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The Relationship between Demographic Background and Test Score Submission to
GRE-Optional Graduate Programs:

It’s Complicated

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Abstract

Faculty members are committed to increasing the diversity of their students attending graduate school. One strategy that has been implemented in service of this goal is making the submission of GRE test scores optional. However, almost no research has examined the relationship between student demographics and propensity to submit GRE scores. This is the first study to do so using a relatively large sample ($N > 15,000$). We studied two demographic categories that are underrepresented in many academic disciplines: Females and racial/ethnic minorities (Black/African American, Hispanic/Latino, Multiracial, Native American/Pacific Islander applicants). Given the prominence of international students in U.S. graduate programs we also examined their presence in pools of GRE scores and nonsubmitters. Analyses were conducted at the overall sample level for applied, admitted, and enrolled students, and also master's and doctoral programs in five academic disciplines. International students comprised larger portions of GRE score submitters than nonsubmitters among applied, admitted, and enrolled students. Members of racial/ethnic minorities comprised a larger percentage of GRE score nonsubmitters than submitters among applied but not admitted or enrolled students. Additionally, the 95% confidence intervals for female score submitters and non-submitters overlapped. More fine-grained analyses revealed additional differences: Racial/ethnic minority applicants were less likely to submit scores to humanities master's, and STEM doctoral, programs. International applicants were more likely to submit scores to social sciences, nursing, and STEM master's, and humanities and STEM doctoral, programs. Confidence intervals overlapped for all other comparisons. Descriptive trends varied across demographic groups, disciplines, and degree levels. Our results suggest that GRE-optional policies are neither a

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panacea nor a poison for graduate program diversity and that the effects of these policies need to be considered at fine-grained levels of analysis (e.g., academic discipline, degree level).

For Review Only

Introduction

Increasing the diversity of students attending graduate programs in the United States is an urgent concern. A multitude of reports (Kent & McCarthy, 2016; Masterson, 2019), popular and academic articles (e.g., Cassuto, 2019; Griffin & Muñiz, 2011; Flaherty, 2019; Thompson & Campbell, 2013), books (e.g., Cassuto, 2015; Posselt, 2016, 2020), and reports from academic societies (Biomedical Engineering Society, 2020; Council of Graduate Schools, 2019; Monet, 2018) and graduate programs (e.g., The Trustees of Princeton University, 2020; University of Illinois Board of Trustees, 2020) affirm widespread support of, and commitment to, enhancing the representation of members of diverse¹ groups in the United States' higher education system (cf. Council of Graduate Schools, 2010).

A wide variety of approaches have been suggested and implemented with the goal of increasing the representation of people from diverse backgrounds in graduate programs (Michel et al., 2019; Rogers & Molina, 2006; Vasquez et al., 2006). In a notable instance, the National Science Foundation (NSF, 2014) proposed an expansive array of tactics for increasing the presence of members of underrepresented groups (e.g., Black/African Americans, females) in science, technology, engineering, and mathematics (STEM) graduate programs. These approaches ranged from funding individuals from underrepresented groups to visit STEM labs to creating research institutes dedicated to studying and providing evidence-based recommendations for increasing diversity. Other strategies currently being carried out (e.g.,

¹Diversity can be defined in different ways and its meaning can vary across disciplines (Cahn, 2015; Lee Baker et al., 2016). Nonetheless, diversity is frequently defined in terms of currently or historically underrepresented groups (e.g., American Academy of Arts and Sciences, 2020; NSF, 2019; National Institutes of Health, 2020) and, accordingly, for this study we defined diversity in terms of the demographic categories of gender (female) and frequently underrepresented racial/ethnic minority groups (e.g., Black/African American, Native American/Pacific Islander, Hispanic/Latino).

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Wilson et al., 2018) include building partnerships between graduate programs and undergraduate institutions to enhance the recruitment pipeline and identifying potential applicants at diversity conferences (e.g., Society for the Advancement of Chicanos and Native Americans in Science [SACNAS]). Also noteworthy are programs dedicated to providing individuals from underrepresented groups with the experiences, opportunities, preparation, and support that will enhance the probability that they will undertake and complete graduate educations. Such programs include the City University of New York’s Pipeline Program (City University of New York, 2020), Mellon Mays Undergraduate Fellowship Program (Andrew W. Mellon Foundation, 2019), McNair Scholars Program (U. S. Department of Education, 2020), Meyerhoff Scholars Program (University of Maryland, Baltimore County, 2020), and bridge programs such as those at Columbia University, Fisk and Vanderbilt Universities, and a partnership of over 50 California campuses (Rudolph et al., 2019), in addition to bridge programs funded by the American Physical Society (Hodapp & Sparks Woodle, 2017).

Changes to the components that traditionally make up graduate applications (e.g., personal statement, research statement), in addition to how evidence from those applications is weighed during decision-making, have also been suggested as a means for increasing graduate student diversity, with these innovations generally being subsumed under the label “holistic review” or “whole file review” (Kent & McCarthy, 2016). The essence of holistic review is that the entirety of applicants’ files is reviewed by faculty members or other admissions personnel; cuts based on quantitative metrics, such as scores on the Graduate Record Examination (GRE) General or Subject tests or undergraduate grade point average (UGPA), are not made. By ensuring that applicants’ entire files are read, promising applicants who might score below hard quantitative cuts (and thus be automatically rejected) can be identified, as components of their

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3 applications that might otherwise remain unexamined (e.g., letters of recommendation, personal
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5 essay, resume/curriculum vitae) may reveal strengths, skills, and qualifications (e.g., intra- and
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7 interpersonal attributes, relevant experience) that suggest the applicant will likely be successful if
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9 admitted to the program (Rudolph et al., 2019). Some programs have also opted to include
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11 optional diversity essays in their application materials. In these essays, applicants are requested
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13 to write about how their life experiences will allow them to contribute to the social, intellectual,
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15 or cultural diversity of their chosen university and academic discipline, along with how their
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17 skills, experiences, and/or willingness to engage in relevant activities would enhance diversity
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19 and equity efforts (Michel et al., 2019). Ultimately, holistic review is intended to ensure all
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21 aspects of an applicant's potential for success are given consideration in graduate admissions
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23 decision-making.
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29 One application-related strategy intended to increase the diversity of graduate students
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31 that has gained attention, especially in the wake of challenges induced by the COVID-19
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33 pandemic (Millar, 2020), is the practice of making submission of scores on GRE tests optional
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35 (Langin, 2019). A major motivator of this policy the fact that, while GRE scores are associated
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37 with aspects of performance in graduate school (Klieger et al., 2014; Schwager et al., 2015;
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39 Zimmermann et al., 2018), they also evince mean differences among some demographic groups;
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41 females, members of often underrepresented racial/ethnic groups (e.g., Black/African American,
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43 Hispanic/Latino), and people from lower socioeconomic backgrounds tend to score lower on
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45 these tests, on average, relative to males, whites, and people from socioeconomically advantaged
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47 backgrounds (Educational Testing Service [ETS], 2019b; Schwager et al., 2015). These group
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49 differences in average scores are sometimes interpreted as evidence for the GRE being biased
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51 against members of those groups (e.g., Langin, 2019). When such differences appear on
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standardized assessments, extensive effort should be expended to investigate their sources (American Educational Research Association [AERA], American Psychological Association, & National Council on Measurement in Education, 2014) – but those differences are not inherently indicative of bias. The *Standards for Educational and Psychological Testing* reject equating group differences in mean test scores with test bias: “the *Standards*’ measurement perspective explicitly excludes one common view of fairness in public discourse: fairness as the equality of testing outcomes for relevant test-taker subgroups... group differences in [testing] outcomes do not in themselves indicate that a testing application is biased or unfair” (AERA et al., 2014, p. 54).

Although average demographic group differences in GRE scores do not constitute de facto evidence for the GRE’s unfairness, they can be problematic for promoting diversity in graduate programs – particularly when cut-scores based on GRE performance are set during the graduate admissions process, a practice in direct opposition to guidelines and recommendations that have been in place for decades (Briel et al., 1993; Carnegie Foundation for the Advancement of Teaching, 1941; ETS, 2015, 2018, 2019a). When hard cut-scores are employed, a greater percentage of applicants from underrepresented groups – due to the average differences in their scores in aggregate – will not meet the required threshold compared to applicants from majority groups, resulting in their automatic rejection and setting the stage for the continued underrepresentation of people from similar backgrounds in some graduate disciplines. Moreover, the use of cut-scores, combined with average group differences in GRE scores, means that a smaller percentage of individuals from underrepresented groups will be given the chance to be considered based on other merits of their applications (e.g., peer-reviewed presentations & publications, relevant coursework, research experience; Hughes et al., 2019) – many of which

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may outweigh their GRE performance – given they will be removed from the applicant pool in one of the first stages of the graduate decision-making process.

A second rationale for making the GRE optional is that the cost of the GRE may represent a financial burden for some individuals. Even though partial fee waivers are available for those who demonstrate financial need, these waivers may not be enough to alleviate the financial challenge for some. Further, the cost bears directly upon those of lower socioeconomic status, who are disproportionately from racial/ethnic minority groups (e.g., Black/African American, Hispanic/Latino) (Davis et al., 2013; Williams et al., 2016); the extent of this economic hardship is systematically – and greatly – underestimated by members of the American public (Kraus et al., 2019). Adding to this burden is the fact that more affluent test-takers can afford to move beyond freely available GRE practice materials to more, and more extensive, test preparation programs.

Making submission of GRE test scores optional when applying to graduate school mirrors a similar trend occurring at undergraduate institutions (Rhodes, 2018), where test-optional policies have been a subject of discussion and debate for a longer period of time than test-optional practices at the graduate level. Nonetheless, relatively few empirical studies of the relationship between test-optional policies and the composition of undergraduate applicant pools and enrolled student bodies have been conducted (Sweitzer et al., 2018). The results of those studies have been mixed. Empirical case studies of specific institutions – often liberal arts colleges – have found that enacting test-optional policies is accompanied by increased enrollment of diverse individuals, including racial/ethnic minorities and people from less privileged socioeconomic backgrounds (Maguire, 2018; Robinson & Monks, 2005). Syverson et al.'s (2018) study of 28 institutions, including, but not limited to, liberal arts colleges, also found

an overall beneficial effect of various types of test-optional policies (e.g., automatic admission if a threshold high school GPA was attained) on diversity.

Other studies have concluded that undergraduate test-optional policies have little to no effect on diversity. Belasco et al. (2015) studied 180 liberal arts colleges’ admissions data from 1992 to 2010 and concluded that the growth of diverse enrollments at test-optional colleges did not differ substantively from those of test-requiring colleges. Saboe and Terrizzi (2019) analyzed data from the Integrated Postsecondary Education Data System (IPEDS) from 2009 to 2014 (1,649 test-requiring & 127 test-optional institutions) and also concluded that test-optional policies did not substantively impact student diversity; Sweitzer et al.’s (2018) study using propensity score-matching reached the same result. Based on this evidence, and the results of its own internal studies, the University of California’s Standardized Testing Task Force (STTF) did not recommend the UC System go test-optional at the current time (Systemwide Academic Senate, University of California, 2020). Underscoring how different institutions have different perspectives and needs, however, a committee devoted to studying the potential effects of test-optional policies at DePauw University (Wilkerson et al., 2019) reviewed much of the same material as the STTF and recommended that DePauw institute a test-optional admissions policy.

If the impact of undergraduate test-optional policies in the United States has been understudied (cf. Sweitzer et al., 2018), their association with student diversity at the graduate level is nearly non-existent. We are aware of only one study that examined the presumed impact of a GRE-optional policy on graduate student diversity. Cahn (2015) interviewed faculty members and others directly involved in graduate admissions at 30 health programs that did not require the submission of GRE scores. When queried as to how successful they perceived their efforts to enroll diverse classes had been, 20% of interviewees responded “successful”, 13%

responded “somewhat successful”, and 44% “not successful” (23% did not answer). Among the programs whose personnel reported they were successful in enrolling diverse student bodies, 83% reported engaging in deliberate recruitment strategies and outreach or by giving greater consideration to applicant characteristics that tend to favor those from underrepresented backgrounds (e.g., overcoming hardship). Cahn (2015) concluded that test-optional policies at the graduate level are unlikely to consistently lead to more diverse classes unless they are married with other techniques, such as proactive outreach and greater consideration of the strengths of members of underrepresented groups (cf. Frankenhuis & Nettle, 2020; Maton & Hrabowski III, 2004).

Cahn (2015) is laudable in studying test-optional policies at the graduate program level, but too much weight cannot be afforded to any single study’s findings, especially when its sample size is small. It is important to emphasize that this study examined only faculty members’ perceptions of student diversity, not the actual numbers of students from diverse backgrounds enrolled. Further, the investigation focused on a single discipline (health) – and a discipline in which the definition of “underrepresented” may differ from how it is often framed (e.g., males are underrepresented in some health fields). Especially in light of recent failures of replication in multiple scientific disciplines (Baker, 2016; Maxwell et al., 2015) and exhortations to conduct studies using large samples (Anderson et al., 2017), the relationship between having test-optional policies at the graduate level and their association with the diversity of graduate students is in need of further empirical investigation. The goal of this study is to conduct such an investigation, using data from multiple programs provided by two graduate schools.

As the first study of the relationship between test-optional policies and student diversity at the graduate level featuring relatively large sample sizes, we pose a research question rather

than form hypotheses. This approach is appropriate for the beginning, exploratory stages of research inquiry (McCall & Bobko, 1990; Tukey, 1977, 1980) and also avoids the danger of overgeneralizing findings derived from undergraduate samples by making predictions based upon them (cf. Simons et al., 2017).

Research Question: What are the differences in the background characteristics (i.e., race/ethnicity, gender, international status) of GRE General score submitters and nonsubmitters to test-optional graduate programs?

We conduct our analyses both at the level of graduate school applicants overall and also at three additional levels, reasoning that the profiles of students may differ systematically according to the following segments: degree level (master’s or doctoral), program discipline, and student status (applicant, accepted, or enrolled).

Method

Sample

An initial pool of 10 universities was contacted about providing data to participate in a study about GRE-optional admissions policies. This pool was identified by members of the GRE Board, GRE Technical Advisory Committee (TAC), and the Council of Graduate Schools (CGS). Data were requested for applicants of all GRE-optional programs over the past five years. These data were: Demographic background (gender, race/ethnicity, international status), whether a GRE score was submitted, the graduate program and degree level applied to, and whether the applicant was ultimately classified as accepted/rejected or enrolled.

Of the initial pool of 10 schools, five eventually submitted data, however one was only for a business program where the GRE was one of two required exams and thus was not truly test optional. Another school provided data only on admitted students and part of its GRE-optional

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pool included students who chose to waive the GRE if they received their undergraduate degree from the same school. A third school did not provide complete information about the students who did not submit GRE scores. Thus, two universities ultimately provided the five years of data analyzed for this investigation. According to the Carnegie Classifications (Carnegie Foundation for the Advancement of Teaching, Indiana University Center on Postsecondary Research, 2017), both schools are considered large, public, doctoral universities with very high research activity. Neither school was financially compensated for the supply or analysis of its data.

School personnel at these two institutions identified programs as being GRE-optional. Some programs that were identified as GRE-optional were in fields such as business where the GRE was one option for providing standardized test scores (e.g., Graduate Management Admission Test [GMAC] or GRE), but submitting scores for *some* test was not optional. Those programs were removed. Also, a review of application requirements for each program (found via institutional & program websites) identified some programs where the GRE was only waived for a subset of applicants depending on other credentials (such as a minimum undergraduate GPA, years of experience in the field, or already holding an advanced degree). Data from these programs, too, were removed.

Analytic Strategy

In several cases we aggregated the data to yield larger sample sizes, as research relying on small sample sizes is more likely to generate inaccurate estimates of the effect(s) under investigation and yield results that fail to replicate (Fraley & Vazire, 2014). First, we combined the datasets provided by the two institutions – not only for statistical reasons, but also to preserve the anonymity of the institutions. The similarity of these two institutions (large, public, research-intensive) provided further justification for combining the datasets. Second, due to the relatively

small numbers of Black/African American, Hispanic/Latino, Multiracial, and Native American/Pacific Islander applicants (see Table 1), we combined their members in the dataset to form an “Underrepresented Racial/Ethnic Group” (URG) category.² Although this approach obscures potential difference in results at the level of these subgroups, sample sizes were too small to conduct individual analyses and could have led to biases in our interpretation of the results. Additionally, the larger sample sizes resulting from aggregating the subgroups served to increase statistical power, which would otherwise have been very low due to the small sample sizes for some groups (e.g., across all doctoral programs there were 68 Hispanic/Latino Black/African American & seven Native American/Pacific Islander applicants). Due to the ambiguity entailed by the racial/ethnic backgrounds of individuals from Unknown/Unspecified groups, we did not include them in our analyses. Third, based both on the data available and the disciplinary categories used by CGS (e.g., Okahana & Zhou, 2019) we grouped programs – and thus participants – into five inductively created academic fields of study: Fine arts, humanities, nursing, STEM, and social sciences.³ This, again, was done to improve sample sizes in order to conduct statistical analyses (e.g., there were only 38 and 24 applicants to master’s and doctoral programs in plant science, respectively, 57 applicants to master’s programs in dance, & 50 applicants to doctoral programs in nursing).

We chose not to focus on traditional statistical significance testing. Overreliance on this practice has been criticized for decades (e.g., Morrison & Henkel, 1970), but has come under particularly intense scrutiny over the past few years (e.g., McShane et al., 2019). Instead, we

²Asian-Americans were not included in the URG group as their representation among graduate or professional degree-holders is approximately equal to their presence in the general US population (White House Initiative on Asian Americans and Pacific Islanders, 2012).

³Some organizations consider nursing to be a STEM discipline (e.g., U.S. Department of Veterans Affairs, 2020) while others do not (e.g., Economics & Statistics Administration; Davidson, 2020). Consequently, we created separate “nursing” and “STEM” categories.

computed 95% confidence intervals for the percentages of interest. Confidence intervals are beneficial in that they provide an estimate of the range of values that are hypothesized to cover the population parameter of interest and allow for a quick, intuitive visual interpretation of the results (Cumming, 2009). When presented graphically, the greater the bars representing the confidence intervals for target values overlap, the less confident the viewer can be that the target values differ.

We limited the majority of our analyses and interpretations to graduate program applicants, rather than to accepted and enrolled students. This was due not only to the small sample sizes of these groups but also because of the interdependence introduced by the fact that both the accepted and enrolled pools were ultimately drawn from the initial applicant pool. Consequently, we did not compute confidence intervals for these samples. However, we do present information about the raw percentages for these groups across the various programs in the Supporting Information available online. Further, post hoc, we probed for the possibility of an interaction of demographic background (i.e., female, URG, international), submission/lack of submission of GRE scores, and acceptance/rejection to graduate school. To do this we first examined the cell counts of female, international, and URG applicants who did and did not submit GRE scores according to whether they were accepted or rejected, then compared those counts to their expected values based on the total data in the sample.

In the following results section, we first present basic descriptive statistics for the sample overall. Next, we examine the confidence intervals for gender, URG, and international student demographic categories, computed separately for applicants, accepted, and enrolled samples, respectively, and across program degree levels and disciplines. Then, we explore the confidence intervals for applicants belonging to these three demographic categories, broken out by discipline

and degree level. Finally, we survey observed versus expected cell counts to identify potential three-way interactions among demographic background, GRE score submission status, and admissions decision outcome. Throughout the results, it should be assumed that the 95% confidence intervals for the percentages discussed overlapped, unless noted.

Results

Basic information about the sample is provided in Table 1. The total sample size of applicants to GRE-optional programs was 15,041. This number comprises approximately 13% of the total number of graduate applicants (to GRE-option *and* GRE-requiring programs) to the two institutions across the five-year study period. Across the two institutions 39 programs were represented (seven for fine arts, nine for humanities, 11 for social sciences, two for nursing, and 10 for STEM). As demonstrated in Table 1, when applying to GRE-optional programs, the great majority of individuals from all demographic categories studied did not submit GRE scores. Overall, approximately 85% of applicants did not submit scores across all disciplines and degree levels. Moreover, the 95% confidence intervals for the percentages of nonsubmitters within groups comprising each of the three major demographic categories (gender, race/ethnicity, international status) largely overlapped. Males and females submitted scores at a nearly an identical rate (15% vs. 14%). White and URG applicants submitted GRE scores at near-identical rates (13% vs. 13%), while Asian-American applicants were more likely to submit GRE scores than either of those groups (17%). The 95% confidence intervals for the percentages of GRE score non-submitters among whites and URG members overlapped, while the confidence interval for Asian-Americans did not overlap with those of either of white or URG applicants. The confidence intervals for domestic and international applicants also did not overlap, with international applicants submitting at a higher rate.

Table 1 also demonstrates that there were disparities in the numbers of applicants from the various demographic groups studied. There were nearly twice as many female as male applicants and more than twice as many white applicants as applicants who were a member of a URG. Although members of the demographic groups studied did and did not submit scores at similar rates, due to imbalances in applicant numbers across categories the percentages representing these rates do not portray the extent to which applicant, accepted, and enrolled pools were actually composed of students from different backgrounds. For instance, approximately 86% of females and 85% of males did not submit GRE scores – but as females comprised approximately 65% of the total sample, 65% of nonsubmitters *and* submitters were female. Similarly, Asian-American applicants comprised 8% of the total sample and 17% submitted GRE scores – resulting in Asian-Americans comprising 34% of the applicant pool submitting GRE scores (Table 1 & Figure S1).

The two preceding examples demonstrate that the great disparities in total sample sizes per demographic group resulted in the makeups of the pools of submitters and nonsubmitters across applied, accepted, and enrolled students being different than might be expected based on the small differences in GRE (non)-submission rates across those groups. Rather than solely examining each demographic group's percentages of score submitters and nonsubmitters, another approach to analyzing these data was to examine the total pool of submitters and the total pool of nonsubmitters, then evaluate the presence of the various demographic groups within each of those pools (e.g., the percentage of females within a pool of submitters & the percentage of females within a pool of nonsubmitters). As this approach provides information about submitters and nonsubmitters per demographic category *and* accounts for differences in sample sizes across groups, we opted for this strategy when conducting the majority of our analyses.

General Findings

As seen in Figure 1, across disciplines and degree levels, females comprised 65% of both the applicant pool submitting GRE scores and the applicant pool not submitting GRE scores. Similarly, among graduate program applicants, URG members comprised 17% (95% CI [16%, 18.7%]) of the pool of submitters and 20% (95% CI [19%, 20%]) of the pool of nonsubmitters, with the confidence intervals not overlapping. Confidence intervals for the percentages of the applicant pool composed of international GRE nonsubmitters (25%; 95% CI [24%, 26%]) and international GRE submitters (34%; 95% CI [32%, 36%]) also did not overlap.

Among accepted applicants who did not submit GRE scores, the percentage of females (70%) exceeded that among accepted applicants who did submit scores (65%), with the same trend observed for URG members (22% vs. 21%). Further, the 95% confidence interval for the percentage of accepted GRE score submitters who were of international origin (19%; 95% CI [16%, 21%]) did not overlap with the confidence interval for the percentage of international students that comprised the pool of accepted nonsubmitters (10%; 95% CI [9%, 11%]).

Females comprised a larger percentage of enrolled applicants who did not submit GRE scores (69%) than those that did submit scores (64%). The percentage of enrolled score submitters who were members of a URG (24%) exceeded that of individuals from a URG among nonsubmitters (22%). Sixteen percent of enrolled score submitters were international students (95% CI [12%, 21%]), compared to 9% of international students within the nonsubmitter pool (95% CI [8%, 10%]), the confidence intervals not overlapping.

Findings by Academic Discipline and Degree Level

Fine arts. Females comprised more than half of the applicant pool to master’s programs (see Figure 2) but, compared to males, constituted a minority of applicants to doctoral programs

in the fine arts. For programs offering either type of degree, females who did not submit scores were more likely to be accepted and enroll (Figure S2).

Members of URGs made up a small percentage of applicants to fine arts programs at both the master's and doctoral levels, comprising a maximum of 22% of any applicant pool. URG members were more likely to be accepted to, and enroll in, master's fine arts programs if they submitted GRE scores, but the trend was the opposite for doctoral programs (Figure S3). International students represented approximately 25% of the master's, and 45% of the doctoral, applicant pools in fine arts. International applicants were more likely to be accepted to and enroll in fine arts programs if they did not submit GRE scores, regardless of degree level (Figure S4).

Humanities. Females comprised the majority of applicants to master's and doctoral programs in the humanities (Figure 2). Female score submitters were more likely to be accepted to humanities master's programs, but less likely to enroll in them, compared to GRE score non-submitters. For doctoral programs, females who did not submit GRE scores were more likely to be accepted and enroll (Figure S5).

Members of URGs made up less than 20% of the applicant pool across degree levels in the humanities. For master's humanities programs, the 95% confidence interval [8%, 14%] for the percentage of score submitters who were URG members (11%) did not overlap with that for those not submitting GRE scores (16%) [14%, 17%].⁴ URG applicants were more likely to be accepted and enroll in humanities programs for both degree categories if they did not submit GRE scores (Figure S6).

⁴The upper bound for the 95% confidence interval for URG score submitters was 13.94% while the lower bound for URG members who did not submit scores was 14.41%.

Across GRE score submitters and nonsubmitters, international students comprised from 46% to 68% of the applicant pools of humanities programs. For doctoral humanities programs, the confidence intervals for the percentages of the applicant pool composed of international GRE score nonsubmitters (68%; 95% CI [65%, 71%]) and international GRE score submitters (46%; 95% CI [41%, 50%]) did not overlap. Across master’s programs, international nonsubmitters were more likely to accept and enroll, while for doctoral programs GRE score submitters were more likely to be accepted and approximately equally likely to enroll as nonsubmitters (Figure S7).

Social sciences. Females were more likely than males to apply to both master’s (> 75%) and doctoral (> 60%) programs (Figure 3). Female nonsubmitters were more likely to be accepted and enroll in master’s programs, but the trend was the opposite for doctoral programs (Figure S8). Members of URGs made up approximately one-third to one-quarter of social sciences applicants across degree levels, with URG GRE score submitters more likely to be accepted to and enroll in social sciences doctoral programs. We observed the opposite pattern for master’s programs (Figure S9).

The 95% confidence interval [19%, 24%] for the percentage of master’s level GRE score submitters from outside the U.S. (21%) did not overlap with that of the percentage of those who did not submit GRE scores (7%) [7%, 8%]. International nonsubmitter applicants were more likely to accept and enroll in master’s programs, while no international applicants (submitters or nonsubmitters) were accepted to social sciences doctoral programs (Figure S10).

Nursing. Females were more likely to apply to nursing programs compared to males, comprising at least 75% of the applicant pool across master’s and doctoral programs (Figure 4). For master’s programs, females who submitted scores were more likely to be accepted – but not

enroll – while submitters were more likely to both be accepted to and enroll in nursing doctoral programs (Figure S11). Members of URGs comprised less than 20% of the applicant pool across nursing programs. Individuals classified as a member of a URG who did not submit scores were more likely to be accepted to and enrolled in nursing master's programs than GRE score submitters, while they were more likely to be accepted to nursing doctoral programs, but less likely to enroll in them (Figure S12).

There was a great disparity in the number of international applicants applying to master's versus doctoral nursing programs, with international applicants comprising at most 2% of the applicant pool for master's programs, but up to 27% of applicants for doctoral programs. Among master's programs, no applicants submitted GRE scores, compared to 2% (95% CI [1%, 4%]) of the pool of nonsubmitters being composed of international applicants, with the confidence intervals not overlapping. Thirty-three percent of score nonsubmitters to master's programs were accepted and 22% enrolled (Figure S13), while for doctoral nursing programs international nonsubmitters were more likely to be accepted and enroll than score submitters.

STEM fields. Females comprised approximately half of the applicant pool for STEM master's programs and over 60% of the applicant pool for STEM doctoral programs (Figure 4). Female nonsubmitters were more likely to be accepted to and enrolled in both STEM master's and doctoral programs (Figure S14).

URG members made up 5% to 10% of the applicant pools of master's STEM programs. Fourteen percent (95% CI [6%, 23%]) of the applicant pool for STEM doctoral programs that did not submit GRE scores was composed of URG members – compared to zero URG members submitting GRE scores to these programs. Individuals from a URG who were score

nonsubmitters were more likely to be accepted to and enroll in both STEM master’s and doctoral programs than URG score submitters (Figure S15).

There was a great disparity in the percentage of international applicants submitting versus not submitting GRE scores to STEM programs. Among STEM master’s applicants, the 95% confidence interval for the percentage of GRE score submitters who were international students (52%) [45%, 59%] did not overlap with that for those international students not submitting scores (16%) [13%, 20%]. Similarly, for applicants to STEM doctoral programs who submitted GRE scores, the 95% confidence interval for the percentage comprised by international students (55%) [33%, 77%] did not overlap with the interval for the percentage of GRE score nonsubmitters composed of international students (10%) [2%, 17%] – but this finding should be interpreted cautiously in light of the divergent sample sizes for submitters ($n = 20$) and nonsubmitters ($n = 63$). For both STEM master’s and doctoral programs, international GRE score nonsubmitters were more likely to be accepted and enroll (Figure S16).

Post Hoc Interaction Probes

To investigate the possibility of three-way interactions among demographic background, GRE score submission status, and admissions outcome we compared observed versus expected cell counts for female, international, and URG applicants. We made these comparisons at the broadest level (i.e., across all degree levels & programs), in order to preserve sample sizes. As we did not make hypotheses about potential discrepancies between observed and expected counts we did not test those we discovered for statistical significance. It is important to note that expected frequencies are based on the current data and are estimates only; these findings should be treated with particular caution.

Among female applicants, the number of individuals submitting GRE scores who were accepted to a graduate program ($n = 438$) was smaller than expected ($n = 462$). Accordingly, the number of rejected female applicants who submitted GRE scores ($n = 968$) exceeded expectations ($n = 953$). These discrepancies were equal to .2% and .7% of the total accepted and rejected pools (i.e., GRE submitted & not submitted), respectively.

Among applicants who were members of a URG, the number of applicants who submitted GRE scores and were accepted was nearly identical to expectations (139 vs. 138). For GRE score submitters that were rejected, there was a gap between observation and expectation, with 232 applicants denied admission, compared to 244 expected to be (equivalent to .7% of the total rejected pool).

Finally, across international applicants, 124 who submitted GRE scores were accepted to graduate programs, compared to an expected 76. This disparity equaled 8.5% of the total pool of accepted students. GRE score submitters were also more likely to be rejected than expected (605 vs. 505), equal to 2.9% of the sample of applicants denied admission. This reflects the fact that the percentage of admitted international applicants (14%), overall, was approximately one-third that of domestic applicants (39%).

Discussion

In the data studied from schools not requiring the GRE, the great majority of applicants did not submit GRE scores and the raw percentages of individuals making this decision varied relatively little across multiple demographic categories. Across all demographic background categories, disciplines and degree levels, and applied, accepted, and enrolled samples, only four major differences (i.e., nonoverlapping CIs) were observed, with three found among international applicants. Across applied, accepted, and enrolled groups, international GRE score

submitters comprised a larger percentage of the score submitter sample than they did the score nonsubmitter sample. Additionally, the confidence intervals for the percentages of GRE score submitters and nonsubmitters did not overlap among applicants who were members of a URG, with the percentage of nonsubmitters exceeding that of submitters. Confidence intervals for female score submitters and nonsubmitters overlapped among the overall applied, accepted, and enrolled groups.

Implicitly averaging across disciplinary areas and degree levels can obscure important differences, and there were seven instances of non-overlapping confidence intervals for the percentages of submitters and nonsubmitters when more fine-grained analyses were conducted. Two of these instances occurred among URG applicants: Humanities master’s degree programs and STEM doctoral degree programs. The remaining five occurrences were among international applicants: Social sciences, nursing, and STEM master’s degree programs and humanities and STEM doctoral degree programs. In all three instances URG members were less likely to submit GRE scores while international applicants were more likely to submit scores to social sciences and STEM master’s programs and STEM doctoral programs and less likely to submit scores to humanities doctoral programs and nursing master’s programs.

Examining percentages alone (i.e., not making inferences to a larger population) reveals further complexities. For example, even within single disciplines trends for the same demographic category could vary: Females were less likely to submit scores to STEM doctoral programs and more likely to submit scores to STEM master’s programs – but this same trend was reversed for female applicants to nursing programs. Similarly, international applicants were more likely to submit scores to social sciences master’s programs but less likely to submit scores to social sciences doctoral programs.

Another layer of complication is added when attempting to interpret trends for accepted and enrolled students, with multiple contradictory findings sometimes being present within the same discipline. For example, individuals from a URG were more likely to be accepted to and enroll in nursing master's programs when they submitted GRE scores – yet when it came to nursing doctoral programs, URG members were more likely to be accepted if they submitted GRE scores, but more likely to enroll if they did not submit GRE scores. Extreme caution must be exercised when examining the results for accepted and enrolled students, as these percentages were not independent (being derived from the same initial pools of applicants) and the sample sizes were sometimes very small. For example, the total number of females who applied to social sciences doctoral programs was 40 – with 24 ultimately being accepted and enrolled. Similarly, and irrespective of GRE submission status, there were only 55 applicants identifying as being a member of a URG to STEM master's programs (32 enrolled) and nine URG applicants to STEM doctoral programs (eight enrolled). In such cases the addition or subtraction of even a few members of a demographic category submitting or not submitting a GRE score could greatly alter the percentage of submitters and nonsubmitters within each category.

Finally, our post hoc investigations of possible interactions among demographic category, GRE submission status, and admission decision did not yield definitive conclusions (nor could they, as we did not test for statistical significance). Observed counts for each of the three demographic groups did deviate from expectations, but those deviations, relative to the size of their relevant applicant pools, did not exceed 3%. The one exception was the number of international students accepted who submitted GRE scores, as 48 more applicants were accepted than predicted – equal to 8.6% of all international students admitted.

Implications

There was an overall trend toward international applicants being more likely to submit GRE scores and applicants from URGs being less likely to submit GRE scores, but these trends did not always hold for individual disciplines or even master’s versus doctoral degree levels within the same disciplines; the relationship between demographic background and GRE submission is a complicated one. Our results suggest that making the GRE optional is neither a panacea nor a poison for graduate student diversity and that program faculty should take into account – at the very least – degree level and academic discipline before deciding to make the submission of GRE scores optional, as the results could differ substantially depending on those factors alone.

Second, although members of all academic disciplines are concerned with the diversities of their student bodies, there is particular concern among members of STEM disciplines regarding diversity (e.g., NSF, 2014, 2019). Members of URGs favored not submitting scores to doctoral programs in STEM disciplines but did not differ in their propensity to submit scores to STEM master’s programs, while the confidence intervals for female STEM applicants overlapped for both master’s and doctoral programs. International applicants favored submitting GRE scores to STEM master’s and doctoral programs. Even in these disciplines which have devoted substantial resources and evoked an urgent need to diversify their student bodies, results were not wholly consistent.

Finally, although an important motivation for making the submission of GRE test scores optional is to encourage diversity, in the current dataset there were over twice as many White applicants as Black/African American, Native American/Pacific Islander, Hispanic/Latino and Multiracial applicants – combined. Despite the data having been gathered across two large institutions over a timespan of three to five years, the number of URG applicants to some

disciplines was often very small. For example, there were only 72 members of URGs who applied to nursing master's programs and 20 who applied to nursing doctoral programs suggesting that, on average, there were only 14 and four URG applicants to those program types per year, respectively. It is possible that programs comparable to those studied here that do require GRE scores be submitted evince even smaller numbers of applicants hailing from URGs – but in an absolute sense the number of URG applicants among these GRE-optional programs is not large.

To increase the number of URG applicants, graduate programs may have to do more than make submitting GRE scores be optional – or employ a different strategy – echoing Cahn (2015), who found that test-optional graduate admissions officials most pleased with their programs' diversity employed a wide variety of tactics beyond merely not requiring the submission of GRE scores. Given the long-standing, and current, state of many aspects of U.S. society this divergence in graduate application rates between whites and members of URGs should not be surprising, and there are many overlapping reasons to potentially explain it (e.g., experiences of prejudice & discrimination as undergraduates, differential attainment of college degrees across demographic groups, fewer financial resources, sparser social networks) – but the mere fact that there are so many viable reasons for this phenomenon also underscores how challenging it is to remediate.

Limitations and Future Directions

This investigation was not of an experimental nature and cannot support causal inferences. We were only able to examine the association between various demographic backgrounds and the degree to which members of those groups comprised submitter and nonsubmitter pools – not make comparisons of the demographic profiles of applicants between

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GRE-optional and GRE-requiring programs or before and after a GRE-optional policy had been instituted. Stronger inferences could be made in future investigations by matching GRE-optional and GRE-requiring graduate programs on many characteristics (e.g., funding availability, ranking, size) and comparing the demographic compositions of their applicant pools and enrolled student bodies. Future research would also benefit from exploring the demographic compositions of applicant and enrolled student pools prior to programs adopting GRE-optional policies and then afterward, to make inferences about the influence of the policy change on differences in the compositions of those pools (if any). Investigations of this sort should consider examining the demographic make-up of applicants and enrollees multiple years after programs have adopted GRE-optional policies, as the undergraduate test-optional literature (e.g., Saboe & Terrizzi, 2019) suggests that many programs experience only a short-term a rise in applications after the policy change is made. Studies of this kind will also have to carefully take into account whether additional recruitment strategies (e.g., online announcements, speaking engagements, recruiting fairs) are enacted concurrently with implementing the GRE-optional policy, as the effects of those strategies would be confounded with those of the test-optional policy itself.

Further investigation of the impact of GRE-optional policies should sample a wider array of institutions, as findings derived from two large, public, doctoral universities with very high research activity may not generalize to institutions that vary along any or all of those characteristics. Indeed, simply attempting to replicate these findings using data from other universities of a similar type should be a priority. Larger sample sizes in terms of program types (degree level & discipline) and demographic groups would also be beneficial, as they would allow for more stable statistical estimates and also for disaggregation of broader groups into more fine-grained categories (e.g., “URG status” into specific racial/ethnic groups,

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“international” into countries of origin, which could reveal even more nuanced trends than the present investigation uncovered. Posing hypotheses about interactions among demographic background, GRE score submission, and admission decision and then testing them statistically would also further this line of research.

A great deal of effort should be expended in attempting to understand why students do and do not submit GRE scores. For example, do many students simply not take the GRE and thus plan to only apply to programs that do not require the submission of GRE scores or do they take the GRE and apply to a mixture of optional and non-optional programs? Among students who do take the GRE, how do they make the decision to submit or not submit scores and does the reasoning process differ across demographic categories (e.g., female vs. male) and program discipline (e.g., humanities vs. STEM)? What inferences do potential applicants make about programs (e.g., atmosphere/climate, competitiveness, difficulty) based on the fact they do or do not require GRE scores?

Particular attention should be paid to how the perceptions and motivations of international applicants may differ from those of domestic applicants, as the former group was (although not completely consistently) the most likely to submit GRE scores across the total applicant, accepted, and enrolled pools. For example, might international students submit GRE scores at a higher rate than domestic students simply because they are less aware of GRE-optional policies or do they believe that they will be viewed more favorably by submitting scores and, if so, why? Devoting specific attention to understanding international applicants’ perspectives seems particularly important because temporary citizens comprise 18% of enrolled graduate students in the United States and over 50% of the graduate student populations in fields such as engineering, mathematics, and computer sciences (Okahana & Zhou, 2019). Moreover,

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international students account for 32% of doctoral degrees awarded in the United States (NSF & National Center for Science and Engineering Statistics, 2019) and this percentage may rise in the future, as undergraduate enrollment has declined for the past five years (National Student Clearinghouse Research Center, 2019).

Gaining better insight into the thought processes of faculty members involved in admissions decision-making in GRE-optional programs will also be important. What inferences do faculty members make about applicants who do and do not submit GRE scores and do these inferences differ according to program discipline or degree level? If an application package is already strong does a high GRE score add any value to it or can anything less than a very high score only detract from it? How do faculty members compare applications of similar strength when one is accompanied by a GRE score and one is not? Do faculty members utilize GRE scores submitted by international applicants (or their absence) in unique ways compared to when evaluating domestic applicants?

Finally, effort should be made to understand potential differences in the outcomes of applicants who do and do not submit GRE scores. Do students who do not submit scores show similar outcomes (e.g., awards, faculty evaluations, grades, job offers, publications, post-graduation career success, time to graduation, retention) compared to those students who do submit scores? What variables may moderate these associations (e.g., academic discipline, degree level, program ranking, program size)?

Conclusion

The relationship between graduate school applicants’ demographic backgrounds and their tendency to submit or not submit GRE scores to test-optional programs is complicated. Overall, there was a trend toward applicants from URGs comprising a larger pool of nonsubmitters than

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submitters and international applicants, accepted students, and enrolled students comprising a larger share of GRE score submitters than nonsubmitters, while no major difference for females was observed. At the level of specific academic disciplines and degree levels, however, these trends were not always present and sometimes reversed. Too much emphasis should not be put on any single study (Amrhein et al., 2019), however, and it is important that other investigators attempt to replicate and extend our findings. To underscore our investigation's central message we end by quoting Espenshade and Chung's (2010) eloquent conclusion to their undergraduate test-optional study, one that was cited verbatim by the University of California's testing taskforce (Systemwide Academic Senate, University of California, 2020, p. 97): "Our take-away message is this: given the great variety of postsecondary institutions in the United States—variety in terms of size, endowment, mission, geography, degree of selectivity, and whether private or public, among others—it is difficult to generalize to all campuses about the likely consequences of a move to a test-optional admission policy" (Espenshade & Chung, 2010, p. 26).

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Table 1

Total Sample Characteristics by Demographic Category and Percentage of GRE Nonsubmitter Status

	Total N	Percentage of Group That Did Not Submit GRE Scores [95% CI]
Gender*		
Female	9,824	85.7% [85%, 86%]
Male	5,208	85.3% [84%, 86%]
Ethnicity/Race		
African-American/Black	1,125	88.5% [87%, 90%]
Asian-American	1,055	82.8% [81%, 85%]
Hispanic/Latino	1,497	86.1% [84%, 88%]
Multiracial	165	87.3% [82%, 92%]
Native American/Pacific Islander	119	89.1% [83%, 95%]
White	6,562	87.3% [87%, 88%]
Member of an Underrepresented Group	2,906	87.2% [86%, 88%]
International Status		
U.S. Citizen	11,061	87% [86%, 88%]
Non-Citizen	3,980	81.7% [80%, 83%]

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*Categories for nonbinary individuals were not available. Underrepresented = Black/African American, Hispanic/Latino, Native American/Pacific Islander, and Multiracial individuals.

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Figure 1. The percentages of applied, accepted, and enrolled female, members of racial/ethnic underrepresented groups, and international non-GRE submitters and GRE submitters, across degree levels and disciplines. Underrepresented = Black/African American, Hispanic/Latino, Native American/Pacific Islander, or Multiracial individuals.

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Figure 2. The percentages of applied female, members of underrepresented racial/ethnic groups, and international non-GRE submitters and GRE submitters to fine arts and humanities graduate programs. Underrepresented = Black/African American, Hispanic/Latino, Native American/Pacific Islander, or Multiracial individuals.

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Figure 3. The percentages of applied female, members of underrepresented racial/ethnic groups, and international non-GRE submitters and GRE submitters to social sciences graduate programs. Underrepresented = Black/African American, Hispanic/Latino, Native American/Pacific Islander, or Multiracial individuals.

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Figure 4. The percentages of applied female, members of racial/ethnic underrepresented groups, and international non-GRE submitters and GRE submitters to nursing and STEM programs. Underrepresented = Black/African American, Hispanic/Latino, Native American/Pacific Islander, or Multiracial individuals.