Searching for a New Homeland: How Geography Matters in the College Selection and Career Decisions of Computing and Engineering PhDs

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Where do Black and Latin@ STEM doctoral students want to live post-graduation, and what are their criteria for making these decisions? This study explored the decision-making process of doctoral students and graduates with respect to their future career destinations. It investigated the regions most appealing to racially underrepresented minoritized (URM) doctoral students and their white counterparts. We explored the role that racial diversity in URM students' current program played in their geographical preferences. The paper investigates how perceptions of racial discrimination impacted their decisions regarding the geography they favor. The study analyzed survey questions from The National Survey, a study of 1641 doctoral students and postdoctoral researchers in engineering and computing schools. The research found that while computing and engineering graduate students generally prefer the coastal U.S., URM students weigh other factors into their geographical preferences, including the racial diversity of their current location and past experiences of discrimination.

Keywords: STEM education, career planning, racial discrimination, engineering, computer science, racialized geography

Various factors are involved in the decision-making of STEM doctoral students when determining where they want to work and live post-PhD. Less understood is the role of geography in the decision-making process. From our qualitative work, we have learned that Black and Latin@ STEM doctoral students incorporate race-conscious considerations into their geographical preferences; for example, they might favor a neighborhood or surrounding area that has a barber shop or hairdresser who works on ethnic hair, a grocery store that has ethnic food, etc. Thus, we embarked on this research on the geographical preference of Black and Latin@ STEM PhDs with some understanding of the importance these students might place on living in proximity to people like themselves and an awareness of the resources they bring to those communities (McGee, 2021). Secondly, we realized that the racialized experiences that Black and Latin@ STEM doctoral students endure during their doctoral training might impact their future living arrangements. Particularly, racial discrimination experienced during their doctoral program has the potential to influence where and how they choose to live after graduation (McGee et al., 2019). There are other factors, such as the geographical profile of specific job concentrations. For example, beyond Silicon Valley, the best cities for tech jobs include Seattle, WA, Washington, DC, Detroit, MI, Denver, CO, and Austin, TX (Harrington, 2020).

This research study investigates the following question: are the regions most appealing to racially underrepresented minoritized (URM) doctoral students also preferred by their white counterparts? What role does their current institutions' racial diversity (or lack thereof) play in their geographic preferences? Do perceptions of acute racial discrimination impact their decisions regarding the geographic location they favor? What specific geographic areas are best for certain STEM disciplines for both URM and non-URM STEM doctoral students? We will begin by providing background from the literature on doctoral institution choice; we will then explore the literature on the career decision-making of post-PhD STEMmers.

Literature Review

How doctoral students choose a university

The decision-making process for choosing a graduate school is multistage and affected by students' and institutions' characteristics and actions (Kallio, 1995). Variability emerges not only concerning different cultural groups (Kallio, 1995; Bersola et al., 2014) but also along the different stages of the decision-making process (Olson, 1992; Joseph et al., 2014). Students weigh their demographic characteristics (e.g., gender, ethnicity, socioeconomic status) in order of importance to choose the environment where they will feel comfortable and where they feel they will thrive. The university they select must align closely with their personal, academic, and future career goals (Lei & Chuang, 2010).

While the literature on the process of choosing a university during the transition from high school to college is abundant, there is a dearth of literature on graduate school selection (Lei & Chuang, 2010; Bersola et al., 2014; Lewis et al., 2017). However, some studies discovered that some factors influence both undergraduate and graduate school selection, including academic reputation, program quality, class size, geographical location, financial aid, tuition, and contact with faculty (Kallio, 1995; Poock & Love, 2001; Lei & Chuang, 2010). We have adapted these findings regarding the selection of undergraduate institutions to inform the process of choosing a graduate school.

Hossler's and Gallagher's (1987) three-step college choice model provides one example. These scholars developed their model initially for college selection, but it is applied widely in the studies of graduate enrollment (Poock & Love, 2001; Bersola et al., 2014). The first stage is called predisposition, during which students decide if they want to continue their education after completing their bachelor's degree. Background characteristics influencing students' choice include participation in research during their undergraduate career (Barlow & Villarejo, 2004), total indebtedness (Millett, 2003; Malcom & Dowd, 2012), and family influence. The second stage, search, begins when students gather more information about prospective institutions. Furthermore, universities start interacting with students at this stage as they search for potential department applicants. The final step, choice, is the most studied phase of the model, during which students decide which specific institution to attend. These choices are influenced by factors such as institutional appropriateness, departmental fit, financial support, familial support, and how graduate school aligns with their ultimate career goals.

Students' criteria for universities change over time as they move through their decision process. Factors considered necessary at the search stage may carry less weight at the choice stage. In a sample of prospective students in Germany, Joseph et al. (2014) found that living accommodations and campus attractiveness received less attention as students went from the second to the final stage. In contrast, location, cost of education, interaction with faculty, and academic reputation became more important by the end of the college selection process (Joseph et al., 2014). Some factors consistently rank highly for students, such as faculty contact and academic reputation (Bersola et al., 2014).

Disparities between URM and non-URM students exist throughout the three stages, mainly around factors such as cost, financial support, geographical location, and community diversity (Kim, 2004; Bersola et al., 2014). For example, heavy debt negatively impacts Latin@ STEM students' decisions regarding graduate school enrollment compared to their white counterparts (Malcom & Dowd,

2012). In general, URMs prioritized cost and financial support; they were more likely than non-URMs to accept an offer that included a fellowship (Bersola et al., 2014). Aside from resources, URM students also value the social experience of their chosen institutions. Feelings of social connectedness are essential for URMs because a lack of belonging or reminders of their underrepresentation can trigger negative thoughts about their acceptance and belonging at the institution (Fisher et al., 2019).

One key difference between undergraduates and doctoral students is that individual departments bear the most significant degree of responsibility for student success (Enhrenberg et al., 2009). Moreover, the students' relationship with their advisor(s) directly impacts their experience in their doctoral program, including the quality of the research they produce while in the program, and when the student graduates. Especially in STEM disciplines, efficient and culturally responsive mentorship is essential for retaining students in doctoral programs (Howell et al., 2020). URM students face greater challenges than others concerning establishing successful mentor relationships before deciding on an institution, especially if they come from a minority-serving institution (MSI), i.e., historically Black colleges and universities or Hispanic-serving institutions. Faculty at predominately white institutions (PWIs) have less robust relationships with students than faculty at MSIs; these relationships play a role in the recruitment and admission of highly talented individuals (Tanenbaum et al., 2020). Students going into STEM disciplines tend to have fewer financial constraints when selecting programs because these "hard/applied" fields like engineering have better resources and greater funding when compared to the humanities or "soft/pure" disciplines (Barnes & Randall, 2011).

Geographical considerations of institutional choice for URM students

Regional and community diversity are vital for URMs (Poock & Love, 2001; Bersola et al., 2014). When evaluating the institution, they visit the campus and talk to other URMs who have been through the program to get information about whether the institution is sensitive to their needs (Heilbronner, 2011). Their unique approach to college selection stems from a culturally distinctive social concept, where their community is considered to be extended family. It has been demonstrated that socialization is a determining factor in doctoral student success; successful socialization varies based on disciplinary and institutional contexts (Gardner, 2008). The experience students of color will have in their doctoral programs depends on structural and social factors characteristic of their department and university, and these factors contribute to doctoral student attrition. Socialization within the department contributes significantly to the student experience in doctoral programs, and the cities where these programs are located also contribute considerably to student satisfaction.

The critical role of location and community is particularly evident in the STEM fields. Several studies discovered that MSIs were the largest granters of doctoral degrees for underrepresented STEM doctoral students; such institutions were located in regions with relatively high URM populations (Lundy-Wagner & Vultaggio, 2013). Recent research also found that an institution's commitment to racial diversity and equity, and the availability of social, academic, and professional support for students of color, were essential elements in retaining URMs in graduate programs (Trent et al., 2021). These findings show that racial diversity is the key to URMs' academic excellence and explain why URMs favor geographical locations that offer community diversity.

Discriminatory experiences negatively affect STEM URM students' career decisions

URM students regularly leave scientific studies or change their career aspirations because of STEM graduate school structures and cultures (Tanenbaum et al., 2020). The attrition rate for women of color (WoC) is exceptionally high; within a seven-year horizon, 34% of WoC leave their STEM doctoral program before graduating (Sowell et al., 2015; Schuyler et al., 2021). Lack of culturally sensitive support from mentors and administration within the department, "microaggressions," stereotyping, and overtly racist experiences leave students feeling unwelcomed and unsupported through an objectively stressful period in their lives. Black women graduate students reported disproportionate discrimination, racism, and white superiority, represented by belittlement and discreditation by white professors and colleagues in their STEM programs (Alexander & Herman, 2015; McGee, in-press).

Research has demonstrated that concerns about one's lack of acceptance due to status characteristics (e.g., ethnicity, race, gender, socioeconomic status, sexuality) can trigger various psychological processes that negatively impact academic performance and the will to persist in their program or field (Fisher et al., 2019). Both these discriminatory experiences and anticipating them can trigger vigilance for impending discrimination, diverting essential attentional and emotional resources from academic tasks (McGee, 2016). Students do not need direct, interpersonal racialized interactions to be reminded that they are minoritized/othered in the space. For example, women in STEM can be negatively impacted by environmental cues that highlight STEM as a "male-dominated" space, such as a lack of women in the classroom or far-off locations of women's restrooms relative to men's (Cheryan et al., 2009). Intentional exclusion from social involvement in the department and the institution can also contribute to negative graduate student experiences in doctoral programs. Extant evidence suggests that isolation is among the considerations when Black women weigh withdrawing from their STEM program (Charleston et al., 2014; Cleare, 2017). The URM students who complete their program then restart another extensive decision-making process as they decide what and where their next step will be.

The decision-making process of doctoral graduates (or potential graduates) concerning post-graduate career destinations

Research on the decision-making process of doctoral students' career choices uses various models to account for variability in career paths. One commonly utilized model is called the Social Cognitive Career Theory (SCCT), developed by Lent et al. (1994). The SCCT mainly addresses two factors: self-efficacy and outcome expectations. Self-efficacy refers to confidence in one's ability to carry out actions required to achieve specific goals (i.e., "Are my goals realistic and achievable?"). Outcome expectations relate to beliefs about probable outcomes as a consequence of performing particular behaviors (i.e., "If I do this, what will happen?"). Self-efficacy and outcome expectations together determine one's occupational interest, which, in turn, leads one to make career choices and execute related actions to accomplish goals, given the hypothesis that people will aspire to choose career paths that correspond to their interests. The SCCT also recognizes that personal factors (e.g., gender, race/ethnicity) and contextual influences (e.g., job availability, perceived and actual barriers to entry, receiving financial, emotional, and instrumental support) can affect the theoretical framework. Recently, there have been expansions of the SCCT to focus on undergraduate and doctoral students in STEM (Byars-Winston & Rogers, 2019; Olson et al., 2020; Connolly et al., 2018). Self-efficacy and outcome expectations were positively associated with career intentions for undergraduate STEM students (Byars-Winston & Rogers, 2019). Connolly et al. (2018) further demonstrated the importance of self-efficacy; they found that development programs for STEM doctoral students who aspired to academic careers increased self-efficacy, especially in women.

A significant contributor to outcome expectations is incentives. As STEM doctoral students approach the end of their Ph.D. programs, they typically weigh the incentives of two paths: academia or industry. Those who have a deep desire to teach, produce research, and mold future professionals are drawn to academia, while industry provides attractive incentives such as higher base salaries with large corporations. As STEM doctoral students move through their programs, they tend to undertake activities that align with their desires; for example, students may see a future in academic publishing in contrast to their industry-driven peers who focus on private sector collaborations (Mangematin, 2000). Preparation to enter the job market, particularly on the industry side, is not a focus of most institutions, departments, or doctoral advisors. Thus, doctoral students often find themselves ill-equipped to enter a competitive job market, especially in highly saturated fields such as STEM (Gumus, 2021).

URM STEM students face a unique challenge when making decisions after completing their doctoral work; not only do they face the problems that plague most STEM postgraduate students, but they must also contend with how their identity will fit into their future university, company, and location. URM STEM doctoral students' career decisions are shaped by the social and cultural context of their lived experiences. For example, during the Donald Trump presidency, Black STEM doctoral students were concerned about the impact of the administration's anti-science rhetoric on the future of their careers, and many decided against government employment because of the President's racist actions (McGee, 2021). URM STEM doctoral students leveraged administrative policies and considered abrupt pivots from public sector and academic positions, which are both heavily reliant on government funding, while also acknowledging the possibility of fewer jobs (McGee, 2021; McGee et al., 2021). URM STEM doctoral students tend to pursue more industry careers post-graduation due to harmful and discriminatory experiences that discourage them from staying in academia (Jaeger et al., 2017; Russell et al., 2018). URM graduates may also see conflicts between their identity and their prospective role as faculty members because they want to study unpopular topics of cultural interest or because of the Eurocentrism of academia (Jaeger et al., 2013; Haley et al., 2014). Their desire to go where they feel respected, comfortable, and duly compensated, is often a result of being mistreated in their academic trajectories.

Geographical Preferences Of STEM Doctoral Graduates

The United States has a large foreign doctoral student population. The research on geographical preferences for STEM doctoral graduates tends to focus on these foreign (non-US citizen) STEM students. As of 2017, 49% of U.S.-trained postdocs were born overseas, a figure that has increased significantly over the past 25 years (Khan, 2020). As these students approach graduation, they must confront the question: will they stay and work in the US or return to their home country? This question garners much attention as there is a considerable investment of resources in these students, from which institutions and government agencies would prefer to benefit. The United States is one of the leading countries in investment per researcher, making it appealing to domestic and international students (Khan, 2020). Foreign Ph.D. students commonly prefer to stay in the United States post-graduation if possible (Ganguli & Gaule, 2018). This preference is partly driven by the significant salary disparity when comparing similar positions in the U.S. versus their home country (Zeithammer et al., 2013). They are also generally more interested in academic careers when compared to their U.S. counterparts, with a low preference for working in industry situations like US tech startups (Ganguli & Gaule, 2018; Roach & Skrentny, 2019).

Though there is a gap in the literature about the geographic choices URM STEM doctoral students make post-graduation, research has provided context on what factors influence their decisions. Both a feeling of community and the presence of racial diversity influence URM students' post-graduate choices regarding their choice of geography as they forge their careers. URM students tend to value family and community, as "giving back to the community and being a role model in the community" are part of their racial, ethnic, and cultural identity (Haley et al., 2014, p. 110). When URM graduates recognize that their research has an altruistic value of helping others and can contribute to the community, they tend to have a greater interest in becoming a scientist and pursuing a Ph.D. (Robinson et al., 2016; McGee et al., 2022; Thoman et al., 2015). This collectivist attitude represents an aspect of what we identified in our previous research as equity ethics: fundamental principles guiding behavior and action thriving toward justice, especially racial justice, and rectifying racial inequities through the employment of one's STEM abilities (McGee, 2020; McGee & Bentley, 2017; McGee et al, 2022)

Purpose of the Study

Efforts to identify the key factors influencing the decision-making processes of institutional selection and career development among STEM doctoral students have shown that racial diversity played a consistently important role for URMs. A preference for specific regions usually represents a preference for racial diversity. However, there is a lack of research on students' geographical preferences regarding career moves. In this study, we explored how STEM Ph.D. students – specifically computing and engineering students – value diversity and geography in career decision-making; we examined quantitatively, and in relationship with other factors, doctoral students' geographical preferences as they make their next career move. We also controlled for racial identity to compare the importance of diversity to URMs vs. non-URMs.

This research posed five specific research questions:

1. What regions do URM doctoral computing and engineering students prefer regarding their next career move?
2. Do we see differences compared to the ideal geographic placement of white and Asian students?
3. What role does the racial diversity of a student's current institution and surrounding neighborhood play in their decision regarding their preferred location for future employment?
4. Do URM students who have experienced racial discrimination have specific geographical preferences compared to those who have experienced other forms of discrimination?
5. What is the relationship, if any, between career preferences and geographical preferences among STEMmers?

Methods

This research is part of The National Survey (formerly known as the Engineering and Computing Doctoral Experiences Survey, or ECDES), a study of 1641 doctoral students and postdoctoral researchers in engineering and computing schools across the US. The ECDES is designed to examine the factors in the career decision-making of engineering doctoral students, doctoral candidates, and

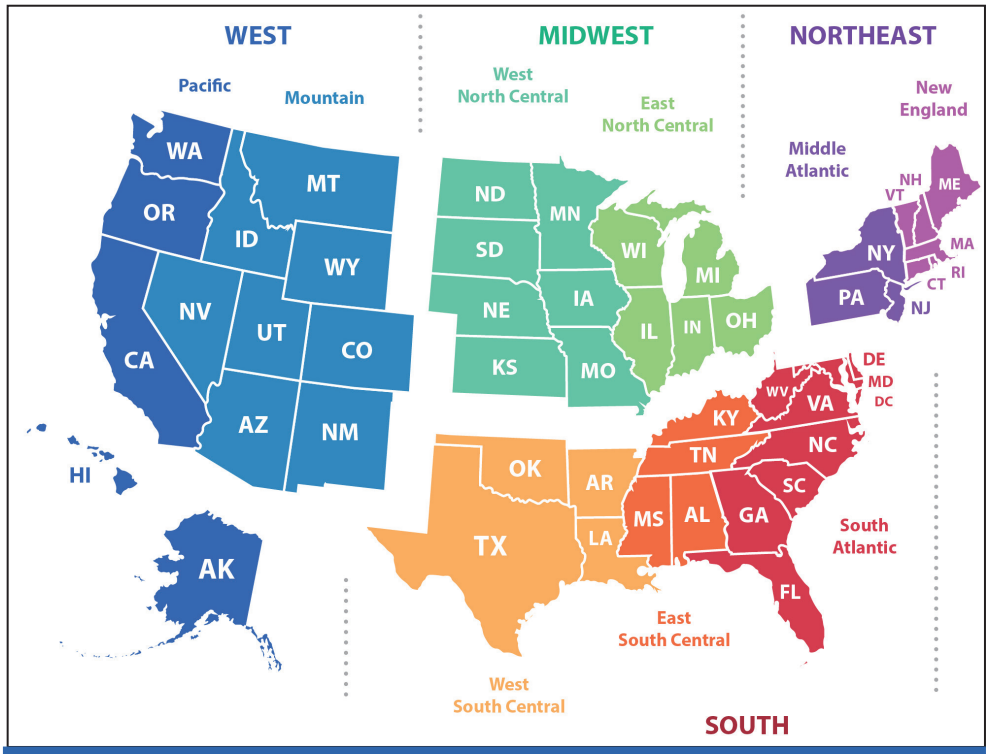


Figure 1. Racial diversity of institutions and surrounding neighborhoods

postdoctoral researchers, with a particular emphasis on understanding the racialized and race-gender experiences of underrepresented groups of color. Specifically, the survey investigated issues related to the career trajectories of engineering and computing doctoral students, doctoral candidates, and postdoctoral scholars, including their experiences of discrimination; their mental health and well-being; their sentiments about becoming faculty members, etc.

The current study examined three of the survey questions in the ECDES. The first question asked students the geographic location(s) that best represented their next career move. As shown in Figure 1, the available choices were New England (VT, NH, ME, MA, RI, CT), Middle Atlantic (NY, PA, NJ), East North Central (WI, MI, IL, IN, OH), West North Central (ND, MN, SD, NE, KS, MN, IA, MO), Mountain (MT, ID, NV, WY, UT, AZ, CO, NM), Pacific (WA, OR, CA, AK, HI), South Atlantic (DE, MD, DC, VA, WV, NC, SC, GA, FL), East South Central (KY, TN, MS, AL), West South Central (OK, AR, TX, LA), outside of the United States, and no preference. The second set of questions asked students whether they had experienced discrimination at their institution and, if so, what they believed was the primary reason for it. The third survey item asked students what careers they found attractive when putting job availability aside. The options were: university faculty with an emphasis on teaching, university faculty with an emphasis on research, a government job, a job in an established firm, and a job in a startup. We also collected a wealth of demographic information about the students in the sample, such as current institution, major racial identity, gender, family household income, and others.

Racial diversity of institutions and surrounding neighborhoods

We determined the racial diversity of institutions based on the states where they were located. We referred to the 2019 statistics of the percentage of the white population in each of the 50 states and the District of Columbia (United States Census Bureau) to rank the states in descending order. As shown in Table 1, the 1st to 17th states are those of high white dominance and, therefore, of low racial diversity; these include ME, VT, WV, NH, WY, IA, ID, MT, UT, KY, NE, ND, WI, SD, CO, KS, and OR. The 18th to 34th states have medium white dominance/medium racial diversity; these include: IN, MN, MO, OH, PA, RI, AZ, MI, TN, MA, AR, CT, FL, WA, NM, TX, and OK. The 35th to 51st states (including DC) are those of low white dominance and, therefore, of high racial diversity; these include IL, NC, AL, DE, NJ, VA, SC, NV, AK, NY, LA, CA, MS, GA, MD, DC, and HI.

1	ME	94.0%	27	MA	77.0%
2	VT	93.8%	28	AR	76.7%
3	WV	93.1%	29	CT	74.6%
4	NH	92.6%	30	FL	74.5%
5	WY	90.9%	31	WA	74.2%
6	IA	89.9%	32	NM	73.9%
7	ID	89.4%	33	TX	73.4%
8	MT	88.0%	34	OK	72.4%
9	UT	87.3%	35	IL	71.4%
10	KY	86.7%	36	NC	68.1%
11	NE	86.2%	37	AL	67.8%
12	ND	85.8%	38	DE	67.7%
13	WI	85.2%	39	NJ	67.1%
14	SD	84.1%	40	VA	67.0%
15	CO	83.7%	41	SC	66.7%
16	KS	83.6%	42	NV	64.6%
17	OR	83.5%	43	AK	64.2%
18	IN	82.8%	44	NY	63.2%
19	MN	82.1%	45	LA	61.8%
20	MO	81.8%	46	CA	59.4%
21	OH	80.9%	47	MS	58.0%
22	PA	79.6%	48	GA	57.8%
23	RI	78.7%	49	MD	54.5%
24	AZ	78.3%	50	DC	42.5%
25	MI	78.2%	51	HI	24.1%
26	TN	77.2%			

Table 1. Percent of White Population by State

Sample characteristics

Of 1641 participants, 582 did not provide their racial identity, 71 were Middle Eastern or North African, and 7 represented other racial groups. Thus, for this study, we were only concerned with the remaining 981 participants (32.2% female, $M_{age} = 27.95$, $SD_{age} = 4.39$). Table 2 presents a summary of the participants' characteristics.

42.6% of the participants were born outside of the United States, and 36.8% were non-US citizens. About a third were married or living with a partner, and 8.9% had children under 18 years old. 52.2% of the participants indicated that their incomes in 2015 were less than $25,000.

The sample also represents a wide range of family socioeconomic backgrounds. Participants were asked about their parents' educational experiences. While 12.4% of the respondents' parents had a high school education or less, almost half had parents both of whom had a bachelor's or a higher degree. Regarding their own educational experiences, 13.1% attended community or junior colleges. Most of the respondents majored in various subfields of engineering, such as computer science and engineering (9.3%), electrical engineering (13.5%), and mechanical engineering (18.1%). 82.2% were currently enrolled doctoral students, among whom 28.5% were first-year students, 50.1% were doing their dissertation research, and 12.4% were actively looking for a job or a post-doctoral position.

Geographical distribution of the current institutions

As shown in Figure 2, our sample consisted mainly of doctoral students and postdoctoral researchers in institutions in the coastal areas, particularly VA, NC, IN, CA, and GA. There were 597 participants (60.9%) enrolled in institutions where racial diversity is high, 369 (37.6%) enrolled in institutions where racial diversity is medium, and only 15 (1.5%) enrolled in institutions where racial diversity is low.

Participants Characteristics (N = 981)

Race/Ethnicity		
Underrepresented racially minoritized (URM)	197	20.1%
Black	92	9.4%
Latin@	62	6.3%
American Indian/Alaska Native	2	0.02%
Multiracial Black	20	2.0%
Other Multiracial	21	2.1%
White	396	40.4%
Asian	388	39.6%
Born outside of the United States	418	42.6%
Non-US citizen	361	36.8%
Married/Living with a partner	333	34.0%
Have children under 18	87	8.9%
Personal Income in 2015		
$25,000 to $49,000	327	33.3%
$50,000 to $74,999	42	4.3%
Above $75,000	29	3.0%
Below $25,000	512	52.2%
Mother's Education		
GED/High school or less	209	21.3%
Some college but no Bachelor's degree	139	14.2%
Bachelor's degree	308	31.4%
Graduate/Professional degree	252	25.7%
Father's Education		
GED/High school or less	186	19.0%
Some college but no Bachelor's degree	110	11.2%
Bachelor's degree	259	26.4%
Graduate/Professional degree	347	35.3%
Education		
First generation college student	129	13.1%
Attended community or junior college	129	13.1%
Major		
Computer Science and Engineering	91	9.3%
Electrical Engineering	132	13.5%
Mechanical Engineering	178	18.1%
PhD Students	806	82.2%
Stage in the PhD Program		
First year	230	28.5%
Working on dissertation research	404	50.1%
Looking for a job or a post-doc position	100	12.4%

Table 2. Geographical distribution of the current institutions

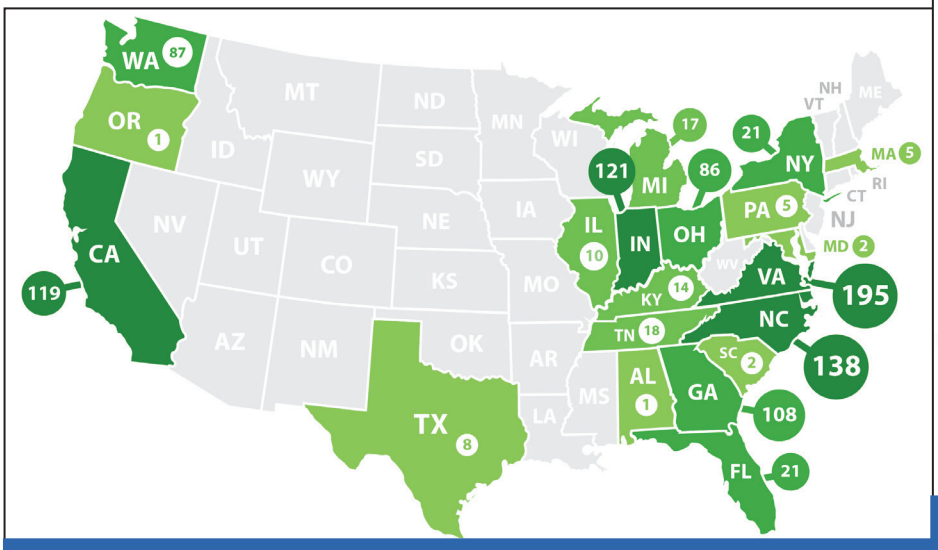


Figure 2.1. Geographical distribution of the current institutions

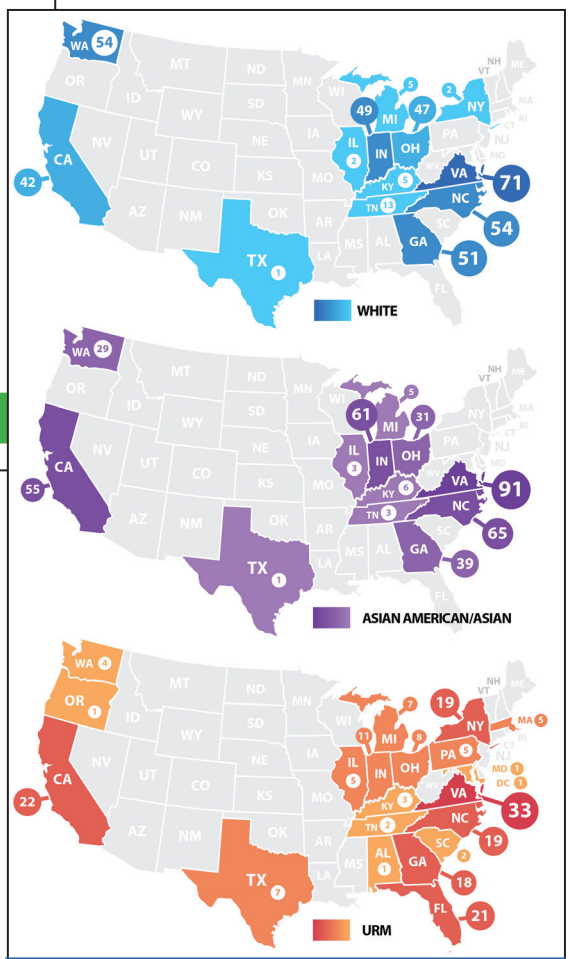


Figure 2.2. Geographical distribution of the current institutions by race

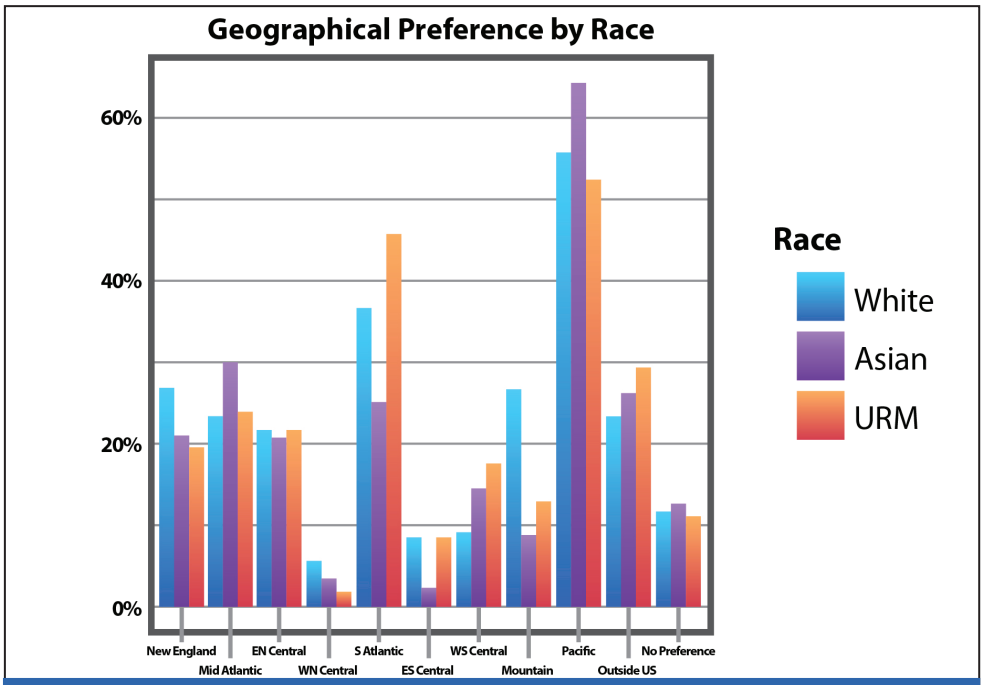
Results

What regions do computing and engineering graduate students prefer for their next career move?

Figure 3 displays geographical preference by race. There are three significant findings. First, students, in general, showed the strongest inclination to work in the Pacific (58.4%), followed by the South Atlantic (33.9%), Middle Atlantic (26.1%), outside of the United States (25.8%), New England (23.2%), East North Central (21.3%), Mountain (17.0%) and other locations (less than 15%). Second, while the South Atlantic is the second favorite location, Asian students did not seem to prefer it as much as white and URM respondents. Only 25.3% of Asian students said they were willing to move to the South Atlantic, while the percentage of white students was 36.6%, and the percentage of URM students was 45.7%. Third, more white students (26.8%) preferred Mountain states when compared with Asian students (9.0%) and URM students (13.2%).

How does the racial diversity of a student's current institution influence the decision regarding the place to work?

Figure 4. (a), (b), and (c) shows how the racial diversity of the current institution affects geographical preference for white, Asian, and URM students, respectively. There are some general patterns across the three student groups' preferences. Students in locations of medium racial diversity were more likely than students in locations of high racial diversity to move to East North Central and less likely to move to South Atlantic. There also exist discrepan-



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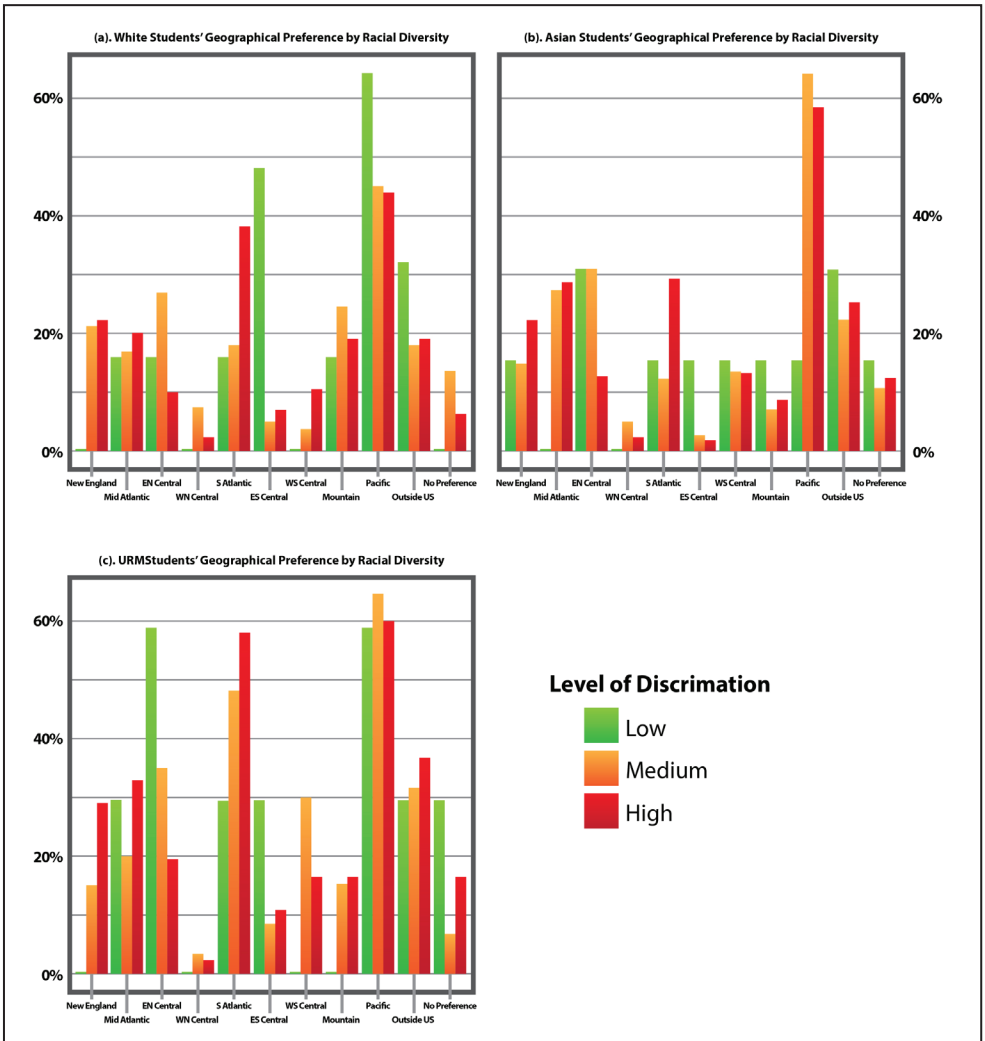

Figure 4. Do URM students who have experienced racial discrimination have specific geographical preferences compared to those who experienced other forms of discrimination?

cies across the groups. For white and Asian students, areas other than East North Central and South Atlantic were equally preferred (Difference < 10%) by students enrolled in institutions where the racial diversity is medium and in those where the racial diversity is high. However, URM students' attitudes toward moving to New England, Middle Atlantic, East North Central, and West South Central differed (Difference > 10%). While fewer URM students in places of medium racial diversity preferred New England and Middle Atlantic, more of these students preferred East North Central and West South Central.

Do URM students who have experienced racial discrimination have specific geographical preferences compared to those who experienced other forms of discrimination?

Of all the URM students, 70.6% indicated that they had once been discriminated against at their current institutions. Among them, 56.1% believed that their racial identity was the primary reason behind the discrimination. In contrast, the others thought they had been discriminated against mainly due to other factors, such as gender, sexual orientation, etc. Those who felt that racial discrimination was the primary form of discrimination showed geographical preferences different from the others. As illustrated by Figure 5, 56.4% reported planning to move to the South Atlantic as their next career move; this percentage was 22% higher than those who experienced other types of discrimination. In addition, regarding the preference for going abroad and no geographical preference, the difference between the students who experienced racial discrimination and the others was greater than 10%.

Is there a relationship between career preferences and geographical preferences?

Figure 6. (a), (b), and (c) show the interaction between career attractiveness and location preferences for white, Asian, and URM students, respectively. The interaction was not significant as the patterns of geographical preference across the career choices were almost the same, controlling for race.

Geographical Preference of Computer Science, Electrical Engineering, and Mechanical Engineering Students

A recent article reported that over the past few decades, US tech jobs have concentrated in eight cities: San Jose, New York, San Francisco, Washington DC, Seattle, Boston, Los Angeles, and Austin (Harrington, 2022). Though pandemic-driven remote work prompted some cities to attract tech workers to their areas, most tech jobs remain in the coastal hubs (Harrington, 2022). Our results (see Figure 7) were consistent with the report. The Computer Science (CS), Electrical Engineering (EE), and Mechanical Engineering (ME) students have a strong preference for the coastal regions, which include the Pacific, South Atlantic, Middle Atlantic, and New England.

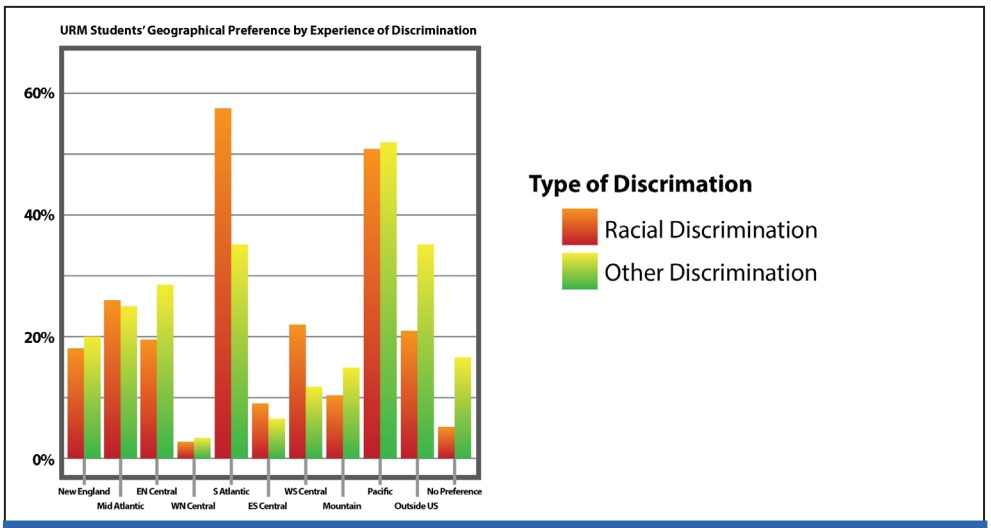

Figure 5. How does the racial diversity of a student's current institution influence the decision regarding the place to work?

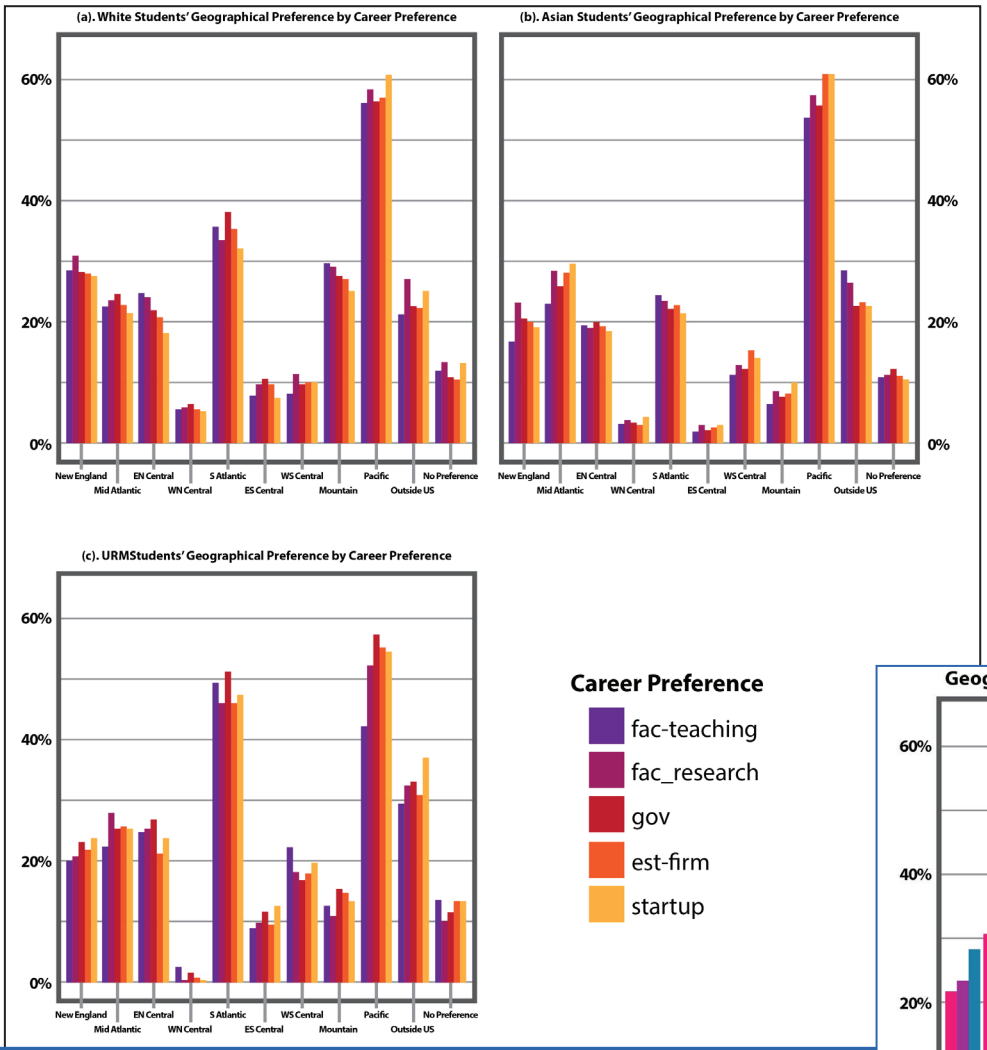

Figure 6. Do URM students who have experienced racial discrimination have specific geographical preferences compared to those who experienced other forms of discrimination?

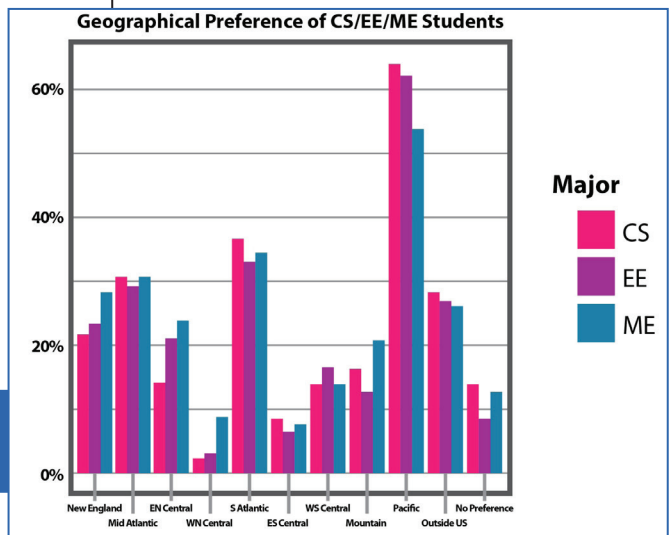

Figure 7. Is there a relationship between career preferences and geographical preferences?

The willingness to move to WS Central, where Austin is located, is less than the willingness to move to the other areas. In addition, the students in our sample indicated a moderate preference for working at a tech company outside the US.

Limitations

The current study has four limitations. First, the findings of this study are based on a sample of doctoral students and postdoctoral researchers enrolled in institutions in the coastal regions. Therefore, the implications drawn from the results may not apply to those enrolled in institutions in the central regions. Second, the state-level rankings of racial diversity may not account for the differences between counties within the states, so the way we determined the racial diversity of the student's current institutions may not be sufficiently granular. Third, we only had region-level data on geographical preferences because we used data from a previous project. Ideally, we would have let participants choose from all 51 geographies (50 states and DC) to determine their top five preferred states so that we would have state-level data to draw more detailed conclusions. This model is less granular and does not account for the differences between the states within the "low, medium, high" groups we've created. Finally, although our interest was in STEM as a whole, our findings were restricted to Computer and Electrical and Mechanical Engineering students and should not be generalized to other STEM fields.

Implications

This study sheds light on the significant impact of race and geographical preference on the career decisions of STEM doctoral students. The results elucidate how geographical choices for future employment are influenced not only by academic and career aspirations but also by considerations of racial diversity and previous experiences of racial discrimination. The implications of this research go beyond academia, extending to policymaking, human resources practices, and talent sustainability in the STEM workforce. There are several areas where these implications come to fruition:

Diversity and Inclusion in the STEM Workforce: The study reinforces the necessity of organizational efforts towards diversity and inclusion. Black and Latin@ STEM doctoral students' preference for racially diverse regions highlights their need for a work environment where they feel respected and comfortable. Organizations must make concerted efforts towards creating inclusive workspaces that address systemic racism and unconscious bias, supporting URM staff, and fostering a sense of belonging.

Geographical Distribution of Opportunities: This research demonstrates that computing and engineering doctoral graduates prefer certain geographic regions—particularly coastal regions—for their next career move. This geographic concentration of opportunities could perpetuate regional economic disparities in the country. Policymakers should consider implementing interventions to distribute STEM opportunities more evenly. Encouraging remote work or nurturing STEM hubs in different regions may tackle this issue.

Institutional Policies: Universities and colleges play a critical role in shaping the career paths of their doctoral students. Therefore, they should incorporate diversity and inclusion strategies into their institutional policies, creating a supportive environment for URM students. Given that URM doctoral students' career decisions are influenced by their racialized experiences, academic institutions, and their faculties have a vital role in providing culturally sensitive mentorship and support.

Conclusion

The current research suggests that while computing and engineering graduate students generally prefer the coastal regions, where there is racial diversity and a concentration of STEM job opportunities, discrepancies exist between the racial groups. Factors impacting future living arrangements do not include career preferences but do include the racial diversity of the current living place and past experiences of discrimination, as our results indicate.

How can we account for these discrepancies? Why are students in locations of medium racial diversity less likely to move to the South Atlantic than students in locations of high racial diversity? Why do URMs who experienced racial discrimination have a stronger preference for South Atlantic than URMs with different experiences of discrimination? Further qualitative studies may hold the answer to these questions.

This study opens new avenues for future research. For instance, the relationship between the racial diversity of an institution's location and the career outcomes of its graduates warrants further investigation. This could provide further insights into the decision-making processes of URM students. In conclusion, this study underlines the importance of addressing systemic racism and fostering diversity and inclusion in the academic and career trajectories of STEM doctoral students. Both institutions and organizations have a role to play in ensuring that URM graduates do not have to compromise on their career aspirations or geographical preferences due to their racial identities.

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