This is represented by the significant regression coefficient of 3.931 for the variable year. Although there was no significant change in level upon adding PRIME-HEq to the application process, there was a significant decrease in slope during this phase. After PRIME-HEq was implemented, the year-to-year percentage increase in accepted CA-URM students matriculating to UCSD appears to have reversed. The coefficient of determination indicates that this model accounts for roughly 63% of the variance in the dependent variable. No evidence of autoregression was found by the H–M test, thus there was no need to account for the effect of one year’s value on the next. Figure 4.8 contains a dot plot for this model.

Overall, there is a general increase in the percentage of OS-nURM students who matriculate after acceptance. However, no parameters were found to significantly predict the matriculation yield for non-URM students from out of state. No autoregression was detected by H–M test for these students either. These results are illustrated in Figure 4.9.

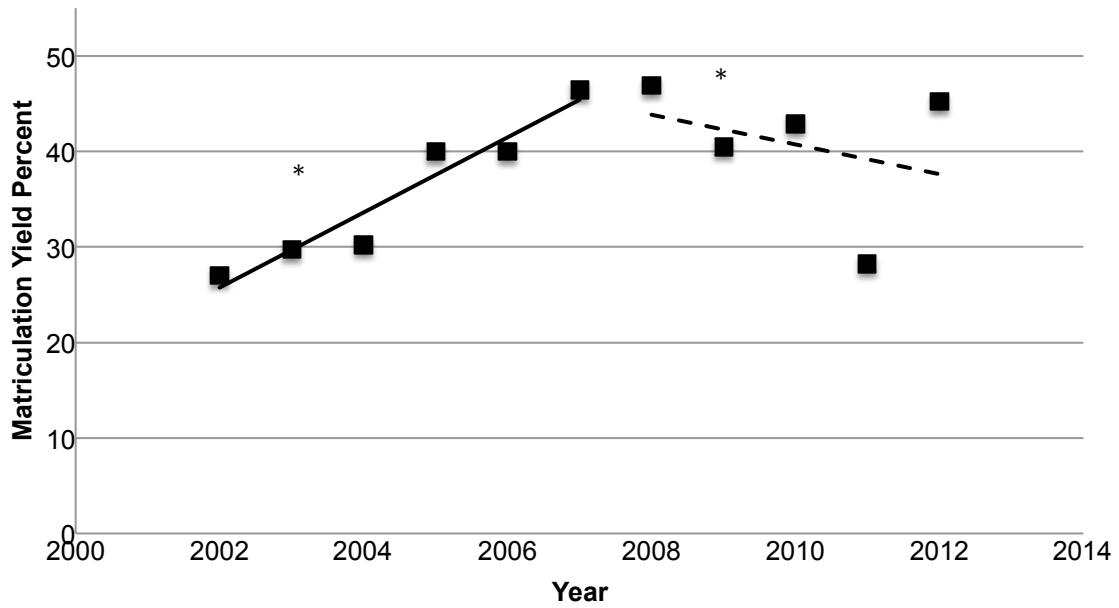


Figure 4.8. Matriculation yield of California resident URM students accepted to UCSD School of Medicine, before and after PRIME-HEq implementation. Note. * = significant slope; dashed lines = significant slope change

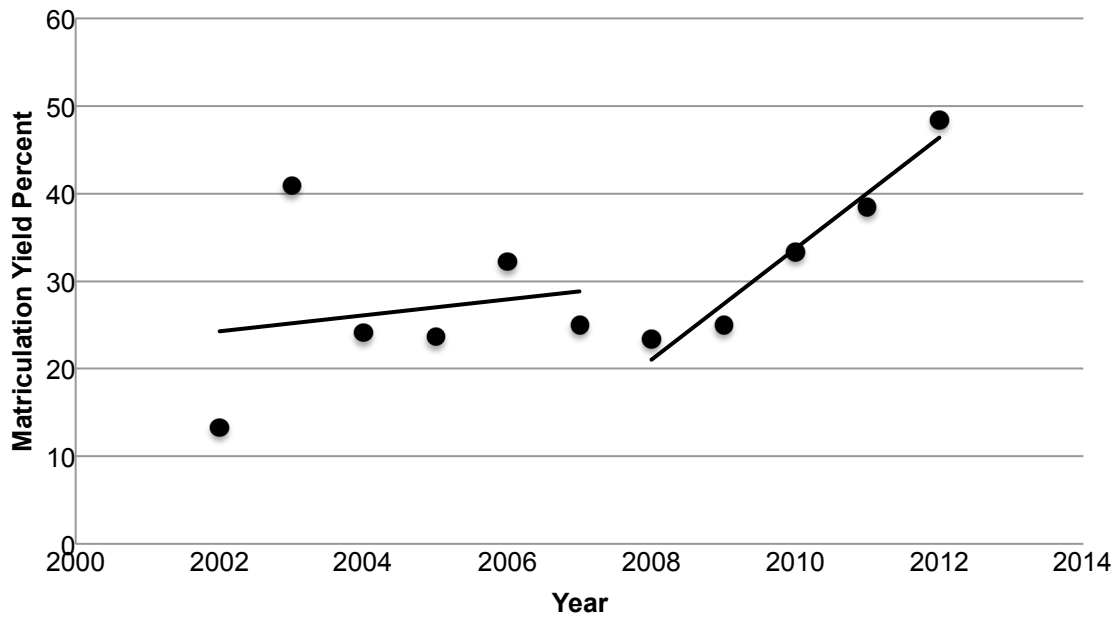


Figure 4.9. Matriculation yield of out-of-state non-URM students accepted to UCSD School of Medicine, before and after PRIME-HEq implementation.

Summary

A few overall trends emerge after carefully examining the data derived from the interrupted time-series and are detailed in Table 4.8. Although a growing number of URM students are applying to UCSD School of Medicine, there is a more drastic increase in the number of out-of-state students applying to the school. The vast majority of these out-of-state students come from majority backgrounds, but there is a growing contingent of URM students in this group. Percentage growth in the number of applications of out-of-state students (87.3%) is greater than that of the total applicant pool (42.5%). This has resulted in a decreasing representation of in-state URM students in the applicant pool by percentage. The majority of growth in non-resident applications occurred primarily before PRIME-HEq.

A significant drop in the percentage of out-of-state and OS-nURM applicants at the time of PRIME-HEq implementation was not observed in their URM and CA-URM counterparts. It is unlikely that PRIME-HEq was directly responsible for such a decrease in applications so whatever caused this decrease should have affected URM applications as well. This was not seen however, thus PRIME-HEq may have provided a protective effect from whatever caused this decrease. A closer inspection of the raw data shows that the only decrease in total URM application numbers was the year 2009. Both out-of-state URM and California resident URM applications dropped that year. Out-of-state applicants from URM backgrounds experienced two consecutive years of decrease in application numbers in 2008 and 2009, with the decrease in 2009 being the largest.

With respect to matriculation, PRIME-HEq does appear to have contributed to a significant increase in the percentage of URM students. When adjusting for the size of an incoming class, this equates to roughly 5 more URM students. This increase was not observed in URM students from California, thus out-of-state URM students appear to account for this increase. No other comparison group or subgroup experienced this same level change, nor

were any significant patterns observed. Looking at the raw numbers again shows a sharp increase in the percentage of out-of-state students over the last two years of the study. The only other year to experience such an increase in non-resident matriculation was 2003.

Of the URM students who are accepted to UCSD, a greater number are matriculating over time. During the years prior to PRIME-HEq, this held true for both the group as a whole as well as the in-state subgroup. After PRIME-HEq was made an available option on secondary applications, the matriculation yield has in fact declined for CA resident URM students. No other groups were found to have significant factors predicting matriculation yield. Raw numbers again show an increase in yield for out-of-state students; however, this was not found to be statistically significant.

Table 4.8. *Effects of Program in Medical Education-Health Equity on Trends in Admission Components*

Comparison Group	No Effect	Effect
URM students	%App %Yield*	%Mat: (+) level change
Out-of-state students	%Mat %Yield	%App*: (-) level change
CA-URM students	%App [†] %Mat	%Yield*: (-) slope change
OS-nURM students	%Mat %Yield	%App*: (-) level change

Note. [†] = (-) slope, * = (+) slope

As stated previously, this study aimed to determine if PRIME-HEq had any effect on the admissions of URM students to UCSD School of Medicine. Conclusions drawn from this analysis include that PRIME-HEq has in fact helped to increase matriculation of URM matriculants. Coefficients of determination for the OLS regression equations describing the various admissions components indicate that these models explain a large amount of the variance. Furthermore, there is no evidence to suggest that the number of these students matriculating one year affects the subsequent year after controlling for class size.

Chapter 5

Discussion

Introduction

Results of this study suggest that PRIME-HEq has had a significant effect on the admissions of URM students. These effects appear to be substantially different depending on the stage of the admissions process, and result in an overall increase in compositional diversity at UCSD with regards to race and ethnicity. This chapter includes a discussion of the differential effects at their corresponding admissions stages. Implications of this study for institutional practice are included in this discussion along with suggestions for future research.

Discussion

PRIME-HEq improves applicant pool diversity. The first stage in which PRIME-HEq appears to improve racial/ethnic diversity is within the applicant pool. The models for both out-of-state applicants as well as OS-nURM applicants experienced a significant decrease in level. Without any sort of intervention, it is assumed that this same decrease in level should have occurred in the percentage of URM and CA-URM applicants. Since this decrease is not paralleled within these two groups, this study suggests that more URM students applied to UCSD than otherwise would have were it not for PRIME-HEq.

A possible explanation for the decrease in percentage of out-of-state applicants could be the economic difficulties experienced across the nation during the time of PRIME-HEq's inclusion on secondary applications. This explanation is corroborated by the expensive nature of applying to medical school (A. N. J. White, 2008). Fee waivers are available for indigent applicants and some may assume URM students are more likely to receive these fee waivers, thus allowing them to apply to schools they otherwise would not. At this point in the analysis, it is impossible to determine how much economic forces factored into trends in application. However, the economy was not central to the study question, since students must still choose where they apply regardless of how the applications are paid for. Furthermore, previous work

supports the hypothesis that PRIME-HEq protected URM application trends as the vast majority of URM students from both in and out of state applied to PRIME-HEq (Bailey & Willies-Jacobo, 2012).

One of the common refrains used to explain the lack of racial and ethnic diversity in medical schools is that URM students constitute a small portion of the applicant pool. Though this explanation may be true, it completely ignores how the applicant pool is created. After all, applying to medical school constitutes a choice made by the students. According to the National Center for Education Statistics, Black, Latino, and Native American students comprise about 30% of students in degree-granting institutions in higher education (Snyder & Dillow, 2012). However, less than 16% of applicants to medical school come from these backgrounds (Castillo-Page, 2012). The disparity between these numbers suggests a large number of URM students are not choosing a pathway leading to medicine.

Several researchers have attempted to understand the choice to attend college, including Becker (1993), McDonough (1997), and Terenzini, Cabrera, and Bernal (2001). Perna (2006) incorporates concepts of human, social, and cultural capital within a framework to describe the choice to enroll in higher education and, in addition to student attributes, includes contextual layers at the school, system, and societal levels. She has even tested portions of this model at the graduate level (Perna, 2004). It may be easiest to study students' choices based solely on individual attributes such as demographics, or even more complex constructs like social and cultural capital. However, it is also important to understand how the other contextual layers affect this choice. Put simply, the curriculum medical schools teach and the types of programs they implement could greatly determine the applicants who choose to apply and attend. Were it not so, medical schools would certainly not engage in recruitment activities. The results of this study, in concert with my previous study, intimate that medical school programs and practices can in fact affect the composition of the applicant pool.

PRIME-HEq improves compositional diversity. Perhaps of greater interest than application trends is how PRIME-HEq affects the actual composition of the enrolled student body. Interrupted time-series analysis supports the idea that PRIME-HEq increases the proportion of URM students who choose to enroll at UCSD. UCSD is not the only medical school to see such increases. There has been a similar increase in URM medical school matriculation across the UC system (University of California Office of the President, 2012). Limited qualitative data even suggests that PRIME has been instrumental in this increase at the system level (Rosenberg, 2013). Further qualitative exploration of PRIME's role in URM matriculants' choice to attend UC schools should be pursued.

Interestingly, an increase in URM matriculation at UCSD was not observed with CA-URM students alone, as was my initial hypothesis. Thus out-of-state URM students must be driving this change in trend. Over the past couple years the percentage of out-of-state students has noticeably increased, even though the models described in this analysis show the overall rate of increase to be insignificant. Parallel observations can be found at the undergraduate level. From 2009 to 2011 there were simultaneous increases in the percentage of both out-of-state and URM Fall freshmen (University of California Office of the President, 2012). URM students were 23.7% of freshmen enrollees for Fall 2009 and 27.4% in Fall 2011. Out-of-state freshmen constituted 5.18% of the Fall 2009 class and 11.64% in Fall 2011. Still, associations between out-of-state and URM admissions are hotly contested and generally seen as having negative effects on URM matriculation (Jaquette & Curs, 2013; Perna, Steele, Woda, & Hibbert, 2005).

Regardless of whether URM students are from California or out of state, it appears PRIME-HEq has helped to increase their representation in the medical school. Of additional interest is the fact that no autocorrelation of errors was noted in the model predicting the percentage of URM matriculants. Without autocorrelation of errors, it becomes less likely that the number of URM students enrolled one year affects the subsequent year. A lack of

autoregression in these models suggests that the success of student-partnered recruitment efforts are not determined simply by the number of URM medical students engaged in such efforts.

PRIME-HEq and matriculation yield. Of the calculated models predicting matriculation yield, only that for CA-URM students saw a significant change after PRIME-HEq implementation. This model indicates that over the years, an increasing proportion of URM students who were accepted to UCSD decided to matriculate to the school. After PRIME-HEq implementation, this changed for the CA-URM subgroup, and the percent yield decreased over the subsequent years. Considering the other favorable effects of PRIME-HEq on admissions, this result seems paradoxical. It should be pointed out that this decline was only seen in the CA-URM subgroup, and this geographical effect could help explain the change in slope.

Several explanations for this decline can be conjectured. A reasonable assumption is that accepted students who do not matriculate to UCSD are simply enrolling at other schools. Thus explanations for the decreasing yield of CA-URM students center on reasons for attending other schools. Some may be choosing private institutions for economic reasons. Student fees and health insurance have increased by 40% since 2008 at UCSD (C. Hartupee, personal communication, May 29, 2013). The gap between education debt incurred at public and private medical schools has diminished, and in 2010 fewer medical students at private schools actually incurred debt (Youngclaus & Fresne, 2012). Although financial aid may influence where students decide to matriculate, work by Perna (2004) demonstrates that purely economic explanations of a student's choice to attend graduate school are incomplete, thus increased tuition and fees are unlikely to be the solitary explanation. Other accepted CA-URM students may have applied and chosen other PRIME programs. Without knowing where these students choose to enroll, it is difficult to determine how much PRIME-HEq has or has not affected CA-URM matriculation yield.

Closer examination of the data reveals that the 2011 class in particular exhibits an abnormally low matriculation yield of CA-URM students. Any particular reason for such an uncharacteristic yield would be purely speculative at this time. It is particularly intriguing that such a decline occurred one year after a racially-themed party generated protests and further hate incidents at the undergraduate campus (Garcia, Johnston, Garibay, Herrera, & Giraldo, 2011). Individuals during the 2010 application cycle would seem to be more likely to turn down acceptances due to such a charged series of events, but delayed effects cannot be discounted either. It might be enticing to reanalyze the data after removing or altering that particular time point, but I am hesitant to do so at this time, considering the limited number of observations and the ability of the methodology to account for such variations.

Implications

One of the reasons studying the relationship between PRIME-HEq and admissions is so appealing is the applicability of such research. Obviously the results of this analysis should not be generalized broadly. Models built from a single institution are unlikely to hold for others, even if they are other UC medical schools with PRIME programs of their own. After all, each PRIME cohort has its own focus, recruitment methods, and is subject to different admissions practices. But, at least for UCSD, these models make a compelling case for continued support of PRIME-HEq. If PRIME-HEq is considered successful, then it is worth entertaining notions of either scaling up the program or replicating the model at other schools.

How would increasing the size of PRIME-HEq affect URM admissions? Roughly half of all PRIME-HEq participants come from URM backgrounds. On average the cohort for each class is composed of 10 students. If the cohort were to increase in size, this may very well increase URM representation within the class. There is an impediment to such growth, however. Students in PRIME-HEq receive limited financial support to offset the cost of an extra year of training. Finding monetary support for additional students and the costs associated with expanding the program is likely to limit the size of the program to its current state.

Another form of expansion would be the adoption of the PRIME model at other medical schools. Given that the increase in URM matriculation came from out-of-state students, wider adoption of a PRIME model could negatively impact URM admissions at UCSD. PRIME-HEq could also be contributing to the dearth of URM medical students in other states. Without the educational options provided to the out-of-state URM students, it would be difficult to determine PRIME-HEq's impact on other schools.

From the national perspective there is some evidence that widespread adoption of a PRIME-like model would improve URM admissions. PRIME-HEq was associated with protecting the proportion of URM and CA-URM applicants. Increasing the proportion of URM students at this critical first step in the admissions process would presumably help address the current disparity. Additionally, there are already several schools that have longitudinal programs designed to train future physicians for underserved areas (Florence, Goodrow, Wachs, Grover, & Olive, 2007; Florence et al., 2007; Godkin, Savageau, & Fletcher, 2006; Rabinowitz, Diamond, Markham, & Hazelwood, 1999). Most of these programs are designed to train physicians for rural underserved areas, focus on primary care, and typically do not require a fifth year of training. At this point it is difficult to know what specific aspects of the PRIME-HEq program resonate with URM students and how they might differ from elements of other such programs.

To my knowledge, PRIME constitutes the first such program to be executed across a university system rather than at a single institution. This has allowed each campus to develop its own focus and capitalize on its own specific institutional strengths. This approach allows students to self-select into a program aligned with their individual aspirations while maintaining similar programmatic benefits such as a focused curriculum.

Given that Vela et al. (2010) found an increase in URM matriculation with implementation of a health disparities curriculum, it could be important to better understand how exactly curriculum influences student choice with regards to matriculation. In 2007, methods

and curriculum was one of the top five reasons for matriculating to a particular school on the matriculating student questionnaire administered by the AAMC (Castillo-Page, 2008). Across all race and ethnicity groups, a larger percentage of students rated methods and curriculum, rather than student diversity, as a top ten reason for matriculating. This connection between curriculum and medical student choice is an appealing avenue of research. Likewise, tailoring curriculum to be more appealing to certain students could greatly assist institutions in diversifying their student body.

Another important implication of this study is the relationship between out-of-state admissions and URM admissions. Overall, URM matriculation increased during a period of growth in out-of-state matriculation. This may pose another method of increasing racial/ethnic diversity in concert with other aspects of diversity such as geographic. This, of course, is controversial, since UC has the explicit mission of meeting California's educational needs, including its physician supply. In a period of decreasing public funds, UC schools have increasingly turned to out-of-state and international enrollment as a source of revenue (Hu, 2011). If increasing out-of-state enrollment does in fact increase URM enrollment, this could provide a fiscal incentive for diversity. Again, this is dependent on whether or not this association is found to persist over time and in more than a single institution.

Besides geographic diversity, racial/ethnic diversity can also be linked to socioeconomic status. In general there has been a decreasing amount of socioeconomic diversity in the American medical education landscape (Grbic, Garrison, & Jolly, 2010; Jolly, 2008). The AAMC uses family income, parental education, and parental occupation to determine socioeconomic status. Although URM students are more likely to come from lower socioeconomic backgrounds, this aspect of diversity was not explored in this study. The main reason for this omission is that evidence suggests socioeconomic background is a poor predictor of physician practice patterns (Hughes et al., 2005; Saha & Shipman, 2006). Relationships between applicants' socioeconomic status and medical school choice are not well understood. There is

some indication that students from lower socioeconomic backgrounds are more influenced by tuition prices than students from more privileged backgrounds (Greysen, Chen, & Mullan, 2011).

Considering the fact that many colleges are turning increasingly towards tuition for revenue, a closer examination of the impact this has on URM students is warranted. Attention to this practice has been given at the undergraduate level (Laura W. Perna, Finney, & Callan, 2011; Laura W. Perna et al., 2005) but has been studied much less in medical education (Greysen et al., 2011). Tuition for medical school is generally so expensive that it may not have the same effect on the choice to attend as it does at the undergraduate level. This avenue of research may be particularly insightful in trying to understand what factors influence students to pursue medicine.

The last implication to be discussed here may be even more controversial than the last. One of the more subtle results of this study was the lack of autoregression in predicting URM applications, matriculations, and matriculation yields. The absence of autoregression indicates a lack of sustained effect one year to the next exerted by the percentage of URM students in the applicant pool and matriculating class. A lack of sustained influence has particular implications with regard to how schools build a “critical mass” of minorities to ensure the benefits of diversity.

Once again dialogue has returned to define what constitutes a “critical mass” of URM students, as the Supreme Court revisits Affirmative Action with *Fisher v. University of Texas at Austin*. Nearly a decade previously in *Grutter v. Bollinger* (2003), supporters of these measures successfully argued a “critical mass” of minorities was necessary to “realize the educational benefits of a diverse student body.” Dissenters pointed to the near impossibility of measuring such a number. In addition, if establishing such a number existed, it would be legally prohibited, as it would constitute a quota. In Justice O’Connor’s opinion of the Court, she conceded that race-conscious policies must be limited in time. This implies that such policies should end when they are no longer needed. California ended such practices with Proposition 209, yet severe racial and ethnic disparities persist in education.

The finite time period of race-based Affirmative Action speaks to another definition of “critical mass” which was not argued in the courts. Another definition for “critical mass” is the minimal point at which some process is self-sustaining. With regards to URM admissions, that would indicate a time at which special consideration of race was no longer necessary to maintain the educational benefits of diversity. Focusing on the simple observation of URM matriculation alone, this perpetuation may very well manifest as an autoregressive pattern when quantified. That no such pattern was reflected in this study could indicate that either a “critical mass” has not yet been achieved, or call into question its existence under such conditions. The overwhelming evidence of the educational benefits of diversity makes a compelling case for the placement of some form of practice (Antonio et al., 2004; Chang et al., 2006; Chang, 2001; Gurin, Dey, Hurtado, & Gurin, 2002; Milem, 2003; Whitla et al., 2003). But the time at which such measures will no longer be needed should be questioned. In this limited scenario, evidence suggests that we have not yet arrived at that point.

Conclusion

As a participant in the PRIME-HEq program, I am not surprised that it has had a positive effect on URM admissions. The program encapsulates many of the reasons for entering the medical profession—helping those who need it most, being a leader, making a positive change. More URM medical students are needed in order to close the gap in representation and begin to redress current health disparities, but it is reassuring to see gains being made.

Though this study only addresses the effects of one dual degree program in underserved medicine, it helps further highlight the importance of questioning who is being taught in our medical schools. If the results of this study hold, and PRIME truly improves URM admissions, then it is not unreasonable to expect a successful public return for vulnerable populations. Perhaps the best reason for engaging in such research is summarized by Dr. Stanley S. Bergen, Jr. (2000), founding President of the University of Medicine and Dentistry of New Jersey, who stated:

Perhaps it is true, at least to some extent, that the underrepresentation of URMs in US medical schools is an unavoidable reflection of underlying racial barriers within US society. It might seem unfair to blame medical schools for a small pool of qualified URM applicants. However, such a simple argument absolves medical schools by exempting them of responsibility from the social context in which they operate. As members of a profession dedicated to caring, listening, and sensitivity, physicians may rightfully ask whether it is professionally appropriate to fail to intervene in such systematic disadvantages for certain individuals. (p. 1139)

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