

**Exiting the Ivory Tower Before and After Graduation: Attrition and Pursuit of Non-
Faculty Career Goals Among Diverse Students**

by

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Dedication

In memory of Ernest Werkheiser.

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Abstract

This study examined the role of gender, underrepresented racial-ethnic minority (URM) status, advisor support, field of study, and perceptions of department climate in relation to department rates of attrition and doctoral students' post-graduate career goals. Two datasets were used: one composed of individual-level student measures (gender, URM status, career goals, perceptions of advisor support for career goals, and perceptions of climate; N=1177 doctoral students), and another composed of department-level measures (attrition, field of study; N=25 departments). Departmental attrition was only found to relate to one variable: (low) advisor support for research careers in non-profit or government settings. In contrast, career goals were related to gender, underrepresented racial-ethnic minority status, advisor support for specific careers, field of study, and climate. Overall, students expressed more interest in tenure-track than non-tenure-track careers, perceived more support from their advisors for tenure-track than non-tenure track careers, more support for career goals at research universities than at 4-year colleges, and more support for non-tenure-track career goals in private research than in non-profit or government work. Advisor support for particular careers was associated with students' goals for those careers. Students in science-related fields were less likely to report desire for tenure-track careers. Climate was positively related to students' goals to pursue tenure track careers in research universities.

Female and URM students differed from their more privileged counterparts in three ways: compared to male and racial-ethnic majority students, both women and URM students were more likely to report desire to pursue careers in non-profit or government settings, lower perceptions of instrumental support from their advisors, and more negative perceptions of department climate. (In contrast to expectations, female students actually perceived more advisor support than men for tenure-track career goals at 4-year colleges, but not research universities.) Cumulatively, these results point to a number of continuing inequities in graduate education that face women and URM students, and to the importance of increased attention not only to their experience in general, but to the available support for students with interest in careers outside of the academy, as well as within it.

Chapter 1: Introduction

“I don’t want to go into academia either, but I’m terrified to tell anyone, especially my advisor.” –anonymous graduate student

Half of those students who begin a PhD program leave the academy before completing their degree (Bair & Haworth, 2005; Council of Graduate Schools, 2010; Crede & Borrego, 2013; Golde, 2005; Lovitts, 2001). Of those who graduate, roughly half go into careers outside of the faculty tenure track (Golde & Dore, 2001; Nerad, 2004, 2009; Rudd, Nerad, Morrison, & Picciano, 2008).

Research on attrition from graduate school has investigated a number of individual and institutional factors related to non-completion, including marginalized identities, perceptions of climate (e.g., friendliness), and perceptions of general advisor support. Other educational research has identified a number of systemic inequities in the educational and career experiences of female and underrepresented racial-ethnic minority students. However, scholars have not yet adequately addressed the role of doctoral students’ post-graduation career goals in their pre-graduation experiences. Lovitts’ (2001) foundational research on Ph.D. attrition noted that students’ career goals vary by field of study, with more natural science students going into non-tenure-track (NTT) careers; however, the connections between attrition, career goals, and other

factors such as discipline are not well understood. An analysis of post-graduation career goals may illuminate whether the processes of developing non-tenure-track career goals are parallel to processes associated with attrition. Patterns of experiences and inequities that contribute to attrition and career goals may be of particular relevance for the outcomes of racial-ethnic minorities and women, because these students are generally at higher risk for non-completion of their graduate training, and are less likely to become tenure-track professors.

Both leaving doctoral programs (attrition) and pursuing non-tenure-track (NTT) career goals among PhD students may represent processes of disengagement from higher educational settings; and accumulation of inequitable experiences may be associated with both paths out of the academy. We need to understand the factors associated with attrition and NTT goals in order to better support students to the completion of their doctorates (Denecke, Frasier, & Redd, 2009; Golde, 1998, 2005; Lovitts, 2001). Attrition is usually a negative experience for the student (e.g., Lovitts, 2001), and the attrition of racial-ethnic minority and women students has been identified as an issue of crucial concern in graduate education (e.g., Council of Graduate Schools, 2010). Racial-ethnic minorities and women are considered "marginalized students" in this work, given their persistent patterns of inequitable outcomes in the academy. (The category of "racial-ethnic minorities" or "underrepresented minorities" is somewhat fluid; for example, Asian/ Asian-American students are the numerical racial-ethnic majority in some departments, but are the minority in far more

departments, and may vary in how they self-identify depending on context.) Because marginalized students are generally less likely to complete their graduate studies, efforts to prevent attrition for all students may especially help marginalized students persist to completion (e.g., Denecke et al., 2009; Solem et al., 2009). At the same time, actors in graduate education (such as faculty and administrators) must acknowledge the reality that half of students who do complete their degrees pursue careers outside of academia. Thus it is important to support students in preparing for those outcomes (Golde & Dore, 2001), just as some existing programs support diverse students in preparing for the tenure track (e.g., Stewart, Malley, & LaVaquer-Monty, 2007). I expect this research to contribute to discussions of the experiences and retention of diverse PhD students, and of the role of multifaceted professional development and career support for all students.

I first review the individual and institutional factors related to attrition. Then, I review how the same factors related to attrition may be related to students' non-faculty career goals. Finally, I discuss how attrition may be related to students' career goals and career support.

Attrition

As noted above, half of American PhD students who start their graduate training do not complete their degrees (Bair & Haworth, 2005; Council of Graduate Schools, 2010; Crede & Borrego, 2013; Golde, 2005; Lovitts, 2001). Attrition has been identified as one of the most urgent issues in doctoral education, and extensive research has been

conducted to understand the causes of attrition and how to prevent doctoral departure (Council of Graduate Schools, 2010; Ehrenberg, Jakubson, Groen, So, & Price, 2007; Ehrenberg & Kuh, 2009; Lovitts, 2001; Millett & Nettles, 2009). Attrition is costly to universities, faculty, and students (Bair & Haworth, 2005; Denecke et al., 2009; de Valero, 2001; Gardner, 2010; Golde, 2005). The institutional resources related to admission, instruction, and administration of each departing student do not ultimately contribute toward the production of a doctoral graduate; this is especially costly for those who leave after years of support (Bair & Haworth, 2005; Gardner, 2010; Golde, 2005). Given the high cost of graduate education and limited sources of funding, a low rate of completion is difficult to justify (de Valero, 2001).

Deciding to leave a graduate program is also costly to students, who have invested time, energy, and opportunity costs into attempting to pursue a graduate degree (Bair & Haworth, 2005; de Valero, 2001; Gardner, 2010; Golde, 2005). Denecke and colleagues report of departers, “students have invested a great amount of intellectual and emotional energy into a degree program, and those who leave may do so with psychological scars that can take years to heal” (Denecke et al., 2009, p. 37). Bair and Haworth (2005) summarize: “Put simply, there are both economic and humanitarian reasons for concern, and the low rate of completion by doctoral students is a problem for post-secondary educators” (p. 483). While some attrition is unavoidable, consistently high attrition rates indicate underlying systemic problems (Denecke et al., 2009). Understanding attrition may help programs – or academic

culture as a whole – understand deficiencies and how to improve student outcomes (Golde & Dore, 2001).

It should be noted that some attrition is inevitable, and that not all attrition is related to institutional factors. Individual experiences vary significantly: 62 reasons for departing were generated in interviews with only 28 departers (Lovitts, 2001). Non-institutional reasons for students' attrition include family factors, health-related problems, loss or lack of motivation, realizing that one is not mature enough to commit to the rigors of graduate training, and realizing that academia is simply not what they want to do with their lives (Lovitts, 2001).

Research on attrition has explored the relationships between individual and institutional characteristics and graduate student departure. Attrition is related to personal characteristics such as gender and race (Council of Graduate Schools, 2010; Denecke et al., 2009; Gardner, 2009; Lovitts, 2001; Solem, Lee, & Schlemper, 2009), as well as institutional characteristics such as department climate and discipline of study (Bair & Haworth, 2005; de Valero, 2001; Gardner, 2010; Lovitts, 2001; Millett & Nettles, 2009). Students with marginalized identities (women and racial-ethnic minorities) have higher rates of attrition than more privileged others (Council of Graduate Schools, 2010; Denecke et al., 2009; Gardner, 2009, 2010; Lovitts, 2001; Solem et al., 2009). However, systematic differences in attrition rates based on group identities suggest the need for further investigation into institutional factors that may systematically influence those individuals.

Incorporating institutional factors that may relate to attrition, as well as individual ones, allow for a person-environment theoretical framing of the process(es) of attrition. According to this perspective, individuals vary, and environments vary, but it is in the interaction between the two that different attrition outcomes arise; this tradition originated with Lewin (1935) in psychology. Bronfenbrenner (1992) conceptualized that an individual's environment was related to their psychological experience at multiple levels: within the individual (microsphere), in interpersonal interactions (mesosphere), and in the influence of institutions (macrosphere). Thus, a person's experience in a given context may relate to individual characteristics such as race, interpersonal characteristics such as feeling supported, and institutional characteristics such as a welcoming environment. Exploring connections and patterns within and between these levels of analysis may help illuminate a fuller picture of students' patterns of departure from academia. Three important environmental aspects of the graduate school experience vis-à-vis attrition are academic discipline, program climate, and advisor support; perceptions of a positive climate in one's graduate program, enrollment in the natural sciences (as opposed to the humanities or social sciences), and higher levels of advisor support are all associated with higher rates of completion (Bair & Haworth, 2005; Barnes & Randall, 2012; Council of Graduate Schools, 2010; de Valero, 2001; Gardner, 2009, 2010; Golde, 2005; Jacks, Chubin, Porter, & Connolly, 1983; Lovitts, 2001). All three factors are external to the student; discipline is an institutional or macrosphere influence, while advisor support is more interpersonal at the level of the mesosphere, and perceptions of climate also arise from

mesosphere interactions. In addition, each of these environmental factors may influence individuals or groups differently; for example, there are low rates of graduation among Black students (individual identity factor) in STEM disciplines (institutional factor)(Council of Graduate Schools, 2010; Millett & Nettles, 2009).

Individual Correlates of Attrition: Marginalized Identity Status

Attrition has been linked to a wide variety of individual differences and group memberships. The individual characteristics of both race and gender are associated with lower rates of graduation from doctoral programs (Council of Graduate Schools, 2010; Denecke et al., 2009; Gardner, 2010; Lovitts, 2001; Solem et al., 2009). Critical race theorists note that there are relationships between race, racism, and social and political power (Delgado & Stefancic, 2012); the theory posits that racism is normalized in ways that make it difficult to address, and that there is little incentive among white (i.e., existing) power structures to address or eradicate that racism. Critical race feminism is a related theoretical perspective from which to understand patterns of inequity in institutions; the theory posits that racism and other forms of prejudice such as sexism are built into social practices and institutions, and that domination can exist without direct interpersonal coercion (Harris, 2012). Critical race feminism explores the systematic impact of race on peoples' lives, in conjunction with gender and other identities (Crenshaw, 2003). There are experiential consequences of being a person of color in a culture that denigrates and excludes racial minorities from formal institutions of power, such as equitable legal protection and support (Harris, 2012), or equitable

educational support and opportunities (Ladson-Billings, 2009). Accumulation of inequitable experiences in a system influenced by racism, sexism, and other forms of discrimination may contribute to marginalized students' departure from their graduate programs. A critical race feminist theoretical framework leads me to analyze marginalized students' experiences in the academic context as they may relate to departure from academia.

Underrepresented minority (URM) students (students who identify as African American, Latino/a, and First Nations/American Native) have higher rates of attrition, compared to their more privileged peers (Council of Graduate Schools, 2010; Denecke et al., 2009; Gardner, 2009; Lovitts, 2001). Minority graduate students also experience a range of other inequities, including racist discrimination and marginalization (Barnes & Wells, 2009; Gay, 2004; Teranishi & Briscoe, 2006). Those URM students who are most strongly identified with academia are at the greatest risk for adverse outcomes (Syed, Azmitia, & Cooper, 2011).

Women are more likely than men to leave the academy before completing their Ph.D., and more likely to take a leave or suspension from their programs (Council of Graduate Schools, 2010; Lovitts, 2001; Solem et al., 2009). Women are more likely to experience difficult personal issues during graduate school (Lovitts, 2001; Solem et al., 2009). Some of the struggles that women face in graduate school may manifest psychologically: women have lower academic self-concept than the men in their programs, despite the proficiency they have demonstrated in gaining admittance to

those same programs (Ülkü-Steiner et al., 2000), and the fact that women and men enter graduate school with similar credentials (Sanders & Wong, 1985). Women report that they are devalued by others, especially when expressing emotion or feminine qualities, and that they experience sexism in graduate school (Barata, Hunjan & Leggat, 2005). Indeed, women may discuss leaving their programs with their advisors as a way of seeking encouragement to continue; however, advisors rarely attempt to dissuade students from leaving (Lovitts, 2001). Family issues may also be a concern: women graduate students express concern about balancing an academic lifestyle with childrearing – a concern echoed by men, to a lesser extent (Mason et al., 2009; Morrison et al., 2011; Nerad & Cerny, 1999; Rudd, Nerad, et al., 2008).

Though these theories posit multiple categories of identity working simultaneously to create an integrated social experience, I will examine each category of identity individually (non-intersectionally) in these analyses. First, a true intersectional analysis would need to attend more closely to variations in racial-ethnic identity than I am able to do with my existing data. Second, there is little research literature to support intersectional predictions for my outcomes; in some instances, I am asking questions about topics that have not been studied quantitatively at all, much less in relation to categories of identity. I hope that this research can open the door for further explorations of identity and intersectionality in relation to career goals within the academy, but must recognize the limitations of my ability to perform intersectional analyses in the absence of more specific data and theory to support a responsible

intersectional analysis. Other important axes of identity such as social class, sexual orientation, and international status are likewise incredibly worthy of analysis, but beyond the analytical capacity of the existing data and theory.

Environmental Correlates of Attrition: Discipline and Climate

In addition to research on individual factors in attrition, previous attrition research has explored a variety of institutional difference measures. Both discipline of study and department climate are important social contexts for doctoral students (Austin, 2002; Barnes & Randall, 2012; de Valero, 2001). With regard to attrition, PhD students are more likely to graduate in the natural sciences and engineering, and less likely to graduate in the humanities and social sciences (Bair & Haworth, 2005; Gardner, 2010). However, climate is also an important organizational factor in graduate students' attrition: students who rate their department climate as more positive are more likely to continue in their programs through graduation (Bair & Haworth, 2005; Crede & Borrego, 2013; de Valero, 2001; Ehrenberg et al., 2007; Lovitts, 2001).

Academic disciplines are institutional influences on the experiences of individual students in the environment of graduate school. The lowest rates of attrition are in the lab and medical sciences, at 25% (Bair & Haworth, 2005; Gardner, 2010), perhaps in part because lab fields are theorized to improve social belonging (de Valero, 2001). Those natural science students who do depart from graduate education are more likely than others to do so because of a bad fit with their advisor or department, or if they anticipate a difficult job market if they continue in academe (Golde, 1998). Higher rates

of attrition occur in the humanities and social sciences, cited by Gardner (2010) at 67% (see also Bair & Haworth, 2005); humanities students are more likely than others to depart due to intellectual and disciplinary difficulties, and disillusionment with faculty life (Golde, 1998).

Department climate, or the general atmosphere of an academic environment, is both institutional and idiosyncratic. As a variable that captures individual experience in interaction with the university, climate is mesospheric in a person-environment interaction theoretical framework. Individuals have unique experiences of climate (Rousseau, 1988), but doctoral program climate “is shaped by department-led and university-wide efforts to create the conditions for high expectations, high performance, and strong student support” (Council of Graduate Schools, 2010, p. 48). This mesospheric variable involves feelings students have in and about their graduate programs. Positive attitudes toward graduate students might be characterized as friendly, supportive, and collegial, and departments that are warmer and more supportive have higher doctoral completion rates than departments that emphasize productivity and competition (de Valero, 2001). Negative characteristics of climate include isolation, hostility, competitiveness, and lack of collaboration (Crede & Borrego, 2013; Ehrenberg et al., 2007; Solem et al., 2009). Isolation may be an especially important aspect of climate vis-à-vis attrition; isolation or lack of fit is a key reason for doctoral attrition (Bair & Haworth, 2005; de Valero, 2001; Lovitts, 2001).

Covariates of Attrition: Marginalized Faculty Representation & Attrition

Though faculty support is important in the graduation of all students, URM students and women may be especially affected by access to faculty, or a lack thereof (Barker 2011, Bonner & Evans 2004, Felder 2010, Milner 2004, Proctor & Truscott 2012, Smith 2003). Diverse faculty are essential to the recruitment of a diverse student body (Turner, Gonzalez, & Wood, 2008); minority students report difficulty finding a suitable mentor for academic and social support, and professors report the importance of sensitivity to a student's background (Lechuga, 2011). Female and URM students are at risk for difficulties and inequities in graduate school and may need specialized support; for more on students' needs and experiences, see below, "Identities in Institution." Cultural diversity in the graduate environment is associated with greater student satisfaction (Maton et al., 2011), and mentoring is important for a sense of belonging among Black and Latino students (Banuelos, 2006; Bonner & Evans 2004). Interacting with faculty with comparable gendered and racialized experiences in the academy can be beneficial for diverse students (Barker 2011; Milner 2004; Noy & Ray 2012); on the other hand, a lack of faculty diversity can be related to problems for students with underrepresented identities (Barker 2001; Bonner & Evans 2004; Felder 2010, Proctor & Truscott 2012). In addition, it makes sense that faculty turnover can be destabilizing to students in a graduate program if students lose their advisors or instructors. Both the presence of diverse faculty in students' graduate programs and the attrition of those diverse faculty from students' programs may relate to diverse students' experiences, and will be included as covariates in analyses, where appropriate.

Covariates of Attrition: Department Size and Time-to-Degree

Attrition is known to relate to both department size (Ehrenberg et al., 2007) and time-to-degree (TTD) (Lovitts, 2001). In order to account for this effect, department size and average TTD will be included as covariates in analyses with attrition, where appropriate.

Doctoral Students' Career Goals

Despite a common assumption in academia that all PhDs want faculty jobs, PhD students' career goals vary and change over time (Nerad, 2009). In line with faculty perceptions of student goals (Nerad, 2009), PhD students enter their programs with high rates of interest in faculty careers (Golde & Dore, 2001; Mason et al., 2009). Students find faculty jobs appealing because of the opportunity for intellectual challenge and autonomy (Lindholm, 2004); however, desire for a tenure-track career decreases over the course of graduate school, and only half of graduating students are interested in pursuing faculty careers (Austin, 2002; Golde et al., 2009; Ülkü-Steiner, Kurtz-Costes, & Ryan, 2000). Of the students who desire tenure-track jobs, 50-65% actually become professors, with another 35-50% in non-faculty careers (Nerad 2009; see also Golde & Dore, 2001; Lovitts, 2001; Nerad, 2004; Rudd et al., 2008).

Though some students remain committed to a faculty career, there are also drawbacks to faculty work. Not all students see tenure-track careers as a way to have the kind of meaningful work that they desire (Austin, 2002; Nerad, 2004). Many would-

be academics fear the supersaturated faculty job market and the difficulty and perceived randomness of success or failure (Austin, 2002; Britt & Shackelford, 2013; Golde & Dore, 2001; Golde, 1998; Jacks et al., 1983; Mangematin, 2000; Mason et al., 2009; Morrison et al., 2011; Rosser, 2004; Rudd, Nerad, et al., 2008). Students are also wary of the all-consuming faculty lifestyle (Austin, 2002; Egan, 1989; Golde & Dore, 2001; Golde, 1998; Mason et al., 2009; Ülkü-Steiner et al., 2000), and some eventually criticize the “single-minded devotion” of faculty life (Lovitts, 2001, p. 172; see also Golde 2005). The degree of family friendliness of academic careers is a source of significant concern for both male and female students, as well (Mason et al., 2009).

Research on graduates’ career paths has focused on how to prevent students, postdocs, or junior faculty from departing the tenure track (e.g., Ostrove, Stewart & Curtin, 2011); much less research has been done on students’ interest in NTT careers. The question of students’ career goals is complicated, not only because these career goals change over time, but also because NTT careers include every other possible job that a student could take after graduation. Students will necessarily have a wider range of reasons why careers may appeal to them if they find a wider range of careers appealing. Some aspects of NTT careers that students find consistently appealing are the potential in NTT careers for the kind of meaningful impact that graduates want in their jobs (Austin, 2002; Nerad, 2004) and that NTT careers seem more family friendly (Mason et al., 2009); in addition, NTT PhDs do well and are valued in the wider job market (Golde & Dore, 2001; Haworth, 1996; Mangematin, 2000). For these reasons,

increasing numbers of researchers and organizations are advocating for greater preparation for doctoral students who want to pursue NTT careers (Council of Graduate Schools, 2010; Dahan, 2007; Ehrenberg & Kuh, 2009; Golde & Dore, 2001; Johnston & Murray, 2004; Mangematin, 2000; Morrison et al., 2011; Nerad, 2004, 2009; Nyquist, 2002; Rudd, Nerad, et al., 2008; Servage, 2009).

Though there can be many benefits to NTT careers for PhDs, it must be recognized that many students pursue NTT careers after graduate school as a “second choice” following a switch away from initial faculty career aspirations (e.g., Golde & Dore, 2001). In addition, in developing NTT goals, students often face tenure-centric bias within academia, and those who have advocated for NTT career preparation have often been met with indifference or hostility (Aanerud et al., 2006; Dahan, 2007; Ellis, 2013; Morrison et al., 2011; Nerad, 2004, 2009; Rudd, Nerad, et al., 2008). Students note a lack of conversations about non-faculty (and non-elite faculty) careers, apprehension about articulating other career goals, and unsupportive climates toward students preparing for NTT careers (Golde, 2005; Nerad, 2004). In the end, given these contradictory pressures, graduate students who remain in doctoral programs may tend to rate tenure-track careers as more attractive than non-tenure-track careers.

Career Goals among Marginalized Students

Individual and collective identities can also influence career goals. Within the academy, underrepresented minority and female professors have been found to be more drawn to academia by a desire to influence change (Lindholm, 2004), and to

report higher interest in social and community-based work (Solem et al., 2009). While some minority students find that academia meets these goals, others decide that careers outside of academia are better routes to the kind of impact they desire (Austin, 2002; Kay, 1978; Nerad, 2004). Domestic URM students and women are less likely to have tenure-track career goals than white students and men (Council of Graduate Schools, 2008). A critical race feminist assessment would account for this differential pattern as a result of systematic inequities that drive marginalized scholars away from the academy, especially in the context of lower rates of hiring and advancement for URM tenure-track scholars, while also recognizing the validity of desires (noted directly above) to remain in the academy.

Domestic students of color and women are less likely to have tenure-track career goals (Golde & Dore, 2001). For URM students, lower rates of tenure-track career goals may be associated with more prevalent negative experiences in graduate school (Gay, 2004). Women shift their goals from a faculty career to a non-faculty career over the course of graduate school, partly due a perceived lack of family-friendliness of academia (Mason et al., 2009; Morrison et al., 2011; Nerad & Cerny, 1999; Rudd, Morrison, Picciano, & Nerad, 2008). Women are also more likely to leave the academy after a postdoc and before entering the professoriate (Moors, Stewart & Malley, 2014).

Career Goal Change over Time and Candidacy Status

Students enter their graduate programs with more interest in faculty careers than they have at graduation (Golde & Dore, 2001; Lovitts, 2000). Students' candidacy status

may serve as a proxy for understanding this change over time; more pre-candidates than candidates would be expected to have tenure-track goals. Accordingly, students' candidacy status will be assessed as a predictor in some analyses with career variables.

Individual and Environment: Career Goals in Context of Discipline and Climate

Discipline is a known environmental factor in variations in career goals (Nerad 2004; Mason et al., 2009), as well as field (Fox & Stephan 2001). Engineers show a preference for industry (Howell Smith, Garrett, Weissinger, & Chandra, 2011; Mangematin, 2000), while natural science graduates have a roughly equivalent interest in faculty and industry positions, on average (Fox & Stephan, 2001). More students in the humanities and social sciences want to be faculty than in the natural sciences (Nerad, 2004), though the natural sciences have undergone the same decrease in available tenure-track positions as other fields (Fox & Stephan 2001).

As far as I can tell, no research has been done on the role of graduate department or program climate in relation to students' post-graduation career goals. Nevertheless, it makes sense that individual students who perceive worse climates in their graduate programs will be less likely to have tenure-track career goals; a negative experience of the academic environment may dissuade students from remaining in academia after graduation, just as negative climate also predicts departure from academia before graduation.

Advisor Support for Student Career Goals

As Lovitts (2001) asserts, “The adviser is the central and most powerful person not only on a graduate student’s dissertation committee but also during the student’s trajectory through graduate school.” A large body of research shows that the advisor relationship is among the most influential factors in students’ decisions to continue or leave their graduate programs (Barnes & Randall, 2012; Council of Graduate Schools, 2010; de Valero, 2001; Ehrenberg et al., 2007; Golde, Bueschel, Jones, & Walker, 2009; Golde, 2005; Jacks et al., 1983; Lovitts, 2001). In addition to faculty relationships with students, components of the advising relationship such as interest in student work can also be related to attrition (Bair & Haworth 2004; Ferrer de Valero 2001; Lovitts 2001). In a longitudinal intervention, better advising improved completion rates (Ehrenberg et al., 2007). Students who do not have advisors, or who do not have good, supportive relationships with their advisors, are much more likely to leave their graduate programs (Barnes & Randall 2012; Council of Graduate Schools 2010; Ehrenberg et al., 2007; Gardner 2009; Golde 2005; Golde et al., 2009; Jacks et al., 1983; Ferrer de Valero 2001; Lovitts 2001).

The role of advisor support for specific careers after graduation with regard to attrition outcomes is less well understood. There is some evidence that advisors’ support can also be important to students with regard to their career outcomes. The centrality of the interaction between advisor and student makes advisor support for students’ careers a mesospheric variable. Advisors provide support primarily for faculty careers (Aanerud et al., 2006), and are extremely important allies to their

students on the faculty job market (Blackburn, Chapman, & Cameron, 1981). Faculty who produce more graduated students use more means to help those students get faculty jobs (Lovitts, 2001), and advisors have been found to help students who do not come from academic families to consider an academic career (Lindholm, 2004). Students pursuing tenure-track careers have reported enriched learning experiences and higher levels of interaction with faculty, compared to students with other career goals (Wang, 2003).

However, the role of advisor support for NTT careers is less well understood. Faculty are more likely to support students' tenure-track careers (Aanerud et al., 2006; Dahan, 2007; Ellis, 2013; Lovitts, 2001; Morrison et al., 2011; Nerad, 2004, 2009; Rudd, Nerad, et al., 2008), and rarely can or do provide significant support for students' NTT career goals (Aanerud et al., 2006; Dahan, 2007; Ellis, 2013; Golde, 2005; Morrison et al., 2011; Nerad, 2004, 2009; Rudd, Nerad, et al., 2008). Many authorities in universities still believe that that sole purpose of doctoral education is to prepare future (elite) faculty (Dahan, 2007; Ellis, 2013; Lovitts, 2001; Morrison et al., 2011; Nerad, 2004; Rudd, Nerad, et al., 2008), perhaps because institutional prestige is assessed partly through the placement of graduates in tenure-track positions in other highly-ranked research universities (Nerad, 2004). At research universities, PhD graduates are largely expected to pursue tenure-track jobs at similarly prestigious universities (Aanerud et al., 2006; Blackburn et al., 1981; Dahan, 2007; Ellis, 2013; Lovitts, 2001; Morrison et al., 2011; Rudd, Nerad, et al., 2008).

In turn, students are less comfortable talking to their advisors about non-faculty careers than they are about careers in academia (Aanerud et al., 2006; Barnes & Randall, 2012); indeed, some face extreme apprehension in disclosing their NTT career goals to their advisors (Golde, 2005). At least one study showed that students who had NTT career goals remembered their mentoring experience less favorably than graduates who had tenure track goals (Aanerud et al., 2006). Overall, then, advisors support TT careers more than NTT careers, regardless of their students' goals.

At the same time, many advisors may support their students regardless of career goal, just as some students are open to pursuing both NTT and/or tenure-track careers. Much of the research on attrition advocates for expanded support for NTT careers and students' career transitions (Aanerud, Homer, Nerad, & Cerny, 2006; Ehrenberg et al., 2007); unconditional advisor support for students' career goals may function in a slightly different way from domain-specific career support, and thus will be analyzed separately. At the present time, however, students report a need for broader advising on career options (Wang, 2003).

There is substantial evidence that advisor support is related to good outcomes for students, but we know less about how advisor support for particular goals, and the congruence of their support for particular goals with students' own aspirations, combine to predict outcomes. It makes sense, though, that if advisors support the goals students have for themselves, that students will be more likely to flourish in graduate school.

Identity in Institution: Inequities in Marginalized Students' Predictors of Attrition

Understanding the relationships between these predictors of departure may provide valuable insight into the processes that precede leaving the academy. As with attrition, students' race and gender can contribute to different perceptions of climate, compared to more privileged students (Crede & Borrego, 2013; Jacks et al., 1983; Settles, Cortina, Malley, & Stewart, 2006; Settles, Cortina, Stewart & Malley, 2007; Solem et al., 2009; Ulku-Steiner et al., 2000). Because climate is situated in a context that is subject to normalized and largely invisible biases against marginalized people (Ladson-Billings & Tate 1995), students with marginalized identities are at greater risk for negative experiences of department climate. Given that both marginalized identity status and climate are known to be associated with attrition (as discussed above), a person-environment theory would predict that experiencing the climate as negative could be a factor in higher rates of attrition among marginalized students.

Underrepresented racial-ethnic minorities may experience the climate of higher education as negative, isolating, discriminatory, and even dehumanizing (Gay, 2004; Gildersleeve, Croom, & Vasquez, 2011; Teranishi & Briscoe, 2006). Graduate students of color may perceive a negative racial climate because they feel that their contributions are only tolerated, rather than welcomed (Gay, 2004). Indeed, graduate curricula do not necessarily include information on topics that scholars of color are often interested in, such as ethnic and cultural differences (Gay, 2004; Le & Gardner, 2010; Stewart & Dottolo, 2005). In light of these negative experiences, these students are expected to give

the climate a lower rating than ethnic majority students.

“Chilly” climate is also pervasive for women at all levels in the academy (Baird, 2005; Settles, Cortina, Malley, & Stewart, 2006; Settles, Cortina, Stewart, & Malley, 2007; Ülkü-Steiner et al., 2000). Women report higher appreciation for supportive communities than men do, but experience a less tolerant, equitable, and diverse climate in universities (Solem et al., 2009). Studies of climate with female faculty show that women continue to experience harassment and chilly environments (Monk-Turner & Fogerty, 2010; Settles et al., 2006).

Students may also have different experiences of advisor support, depending on their marginalized identity status. Women and URM students get less mentoring than their more privileged peers, on average (Taylor & Anthony 2001; Turner & Thompson 2003) and are less satisfied with their advisors (Barnes & Wells, 2009; Lovitts, 2001). Students of color are less likely to be optimistic about their career preparation than white students, and Black and Latino academics are less likely to receive career guidance (Barnes & Wells, 2009; Gildersleeve et al., 2011). In general, marginalized students may perceive less support from their advisors, for all careers, in comparison to more privileged scholars, and experience less congruency between their career goals and the career goals that their advisor support.

Attrition and Career Goals & Support

Evidence on the role of career goals in influencing completion is mixed. Some evidence seems to indicate that students who leave the academic labor system before and after graduation may have similar career goals. Attrition is consistently related to a desire to live a more balanced work lifestyle than faculty seem to have (Austin, 2002; Egan, 1989; Golde & Dore, 2001; Golde, 1998; Lindholm, 2004; Mason et al., 2009). Some students leave because they perceive poor prospects for tenure-track employment and do not see utility in completing the PhD to prepare for NTT careers (Lovitts, 2001). However, students rarely leave their graduate programs solely because they change career plans from tenure-track to NTT (Lovitts 2001). Some students may switch to NTT goals and stay in the academy (Golde & Dore 2001), or even may have entered the academy with an NTT career in mind (e.g., Le & Gardner 2010). In the end, all departers have NTT career goals at the moment they exit, as they have chosen to leave the institution that allows them access to tenure-track careers. Students who decide to leave the academy may depart as soon as they realize that they do not have tenure-track career goals. NTT students, then, represent students at risk for attrition for two reasons: because NTT career goals can be part of a transition to departure, and because NTT career goals are generally not as supported as tenure-track careers.

There are also other factors that may relate to attrition. An environmental factor that may contextualize individual attrition and career decisions is the relative scarcity of tenure-track jobs compared to past eras (Austin, 2002; Golde & Dore, 2001; Golde, 1998; Jacks et al., 1983; Lindholm, 2004; Mason, Goulden, & Frasch, 2009; Morrison, Rudd, &

Nerad, 2011; Rosser, 2004). This external pattern has been reflected in students' decreasing interest in tenure-track careers over the course of graduate school (Golde & Dore, 2001; Ülkü-Steiner, Kurtz-Costes, & Ryan, 2000).

It makes sense, then, for advisor support for particular career goals to influence students' career goals and their choices about remaining in graduate school. In particular, student interest and advisor support for non-tenure-track (NTT) careers may be associated with lower attrition among the students at higher risk for attrition, such as women and students of color. These students are less likely to graduate and to enter the tenure track in general; however, higher advisor support for NTT careers may help these students persist to completion of their degrees, even if they do not anticipate a traditional tenure-track career. Indeed, some research recommends socializing all students to both careers outside of and within academia from the beginning of their programs (Aanerud, Homer, Nerad, & Cerny, 2006). While many within the academy question the value of supporting NTT students through to completion (Aanerud et al., 2006; Dahan, 2007; Lovitts, 2001; Morrison et al., 2011; Nerad, 2004, 2009; Rudd, Nerad, et al., 2008), dismissing students with NTT career goals ignores the valuable work that NTT Ph.D. graduates engage in through industry, government, and research positions (Golde & Dore, 2001; Haworth, 1996; Mangematin, 2000).

Research Questions

In this dissertation, I examine contextualized relationships between attrition, post-graduation career goals, and individual and environmental experiences in

graduate programs. I propose five research hypotheses (also in Appendix A, for reference):

- (1) that attrition will relate to a range of individual and environmental characteristics, reflecting departmental variations by race representation, gender representation, and discipline of study, and the environmental influence of average department climate;
- (2) that students' career goals will relate to the same individual and environmental variables as attrition: race, gender, discipline of study, and climate, as well as the individual variable of candidacy status and the interpersonal variable of advisor support for the student's career goal;
- (3) that students will generally perceive advisors as more supportive of tenure-track careers compared with tenure-track careers;
- (4) that women and racial minority students will have less positive experiences of the environmental factors of climate, and perceived advisor support for career goals;
- (5) that departmental attrition will be related to the department averages of students' career goals, and perceived advisor support for career goals.

Chapter 2: Method

Participants and procedure. Three archived datasets were used for different analyses: Rackham Graduate School's Program Characteristics dataset, ADVANCE's Graduate Students dataset, and ADVANCE's Faculty Survey dataset. See Appendix B for a complete list of variables within each dataset, and an index of hypotheses in which each variable is analyzed. See Appendix C for additional descriptive statistics of the data, such as averages by gender and field of study.

Program Characteristics Dataset.

Rackham Graduate School at the University of Michigan has collected and publicly posted various characteristics of graduate departments; all departments were required to provide complete information. Data for the departments in the Graduate Students Dataset (below) were retrieved; of the departments in which faculty and doctoral students were surveyed, 25 departments had corresponding program data, and 5 programs were not part of Rackham or did not have corresponding data available¹.

¹ Departments that were present in the Program Characteristics dataset but not in the Graduate Students dataset were Screen Arts and Cultures in the Humanities (new program without attrition data); Romance

Program data from the 2000-2004 cohorts were used for these analyses, since most students admitted to those cohorts had enough time to complete or depart from their programs before the other data used in this study were collected (though inevitably a few late completers remained in the dataset). Other measures in the Program Characteristics dataset correspond to the same period, in order to ensure that the data are based on a consistently-defined cohort. See Table 1 for descriptive statistics of this dataset.

Program Measures

Program Attrition. Rackham Program Statistics include data on the number of students from the 2000-2004 cohorts who had officially withdrawn from their graduate program as of 2012. Department-level data were collected to correspond to the years when the individual students studied in the other datasets entered graduate school. Attrition rate was calculated as the percentage of departers out of the initial number of students admitted for the 2000-2004 cohorts. Thus attrition is a department-level variable assessing overall rate of attrition, and is not an indicator for any given individual student. The average rate of attrition across the 25 departments included in the analysis was 28%, with departments varying from a low of 5% attrition to a high of

Languages and Literatures in the Humanities (attrition data was disaggregated and not comparable to other departments), and the Schools of Public Health, Education, and Information in the Professional Schools of Natural and Social Sciences (non-Rackham departments for which attrition data was not available).

53%.²

Program representation of women and underrepresented racial-ethnic minorities.

Program-level data were collected for 2000-2004 on the percentage representation of women and of students who identified as URM (Black, Latino, American Native/First Nations, and Other), out of the students who were admitted into the department for the 2010-2013 cohorts. Thus race and gender are department-level variables assessing overall rate of representation, and not an indicator for any given individual student. The average rate of representation of underrepresented minority students in departments under study was 25% (with a low of 2% and a high of 49%), and the average rate of representation of women was 41% (with a low of 11% and a high of 95%).

Department size. Department size, or the total number of entering graduate students, for the 2000-2004 cohorts was provided by each department. The average combined size of the four cohorts was 70 students with a range of 17 to 224 ($SD=68.14$).

Time-to-degree. The average time-to-degree among the 2000-2004 cohorts was provided by each department. The average TTD across departments was 5.7 years with a range of 4.3 to 7.8.

² The departments included were, by field: Humanities (Romance Languages and Literatures, History of Art, Classics, Comparative Literature, Screen Arts, Germanic Languages & Literatures, Philosophy), Social Sciences (Economics, Linguistics, Anthropology), Natural Sciences (Ecology & Evolutionary Biology, Molecular, Cell, and Developmental Biology, Math, Astronomy, Statistics), Engineering (Chemical Engineering, Industrial and Organizational Engineering, Civil and Environmental Engineering, Computer Science & Engineering, Electrical & Computer Engineering, Macromolecular Science and Engineering, Aerospace Engineering, Atmospheric, Oceanic & Space Sciences, Applied Physics, Nuclear Engineering and Radiological Science), and Professional Schools in Social and Natural Sciences (Schools of Information, Nursing, Public Health, and Education).

Table 1*Descriptive Statistics for Selected Department Characteristics, 2000-2004.*

Variables	<i>n</i>	<i>M</i>	<i>SD</i>	Range
Graduate Student Attrition	25	28.59%	9.86	5%-53%
Graduate Student URM Representation	25	9.32%	6.23	1%-24%
Graduate Student Asian Representation	25	9.88%	6.80	0%-26%
Graduate Student Female Representation	25	40.64%	21.22	11%-95%
Department Size, 2000-2004	25	69.96	57.26	17-224
Time to Degree	25	5.73	.98	4.30-7.80

Department Faculty Dataset.

The NSF ADVANCE Program at the University of Michigan has collected data and prepared reports on faculty characteristics and retention for departments that engaged in climate studies; all of these departments were required to provide complete information. Data for the departments in the Graduate Students Dataset (below) were used in these analyses; data were available for 26 of the 30 departments in the Graduate Students Dataset, and unavailable for 4 departments. Because these measures are expected to covary with attrition, data were collected using the same timeframe as attrition, 2000-2004; the number of departments in this sample includes all departments with attrition data, in addition to four departments that were sampled by ADVANCE that did not have corresponding attrition data. See Table 2 for descriptive statistics of this dataset.

Faculty representation of women and underrepresented racial-ethnic minorities.

Department-level data were collected on the percentage representation of faculty who identified as women and/or URM. Because faculty diversity may covary with attrition, data on faculty composition were collected for the time period when the attrition cohorts entered their programs, 2000-2004. The average rate of URM faculty representation across the 26 departments with available data was 8%, with a range of 0-33% ($SD=6\%$). The average rate of female faculty representation across the 26 departments as 26%, with a range of 0-96% ($SD=16\%$).

Faculty attrition. Department-level data were collected on faculty departures.

Retirements were not counted for the purposes of these analyses because retirements usually planned, and therefore are not likely to contribute to instability in students' advising experiences. Faculty attrition is included because it may covary with student attrition. The average rate of faculty attrition across the 26 departments was 4%, with a range of 0-8% ($SD=2\%$).

Table 2
Descriptive Statistics for Faculty Characteristics.

Variables	<i>n</i>	<i>M</i>	<i>SD</i>	Range
URM Faculty %	26	0.08	0.06	0%-33%
Female Faculty %	26	0.26	0.16	0%-96%
Faculty Attrition Percentage	26	0.04	0.02	0%-8%

Graduate Students Dataset.

Between 2009 and 2013, graduate students across 30 departments were asked to

participate in a survey about their overall experiences in their departments at the University of Michigan. Ph.D. students were recruited via email to complete an Internet survey to assess their experiences of climate and other aspects of their graduate education experience in different departments.

Three departments had been surveyed twice (Near Eastern Studies, Public Health, and Philosophy); in all cases, the most recent survey data from that department were used, and the older survey data (94 students) were excluded. The dataset was also assessed for missing data; 187 students were excluded because they were missing all outcome measures.

International students are another marginalized group within the academy, yet they are extremely successful in comparison to women and domestic students of color. Despite facing an alien culture, isolation, and (for some) language difficulties, international students graduate at higher rates than domestic students and have a higher sense of belonging in academia (Council of Graduate Schools, 2010; Curtin, Stewart, and Ostrove, 2013; Le & Gardner, 2010). Because international students have different patterns of experiences from domestic students, 219 international students were excluded from these analyses. International status was assessed through the same opt-in measure as for underrepresented minorities, through a checkbox in an "I belong to this group" table.

The final sample was 1177 US-born Ph.D. students in 30 departments. The average response rate was 62% and ranged from 41% to 100%. Of the students in the

dataset for analysis, 47% (522) were women; data on gender were missing for 68 participants. Data on race/ethnicity were collected in the context of group identifications (“I belong to”); 13% of participants self-identified as underrepresented ethnic minorities (n=157). Underrepresented minorities may be slightly underreporting their racial identity in the “I belong to” table. Alternatively, since there was no definition provided, students may be overrepresenting their URM status. Asian students may self-select as URM in departments in which they are a numerical minority, though the federal Census categories would not classify Asian as URM. It was not possible to make further distinctions within race-ethnicity because the ADVANCE dataset only includes information on self-selected URM status, and not any information on other forms of racial-ethnic identification.

See Tables 3 and 4 for descriptive statistics for this dataset for the overall student sample. See Appendix C for descriptive statistics and preliminary comparisons on major outcome variables, compared by URM status, gender, candidacy status, field, and career goal.

Individual Measures

Gender. Students were given the option of selecting “female” or “male.” Some students were also given the option “transgender or other” starting in 2013 (at my recommendation), but no students had selected this option at the time of the data analysis. However, transgender graduate students certainly exist at UM and their experiences are either excluded or included under binarist labels in these analyses.

Women are represented at 47% ($SD=.50$). See Appendix C for additional tables of descriptive statistics, compared by gender.

Underrepresented racial-ethnic minority status. As already noted, participants were given the opportunity to indicate underrepresented minority status in the context of the survey of student climate. It included a six-item checklist of identity groups with the prompt “I belong to this group,” and the answer option “underrepresented minorities” (among others such as “sexual minorities”). The US Census defines URM as Black, Latino/a, First Nations/ American Native, and other race-ethnicity identifications that are neither White nor Asian/ Asian American. However, in the study, students were not given a definition of “underrepresented minority,” so the students who selected that option may differ from the definition of URM above. URM students may be underrepresented in the analyses, since women were less likely to self-identify through the “I belong to” table than they were through other measures. Underrepresented minority students identified themselves at a rate of 13% ($SD=.50$), which is roughly consistent with graduate school data as a whole. Students will be referred to as either URM or “majority” throughout, though “majority” may include Asian and other non-white students as well as white students. See Appendix C for additional tables of descriptive statistics, compared by URM status.

Candidacy status. Candidacy status is awarded after completion of all requirements for the PhD except the dissertation proposal and the resulting dissertation. Therefore, it indicates rough status in the program as “early” or “late.”

Students were given two options to indicate their candidacy status, using terms in common use on this campus: “pre-candidate” and “candidate.” Candidacy status is included as a covariate to approximate change over time during graduate school. More students were candidates than not, at 68% ($SD=.49$). See Appendix C for additional tables of descriptive statistics, compared by field.

Field of study. During data collection, each student was given a code corresponding to their department. Departments were recoded into a field of study variable: humanities students in the College of Literature, Sciences, and the Arts (LSA) ($n=138$); social science students in LSA ($n=165$); natural science students in LSA ($n=109$); engineering students ($n=387$); and applied social and natural sciences students in professional schools (Schools of Information, Education, and Nursing; $n=380$). See Appendix C for additional tables of descriptive statistics, compared by field.

Table 3
Descriptive Frequencies of Demographic Characteristics and Field of Study.

Variable	<i>n</i>
URM Status	
URM	157
Non-URM	1022
Gender	
Female	522
Male	589
Candidacy Status	
Pre-Candidate	465
Candidate	656
Field of Study	
Humanities	138
Sciences	109
Applied Engineering	387
Applied Social & Natural Sciences	380
Social Sciences	165

Climate. The survey of student climate included a 16-item scale assessing aspects of the department environment, on five-point bipolar scales. The bipolar items included racist/non-racist, sexist/non-sexist, homophobic/non-homophobic, exclusionary/inclusionary, alienating/welcoming, hostile/friendly, diverse/homogenous, disrespectful/respectful, contentious/collegial, individualistic/collaborative, competitive/cooperative, not supportive/supportive, rigid/flexible, threatening/protective, discouraging/encouraging, and snobbish/down-to-earth. An aggregate climate score for each student was calculated by averaging the scores of the items, after ensuring that all high scores were coded or reverse-coded such that a higher score represented a more positive perception of climate ($\alpha=.93$). Students were prompted, "Please rate [your department's] climate on the following

continua by selecting the appropriate radio button." Students generally rated the climate to be moderately positive (3.82 on a 5-point scale; $SD=.71$, range 1.06-5.00).

Attractiveness of career goals. The survey of graduate student climate included a nine-item scale of the attractiveness of career goals, with instructions that read, "Below are goals that many graduate students have for the future. Please rate how attractive each of these goals is to you personally." Participants were asked to rate each career goal on a four-point scale that ranged from "very unattractive" (coded as 1) to "very attractive" (coded as 4).

Of these, two indicated interest in NTT careers and were used as measures of NTT career attractiveness: "get a research job in industry or the private sector" ($M=2.81$, $SD=.89$) and "get a job in a non-profit or government agency." ($M=2.85$, $SD=.84$)³ From the same scale of attractiveness of careers, two careers were selected to represent tenure-track career attractiveness: becoming a professor in a top research university ($M=2.98$, $SD=.69$), and becoming a professor in a 4-year college ($M=3.01$, $SD=.85$). Two departments were missing partial data for these measures: Classics did not ask students about any NTT career goals, and Public Health did not ask about non-profit/government careers.

Advisor support for students' career goals. The survey of student climate included a nine-item scale of perceived advisor support for careers. Participants were asked to rate

³ While many other NTT careers exist, such as adjunct teaching or full-time caregiving, the options included in this analysis were selected because they were the NTT options available in the original data.

their advisor's support on a three-point scale that ranged from "not at all supportive" (coded as 1) to "very supportive" (coded as 3). Of the items, two indicated support for NTT careers and were used as measures of advisor support for NTT careers: "get a research job in industry or the private sector" ($M=2.33$, $SD=.69$) and "get a job in a non-profit or government agency" ($M=2.22$, $SD=.69$). Two items from the career goals scale were used to test for advisor support for tenure-track careers. The two items representing tenure-track careers were: become a research professor in a top research university ($M=2.75$, $SD=.49$), and become a professor in a 4-year college ($M=2.54$, $SD=.61$). Two departments were missing partial data for these measures: Classics did not ask students about any NTT career goal support, and Public Health did not ask about non-profit/government career goal support.

Unconditional advisor support for careers. One item was included from the Advisor Support section to assess flexible advisor support for students' careers. Students were asked to rate if their advisor "would support me in any career path I might choose" on a scale of 1 (strongly disagree) to 4 (strongly agree). Students agreed that their advisors would support any of their career paths at a moderately high rate ($M=3.07$, $SD=.78$).

Instrumental and psychosocial advisor support. In line with Curtin and colleagues, advisor support was assessed as a predictor of career goals (Curtin, Malley & Stewart, 2013); two forms of advisor support, instrumental and psychosocial mentoring, were included in order to assess whether advisor support for specific careers functions differently from general advisor support. Instrumental advisor support included seven

items on ways in which a mentor can help students prepare skillsets for careers: teaching students the details of good research practice, advising students about getting their work published, providing regular and constructive feedback on students' research, assisting students in writing publications, teaching students to write grants and research proposals, instructing students in teaching methods, and helping students secure funding ($M=2.91$, $SD=.63$, $\alpha=.86$). Psychosocial advisor support included eight items on the ways in which a mentor can provide interpersonal support during graduate school: treating students' ideas with respect, building students' confidence, treating students as whole persons and just as scholars, treating students' ideas with respect, providing students with emotional support when they need it, being easy to discuss ideas with, treating students as colleagues, inspiring students intellectually, and encouraging students' interests and goals ($M=3.16$, $SD=.64$, $\alpha=.92$). Students were asked to rate whether their advisors provided these kinds of support on a scale ranging from 1 (strongly disagree) to 4 (strongly agree).

Table 4

Descriptive Statistics for Climate, Career, and Advisor Support Variables.

Measure	M	SD
CLIMATE	3.82	.71
CAREER GOALS		
Research University	2.98	.69
4-Year College	3.01	.85
NTT Overall		
Private Sector Research	2.81	.69
Non-Profit or Government	2.85	.84
ADVISOR SUPPORT		
Research University	2.75	.49
4-Year College	2.54	.61
Private Sector Research	2.33	.69
Non-Profit or Government	2.22	.69
Unconditional Career Support	3.07	.78
Instrumental Support	2.91	.63
Psychosocial Support	3.16	.92

See Appendix C for additional tables of climate, career goal, and advisor support variables, compared by URM status, gender, candidacy status, and field.

For descriptive purposes, Table 5 displays correlations between career goal and advisor support variables. Additional correlations between variables in the Graduate Student Dataset are in Appendix D.

Table 5
Correlations Between Career Goal and Advisor Support Variables.

	1	2	3	4	5	6	7	8	9
1. Goal: Private Sector Research	---						-		
2. Goal: Non- Profit or Government	.177**	---					-		
3. Goal: Professor at Research University	-.051	-.096**	---						
4. Goal: Professor at 4- Year College	-.230**	.028	.401**	---	-				
5. Support: Private Sector Research	.247**	.033	-.021	-.040	---				
6. Support: Non-Profit or Government	.084*	.222**	-.012	.003	.606**	----			
7. Support: Professor at Research University	-.044	-.022	.200**	.177**	.327**	.283**	---		
8. Support: Professor at 4- Year College	-.139**	.019	.157**	.343**	.349**	.372**	.544**	---	
9. Unconditional Advisor Support	.014	-.008	.081*	.042	.416**	.441**	.136**	.274**	---

Note: * $p < .05$ ** $p < .01$ *** $p < .001$. Hypotheses

In this section, I will outline five broad research questions, and list the specific hypotheses that address those questions. See Appendix B for a complete index of hypotheses.

First, the institutional factor of department rate of attrition should be related to the institutional factors of departmental representation of underrepresented minority and female students, discipline type, and average department climate (Research Question 1). Higher rates of attrition will be associated with higher representation of URM (Hypothesis 1a) and female (Hypothesis 1b) students, because more students of color and women enter their programs initially, then leave their programs before completion (Council of Graduate Schools, 2010; Denecke et al., 2009; Gardner, 2009, 2010; Lovitts, 2001; Solem et al., 2009). Consistent with the work of Bair and Haworth (2005) and Gardner (2010), there should be lower rates of attrition in the natural sciences and engineering than in the humanities and social sciences (Hypothesis 1c). The institutional factor of department rate of attrition should be related to the mesospheric/interpersonal factor of perceived department climate; consistent with previous research (Bair & Haworth, 2005; de Valero, 2001; Ehrenberg et al., 2007; Lovitts, 2001), higher rates of attrition should be related to lower ratings of average department climate (Hypothesis 1d).

Second, the individual outcome of students' post-graduation career goals should be related to the same individual/microsphere, interpersonal/mesosphere, and institutional/macrosphere factors as attrition, as well as the additional factors of candidacy status and advisor support for careers (Research Question 2). Career goals should be related to the individual factors of race (Hypothesis 2a) and gender (2b), because minorities and women are generally less likely to desire tenure-track jobs than

their more privileged counterparts. Candidacy status should relate to career goals, with more pre-candidates than candidates interested in tenure-track career goals (Hypothesis 2c), in line with the finding that students' interest in tenure-track careers decreases over the course of graduate school. With regard to the institutional factor of discipline, NTT career goals should also be more common in the natural sciences, congruent with previous research (Fox & Stephan, 2001; Mason et al., 2009; Nerad, 2004) (Hypothesis 2d). Career goals should also be related to the mesospheric factor of climate (Hypothesis 2e), because I theorize that NTT goals arise from parallel processes to those of attrition. The same factors should have the same effects in the same direction, with higher rates of NTT career goals corresponding to lower perceived climate.

Third, students generally will perceive their advisors as more supportive of tenure-track careers than NTT careers (Research Question/Hypothesis 3), consistent with previous research that finds greater advisor support for tenure-track careers (Aanerud et al., 2006; Dahan, 2007; Lovitts, 2001; Morrison et al., 2011; Nerad, 2004, 2009; Rudd, Nerad, et al., 2008).

Fourth, the individual factors of race and gender should be related to the mesosphere/interpersonal factors that relate to attrition (climate, perceived advisor support, congruency between student's career goal and perceived advisor support for that goal); inequities in these experiences may contribute to inequities in attrition rates (Research Question 3). Congruent with previous findings (Gay, 2004; Gildersleeve et al., 2011; Settles et al., 2006; Teranishi & Briscoe, 2006), underrepresented minority and

women students will report more negative experiences of climate (Hypothesis 4a). Women and minority students should also report lower levels of perceived advisor support for career goals (Hypothesis 4b), as has been found in previous research (Antony & Taylor, 2001; Barnes & Randall, 2012; Turner & Thompson, 2003).

Fifth and finally, the institutional factor of departmental attrition should be related to the department averages of the individual factor of student career goal (5a), because the same factors often precede both outcomes; department averages are used for statistical compatibility with attrition data. An analysis of attrition and the department averages of the interpersonal factor of advisor support for careers (5b) test an extension of the general finding, to determine whether the relationship between advisor support and attrition is influential in the specific domain of advisor support for careers.

Plan for Analyses

First, I will examine the descriptive statistics associated with each variable. Understanding baseline data will provide important context for analytic variations. I will test for the covariates of attrition, using correlations between doctoral student attrition and faculty diversity, faculty attrition, time-to-degree, and department size.

In the first set of analyses, I will focus on the relationships among department-level, institutional indicators. I will use correlation coefficients to assess whether departmental rate of attrition is significantly related to representation of women and

underrepresented minorities in the department. I will use one-way ANOVA to examine the relationship between field of study and attrition rate, and regression to examine the relationship between attrition and climate (RQ1).

I will test for differences in students' career goals in relation to the same factors used in analyses for attrition (RQ2): race (H2a), gender (H2b), climate (H2e), and discipline (H2d), in addition to the new factors of candidacy status (H2c) and advisor support for career goals (H2f). Running these analyses in mixed modeling at level 2 (because they are individual variables) and including a random variable at level 1 (department level) enables the output to distinguish the relative influence of individual variation and variation due to department-level influence.

In the third analysis, I will test whether students perceive their advisors to be more supportive of tenure-track careers than non-tenure-track careers (RQ3/H3) using a pairwise t-test.

In the fourth set of analyses, I will test for differences in students' mesospheric experiences of climate (H4a) and advisor support (H4b), with two binary categories of comparison: race and gender (RQ4). I will also assess whether the variation related to the influence of race and gender varies by department, using multilinear modeling. It may be that race and gender have larger effects on the variation in students' experiences in some departments, and not others. In order to assess this possibility, I will run mixed-model analyses with race or gender as a level-2 (individual-level) predictor; with climate or average advisor support as a level-2 (individual-level) dependent variable;

and with a random intercept in the mixed modeling equation at level 1 (department level), in order to allow for the influence of race or gender to vary by department (level-1 variable). Mixed modeling accommodates categorical, continuous, and binary variables, and thus does not require distinctions in analyses such as those between regression and ANOVA. The final result of using mixed modeling in this analysis is that it will allow me to assess how much of the variation in an individual student's experience is due to the individual's race or gender, and how much of the variation in an individual student's experience is due to departmental variations in the influence of race and gender on that individual's experiences. Thus, being a racial-ethnic minority or a woman may have stronger statistical influence in some departments, and this method captures the variation in departmental influence.

In the fifth and final set of analyses, I will examine whether departmental attrition is associated with students' career-related experiences (RQ5). I will test the relationships between departmental attrition rate and departmental averages of students' career goals and advisor support for careers. Using the departmental averages is statistically necessary for these analyses, because it is unsound to use individual-level variables to predict department-level outcomes, and the attrition variable is only available at the department level. I will use a correlation to test the relationship between departmental attrition rate and the departmental average of career goals, average congruency between advisor support and student goals, and average advisor support for NTT and TT careers. Because the analyses for Hypothesis 5 will be conducted using

the department averages, the sample sizes will necessarily be smaller than is ideal for statistical analyses (maximum $n=25$).

Chapter 3: Results

Preliminary results: Covariates of attrition. Potential covariates of departmental rate of graduate student attrition were investigated through preliminary correlations with variables including departmental URM and female faculty representation, departmental faculty attrition, average departmental time-to-degree, and average department size (See Table 6). Only one of these variables was significantly correlated with graduate student attrition at the departmental level: departmental representation of URM faculty (see Table 6; $r=-.44$, $p=.010$). This negative relationship indicates that departments with more URM faculty are likely to have lower rates of graduate student attrition than departments with fewer URM faculty. Given the significance of this relationship, analyses of departmental graduate student attrition included faculty URM representation as a covariate. However, including URM faculty representation as a covariate in attrition analyses did not change the significance of the analyses in any case, and results are presented without the covariate unless otherwise noted.

Research Question 1: Attrition and departmental characteristics. Departmental rate of graduate attrition was hypothesized to correlate with measures of diversity: that is, departments with more URM (Hypothesis 1a) and female students (Hypothesis 1b) were expected to have higher rates of attrition, given previous research showing that

women and underrepresented minorities drop out at higher rates than their more privileged counterparts. The relationships between department rate of graduate student attrition and department representation of women and URM students were assessed via correlation for the departments in the ADVANCE sample; neither gender nor race representation among graduate students in the department was significantly related to the departmental rate of attrition ($r=.05, p=.818$ for gender, $r=-.002, p=.991$ for URM students, and $r=-.25, p=.223$ for Asian students; $n=25$ for all).

Table 6
Covariates of Departmental Graduate Student Attrition.

Measure	1	2	3	4	5	6
1. Attrition	---					
2. % URM Faculty	-.44*	---				
3. % Female Faculty	-.13	.46**	---			
4. % Faculty Attrition	.15	-.20	-.26	---		
5. Time-to-Degree	.13	.27	.60**	-.27	---	
6. Cohort Size	.13	-.05	-.41	.74***	-.27	---

Note: * $p<.01$ ** $p<0.01$ *** $p<.001$.

Attrition and diversity were also not significantly related when faculty URM representation was included in a partial correlation, per results above that show that faculty URM representation is significantly correlated with departmental rate of graduate student attrition ($r=.15, p=.963$ for gender and $r=.01, p=.500$ for URM status; $n=23$ for both). It should be noted that analyses conducted at the department level necessarily have much smaller n 's than individual-level analyses.

Attrition rate of graduate students was also hypothesized to vary by discipline (Hypothesis 1c). A one-way ANOVA was used to test for differences in rate of graduate

attrition among four of the disciplines in the ADVANCE dataset (Applied Social and Natural Sciences was excluded because most departments lacked attrition data); at the department level, attrition did not vary significantly across disciplines, $F(3, 24)=.33$, $p=.801$. Rates of attrition were highest in the humanities ($M=32\%$), equal in the sciences and engineering (28% for both), and lowest in the social sciences (26%); this was as predicted for the humanities, natural sciences, and engineering, and not as predicted for the social sciences, which were predicted to have attrition rates closer to those of the humanities (social sciences had a lower rate than expected).

Departmental attrition was also hypothesized to relate to students' perceptions of climate (Hypothesis 1d). A correlation was used to test for a relationship between departmental average of climate and departmental rate of graduate student attrition; climate was not significantly related to attrition ($r=-.12$, $p=.568$). Climate and attrition were also not significantly related when URM faculty representation was included as a covariate of attrition, $r=.06$, $p=.809$.

Research Question 2: Career goals and student characteristics. URM (Hypothesis 2a) and female students (Hypothesis 2b) were expected to report less interest in tenure-track careers than majority students. Hypothesis 2a was tested in mixed modeling; analyses were conducted using the HLM 7 software package. The individual characteristic (level 2 variable) of URM status was expected to relate to individual students' career goals (level 2 outcome). Mixed modeling is used to prevent inflation in ANOVA and regression as a result of data that come from within nested structures. In

this case, the structure that the students are nested in is the department (level 1 variable). See Appendix E for a complete index of HLM equations in this dissertation.

The hypothesized relationship between URM status and career goals was tested using multilevel regression (Hypothesis 2a). The model tested for main (level-1) effects of race on career goals, and for random effects of the level-2 intercept (departmental variation). Initial mixed modeling analyses did not show a significant relationship between URM status and tenure-track career goals (research university: $\beta = -.04$, standard error = .08, $p = .601$, Equation 1; 4-year college: $\beta = -.02$, s.e. = .08, $p = .843$, Equation 2). The relationship between URM status and NTT career goals (Hypothesis 2a) was partially supported in mixed modeling; URM status tended to relate to non-profit or government career goals ($\beta = .15$, s.e. = .08, $p = .071$, Equation 3), though URM status was not related to interest in careers in private sector research ($\beta = .06$, s.e. = .07, $p = .338$, Equation 4). Women were also hypothesized to have fewer tenure-track career goals than their more privileged counterparts (Hypothesis 2b). The hypothesized relationship between gender and career goals was tested in mixed modeling using multilevel regression. The model tested for the individual-level predictor of gender on reported career goals (level 1 main effect), and for random effects for the level-2 intercept (variance related to nesting students in departments). Female Ph.D. students were significantly less likely than their male counterparts to report interest in careers at a research university ($\beta = -.22$, s.e. = .06, $p < .000$, Equation 5). However, women were not more or less likely to report interest in working at 4-year colleges ($\beta = -.03$, s.e. = .05,

$p=.600$, Equation 6). Within NTT goals, women were not more or less likely to report interest in working in private sector research ($\beta=.03$, $s.e.=.06$, $p=.664$, Equation 7); however, and like their URM fellows, women were more interested in working in non-profit or government careers ($\beta=.24$, $s.e.=.05$, $p<.000$, Equation 8). Candidacy status was predicted to relate to tenure-track careers, with lower rates of tenure-track career desire among older students (Hypothesis 2c). Career goal differences by candidacy status were assessed in multilevel modeling. Predicted differences between candidates and pre-candidates with regard to tenure-track career goals were partially supported in a multilevel regression: candidates were less interested in careers at research universities ($\beta=-.12$, $s.e.=.06$, $p=.041$, Equation 9). Candidacy was not found to be significantly related to either the remaining tenure-track career goal (4-year colleges: $\beta=.05$, $s.e.=.06$, $p=.380$, Equation 10) or to goals for a non-tenure-track career in nonprofits or government: $\beta=-.06$, $s.e.=.04$, $p=.175$, Equation 11. However, candidates were more interested than pre-candidates in private sector research ($\beta=.13$, $s.e.=.06$, $p=.023$, Equation 12). Students' career goals were hypothesized to vary by field (Hypothesis 2d). A relationship between field and students' tenure-track career goals was also supported in mixed modeling. The five categories for field were coded into dummy variables for categorical comparisons in HLM, with social sciences as comparison group in the dummy coding. In a multilevel regression model predicting students' career goals, field was included in the model as a fixed effect at level 2; field is included at level 2 because it is a departmental characteristic, and not a student characteristic (Equation 13). There were significant effects for field in all categories (See

Table 7). Students in Engineering, natural sciences, and applied social and natural sciences were all less interested in both kinds of tenure-track career goals, at both 4-year colleges and research universities. In addition, students in those same fields were more likely to report interest in private sector research; in contrast, students in the humanities tended to be less likely to report interest in private sector research. Overall, this means that students in all of these fields were less likely than students in the social sciences (dummy-coded as the reference group in analyses) to desire tenure-track careers overall.

Table 7
Hierarchical Linear Models of Field of Study and Students' Career Goals.

	Humanities		Natural Sciences		Engineering		Applied Social & Natural Sciences	
	<i>B</i>	<i>se</i>	<i>B</i>	<i>se</i>	<i>B</i>	<i>se</i>	<i>B</i>	<i>se</i>
	Private Sector Research	-.30 ^t	.15	.31 ^t	.15	.74 ^{***}	.11	.25 [*]
Non-Profit or Government Research University	-.27 ^t	.13	-.22	.14	-.05	.13	-.03	.13
4-Year College	.03	.10	-.24 [*]	.11	-.47 ^{***}	.05	-.41 ^{**}	.13
	.13 ^t	.07	-.28 ^{***}	.05	-.66 ^{***}	.09	-.39 ^{**}	.11

Note: ^t $p < .10$ ^{*} $p < .05$ ^{**} $p < .01$ ^{***} $p < .001$.

Students' career goals were also expected to be related to their perceptions of climate (Hypothesis 2e). Mixed modeling showed support for a significant positive relationship between climate and students' research university tenure-track goals ($\beta = .26$, $s.e. = .04$, $p < .000$, Equation 14) and students' 4-year college tenure-track goals ($\beta = .08$, $s.e. = .04$, $p = .045$, Equation 15). The relationship between climate and students' NTT career goals was not significant in mixed modeling (private sector research: $\beta = .01$,

s.e.=.05, $p=.804$, Equation 16; non-profits or government: $\beta=-.04$, s.e.=.04, $p=.327$, Equation 17).

Career goals were also predicted to be related to the mesospheric characteristics of perceived advisor support for careers (Hypothesis 2f). Analyses showed a relationship between tenure-track careers and advisor support for tenure-track careers, in both research universities (Hypothesis 2f) and 4-year colleges. A multilevel regression model tested for the main effects of advisor support for research university careers on research university tenure-track goals among graduate students. The relationship between perceived advisor support for research university tenure-track careers and research university tenure-track career goals was significant ($\beta=.34$, s.e.=.07, $p<.000$, Equation 18). In addition, the relationship between 4-year college career goals and 4-year college career goal support was also significant ($\beta=.49$, s.e.=.04, $p<.000$, Equation 19). When advisors supported one tenure-track career, students also had higher interest in the other tenure-track career; thus, support for 4-year college career goals was associated with students' research university goals ($\beta=.22$, s.e.=.05, $p<.000$, Equation 20). In addition, support for research university career goals was also associated with students' 4-year college career goals ($\beta=.24$, s.e.=.06, $p<.000$, Equation 21).

Mixed modeling analyses also supported the significance of the relationship between NTT career goals and NTT advisor support (Hypothesis 2f). A multilevel regression model was run in HLM; the model tested for the individual-level predictor

of perceived advisor support for NTT careers on the outcome of NTT goals. The relationship between NTT career goals and NTT advisor support was significant for both private sector research careers ($\beta=.18$, $s.e.=.03$, $p<.000$, Equation 22) and nonprofit or government careers ($\beta=.26$, $s.e.=.05$, $p<.000$, Equation 23). Students whose advisors were supportive of private sector research careers were not more likely to have career goals in the other NTT career, non-profits and government ($\beta=.04$, $s.e.=.04$, $p=.262$, Equation 24). Likewise, advisor support for non-profit careers was not associated with student interest in private sector research careers ($\beta=-.01$, $s.e.=.05$, $p=.851$, Equation 25).

Patterns of advisor support across the tenure-track/NTT divide were also assessed. Advisor support for students' career goals at 4-year colleges was not associated with career goals in non-profits/government ($\beta=.11$, $s.e.=.04$, $p=.802$, Equation 26), but was positively associated with career goals in private sector research ($\beta=.08$, $s.e.=.03$, $p=.013$, Equation 27). However, advisor support for students' research university careers was not significantly related to either NTT goal (private sector research: $\beta=.01$, $s.e.=.04$, $p=.748$, Equation 28; non-profits or government: $\beta=.04$, $s.e.=.04$, $p=.424$, Equation 29).

Students' 4-year college career goals were related to perceptions of advisor support for both non-profits/government ($\beta=.09$, $s.e.=.04$, $p=.027$, Equation 30) and private sector research ($\beta=.07$, $s.e.=.04$, $p=.055$, Equation 31). However, students' research university career goals were not related to advisor support for either NTT

career (private sector research: $\beta=.05$, $s.e.=.04$, $p=.226$, Equation 32; non-profit or government: $\beta=.05$, $s.e.=.04$, $p=.178$, Equation 33).

Post-hoc analyses were conducted to determine whether including climate as a level-2 predictor in significant models would improve the fit of the model. In one instance only, including climate at level 2 improved the fit of the model, though climate was not itself significant in the model; nevertheless, the fit between advisor support for private research career goals and students' private research career goals was improved when climate was included ($\beta=.10$, $s.e.=.23$, $p=.674$, Equation 34). In comparing the two models, the residual without climate was .924; the residual in a mixed model including climate at level 2 was .801, a 13% reduction.

Research Question 3: Advisor support for NTT and academic careers. As predicted, a paired-samples t-test showed that advisors were perceived by their students as significantly less supportive of NTT careers ($M=4.54$ on a 6-point scale, $SD=1.24$) than tenure-track careers ($M=5.27$, $SD=.98$), $t(876)=17.643$, $p<.000$.

Post-hoc analyses were conducted to determine whether there were significant differences in students' overall career goals, and whether there were differences within groups (by gender and URM status) with regard to career goal desire and perceptions of career goal support. Overall, students were more interested in tenure-track career goals than non-tenure-track careers (see Table 8). In addition, students perceived more advisor support for careers in private sector research than in non-profits or government, and more support for careers in research universities than in 4-year colleges.

Table 8
Differences in Career Goals and Perceived Support for Career Goals: T-Tests Within Groups.

Career 1	Career 2	Overall	Women	Men	URM	Non-URM
Goal: Private Sector Research	Goal: Non-Profit or Government	<i>ns</i>	$t(414) = -5.56^{***}$	$t(527) = 2.45^*$	$t(135) = -2.83^{**}$	<i>ns</i>
Goal: Research University	Goal: 4-Year College	<i>ns</i>	$t(515) = 5.50^{***}$	$t(581) = 2.48^*$	$t(155) = -2.20^*$	<i>ns</i>
Support: Private Research	Support: Non-Profit or Government	$t(881) = 5.45^{***}$	<i>ns</i>	$t(478) = 5.94^{***}$	<i>ns</i>	$t(754) = 5.52^{***}$
Support: Research University	Support: 4-Year College	$t(1051) = 12.44^{***}$	$t(461) = 6.74^{***}$	$t(540) = 10.02^{***}$	$t(146) = 3.46^{**}$	$t(904) = 11.98^{***}$
Goal: Tenure-Track Career	Goal: Non-Tenure-Track Career	$t(1003) = 5.21^{***}$	$t(413) = 2.63^{**}$	$t(525) = 4.05^{***}$	<i>ns</i>	$t(867) = 5.14^{***}$
Support: Tenure-Track Career	Support: Non-Tenure-Track Career	$t(876) = 17.65^{***}$	$t(356) = 13.95^{***}$	$t(475) = 10.91^{***}$	$t(126) = -6.34^{***}$	$t(749) = 16.46^{***}$

Note: * $p < .05$ ** $p < .01$ *** $p < .001$.

Career goals and perceptions of support were also compared by gender and URM status. Women were more likely to have tenure-track career goals than NTT goals, but reversed the overall trend with regard to individual careers: women were more likely to want non-profit or government jobs than careers in private sector research, and were more likely to want to work at a 4-year college than a research university. Women were also more likely to report support for tenure-track careers than for NTT careers, and for research university careers over 4-year colleges, but reported no difference in

perceived support between NTT careers (private sector research or government/non-profit work).

Men also expressed significantly more interest in academic careers than NTT careers; in contrast to women, they were less interested in non-profit careers than careers in private sector research, and were more interested in research university careers than careers at 4-year colleges. Men's perceptions of advisor support adhered to the overall trend: more support for tenure-track than NTT jobs, more support for private research than non-profits, and more support for research universities than 4-year colleges.

Career goals and perceptions of support were similar for URM students and female students. URM students, like female students, were more interested in non-profits than private sector research, and more interested in 4-year colleges than research universities. However, URM students were not more likely to report desire for a tenure-track career goal overall; the relationship was not significant. Also similar to female students, URM students perceived higher levels of advisor support for tenure-track careers than NTT careers, and more support for work at research universities than 4-year colleges; as with women, there was no significant differences in perceptions of advisor support for government/non-profit work, compared to support for private research work.

Research Question 4: Race and gender differences in graduate experiences. Race and gender were predicted to relate to the graduate school experiences variables assessing

climate (Hypothesis 4a) and perceived advisor support for career goals (Hypothesis 4b). A multilevel regression showed a significant effect for URM status on climate ($\beta = -.30$, $s.e. = .09$, $p < .000$, Equation 35). A multilevel regression also showed a significant fixed effect for gender on climate ($\beta = -.17$, $s.e. = .05$, $p < .000$, Equation 36).

Post-hoc analyses were conducted to determine whether allowing for random variation between departments would improve the fit of the model. For URM students only, allowing for random variation showed a significant effect for URM status at level 2 ($\chi^2(24) = 46.93$, $s.e. = .30$, $p = .004$, Equation 37), indicating that the relationship between URM status and climate varies by department. The relationship may be stronger in some departments and weaker in others. In comparing the two models, the residual without random variation was .676; the residual in a mixed model including random variation of climate at level 2 was .667, a 1% reduction.

There was no mixed-modeling support for the hypothesis that race was significantly related to measures of perceived advisor support for career goals. URM status was not associated with perceived advisor support for tenure-track (research universities: $\beta = -.02$, $s.e. = .05$, $p = .643$, Equation 38; 4-year colleges: $\beta = .005$, $s.e. = .06$, $p = .936$, Equation 39) or NTT career goals (private sector research: $\beta = .04$, $s.e. = .07$, $p = .593$, Equation 40; non-profits or government: $\beta = .03$, $s.e. = .07$, $p = .618$, Equation 41). Gender was associated with perceived advisor support for 4-year college career goals, with higher support for women students ($\beta = .10$, $s.e. = .04$, $p = .017$, Equation 42). However, gender was also not associated with perceived advisor support for tenure-track careers

at research universities ($\beta=.04$, $s.e.=.03$, $p=.249$, Equation 43) or NTT career goals (private sector research: $\beta=-.02$, $s.e.=.04$, $p=.609$, Equation 44; non-profits/government: $\beta=.03$, $s.e.=.04$, $p=.462$, Equation 45) in multilevel modeling analyses.

Given the high level of intercorrelation between advisor support measures, post-hoc t-tests were conducted to assess whether other forms of advisor support differed by gender and race, and whether students with different career goals perceived different levels of other kinds of advisor support. Significant gender differences were found for perceived instrumental support, but not psychosocial support. Women perceived less instrumental support from their advisors ($M=2.83$, $SD=.67$) than men ($M=2.97$, $SD=.59$), $t(948)=3.54$, $p<.000$. URM students were also less likely to agree that their advisor provided instrumental support ($M=2.74$, $SD=.71$) than majority students ($M=2.94$, $SD=.61$), $t(1010)=3.45$, $p=.001$, but did not differ from majority students with regard to perceptions of psychosocial support.

Post-hoc analyses were also conducted to determine whether students' career goals were correlated with perceptions of some forms of advisor support. Students with different career goals were confirmed to have different perceptions of advisor support. Academic career goals were associated with higher perceptions of both instrumental support ($r=.19$, $p<.000$) and psychosocial support ($r=.26$, $p<.000$). In addition, non-tenure-track career goals were significantly negatively associated with psychosocial support ($r=-.07$, $p=.043$).

Table 9
Correlations Between Career Goals and Advisor Support Variables.

	Private Sector Research	Non-Profit/ Government	4-Year College	Research University
Climate	.044	-0.029	.182***	0.04
Instrumental Support	.084**	-0.041	.208***	.098*
Psychosocial Support	-0.05	-0.052	.249***	.175***

Note: * $p < .05$ ** $p < .01$ *** $p < .001$.

Research Question 5. Correlations were calculated between departmental attrition and the career variables: departmental averages of career goals and perceived advisor support for careers. Contrary to expectations, attrition was not correlated significantly with any career variable; this lack of relationship persisted when controlling for the covariate of attrition, faculty URM representation, in partial correlation analysis. Attrition was not related to departmental averages of academic career goals ($r = .05$, $p = .828$), NTT career goals ($r = -.33$, $p = .118$), or any individual career goal item. Attrition was also not related to departmental averages of perceptions of advisor support for academic careers ($r = .06$, $p = .787$). However, there was a trend for attrition to relate to the departmental average of perceived advisor support for NTT careers ($r = -.36$, $p = .082$), indicating that more advisor support for NTT careers may be associated with lower attrition in some instances. In addition, perceived advisor support for an NTT career in non-profits or government was significantly associated with attrition at the department level ($r = -.45$, $p = .026$), indicating that more advisor support for non-profit or government careers is associated with less attrition. Post-hoc analyses were conducted to determine

whether unconditional career support from advisors, instrumental advisor support, or psychosocial advisor support were related to attrition at the department level; in all cases, the relationship was not significant.

Chapter 4: Discussion

Nationally, only one-fourth of Ph.D. students who begin their programs will complete them and move into tenure-track academic careers. It is therefore crucial to understand what factors are related to departure from the academy and non-academic career choices, as well as what factors relate to more positive or negative experiences of students' programs.

Attrition

In this study, doctoral student attrition was not significantly related to most of the variables under investigation; these included gender, underrepresented racial-ethnic minority status, students' career goals, advisor support for students' tenure-track career goals, and climate. However, attrition was significantly negatively related to the department average of students' perceptions of advisor support for students' non-profit or government careers, indicating that departments with faculty who are perceived as more supportive of this non-tenure-track career are likely to have lower rates of attrition than other departments. In contrast, attrition was higher in departments where advisors are not seen as supportive of students' non-profit or government careers. Students may be less inclined to remain in their graduate programs to completion if they perceive their advisors as not supportive of this NTT career. Overall, the finding implies that students who may be preparing for departure from the academic system

might be more inclined to leave after graduation if they feel supported toward graduation despite their NTT goals, but might be more inclined to leave before graduation if they do not feel supported. In addition, this link between attrition and advisor support confirms the importance of advisor support in student outcomes. Only a few factors in these analyses were significantly related to the attrition rate in all fields; in addition to support for non-profit careers, departments with a higher proportion of URM faculty were likely to have lower attrition rates than low-URM-faculty departments. The presence of URM faculty benefits URM students in many ways (Noy & Ray, 2012); these students may need extra support in the face of an inequitable program climate (Gay, 2004; Gildersleeve, Croom, & Vasquez, 2011; Teranishi & Briscoe, 2006). The relationship between attrition and URM faculty representation may relate to the need for URM students to receive culturally competent mentoring; students report a lack of diverse leadership, though mentoring is the strongest predictor of satisfaction among students of color (Barker, 2011; Felder, 2010; Maton et al, 2011).

In contrast with expectations, departmental rate of attrition was not found to be related to student gender composition at the department level (Hypothesis 1a), student URM representation at the department level (Hypothesis 1b), field of study (Hypothesis 1c), or student perceptions of climate at the department level (Hypothesis 1d). The lack of results for these hypotheses may be related to statistical constraints on the data that was available; attrition analyses had low statistical power because of a low n at the department level (fewer than 30 departments). In addition, the university sampled has lower rates of attrition than the national average, especially in the social sciences (which

are highly ranked). Overall, the university may attend to marginalized students' needs adequately enough to prevent identity-related attrition.

Career Goals

In addition, there were important findings for students' adoption of non-academic career goals. While the majority of students did report tenure-track goals, both female and URM students were more likely to have a non-tenure-track career goal than male and majority students (non-profit or government; trend for URM), which can be seen as a different form of "exit" from the academy than attrition from a doctoral program. Women and URM students were also more interested in non-profit careers than they were in private sector research careers. At the same time, women were less interested in private sector research than men, while candidates were more interested in the private sector research than pre-candidates. More advanced students may see private research as a close, appealing alternative to academic research; female students may find private research to be less appealing than men do for the same reason, that it is a close alternative to academic research. More advanced students may generally develop toward moving away from the academy (they also have lower tenure-track career goals than pre-candidates), and see the private research sector as a respected alternative to academic research that suits their educational training. Women may also see private sector research as a close alternative to academic research, but they may be wary of similar climate inequities to those in academe; in addition, women generally invest more time and emotional energy into teaching than men (Hurtado, Eagan, Pryor, Whang, & Tran, 2012; Bozeman & Gaughan, 2011). In combination, women may find a

non-teaching position with a potential climate problem in private sector research to add up to a less appealing career option.

Students also reported baseline differences in experiences of students with NTT career goals. Students, regardless of career goal, perceive advisors to be more supportive of tenure-track career goals than NTT careers. While this phenomenon has been well-documented in popular press (Ellis, 2013) and qualitative research such as the interviews in Lovitts (2001), this study appears to be the first quantitative verification in one large research university that doctoral students on average (regardless of their goals or their fields) perceive more support from their advisors to pursue tenure-track careers. In addition, NTT career goals were associated with lower ratings of psychosocial support from students' advisors. Advisors were also seen as less supportive of non-profit NTT careers than they were of private sector research careers, overall.

The non-tenure-track career of private sector research was more prevalent in Engineering, the natural sciences, and Applied Social & Natural Sciences than in the social sciences. This pattern may be a result of the availability of more applied jobs in these fields; in contrast, the skills developed in the humanities and social sciences are perceived as less transferrable to the non-academic workforce (Ehrenberg, Jakubson, Groen, So, & Price, 2007). In addition, students in these science-oriented fields may be less likely to obtain graduate funding through teaching than students in the humanities and social sciences, instead receiving funding as graduate student research assistants.

Without exposure to teaching, students may see less appeal to pursuing teaching as a component of their research careers. Gender has also been found to relate to decreased interest in private sector careers, and there are generally fewer women in the natural sciences and Engineering than men; perhaps gender representation within the fields may be related to this career goal pattern.

Advisor support was also associated with career goals for specific careers within the NTT domain. Thus, support for research careers was associated with research goals, and support for non-profit careers was associated with non-profit goals. It may be that students seek advisors who are supportive of existing or developing career goals, or that students switch to advisors who are supportive of their goals. Some advisors may be seen as supportive of all careers, or some students may simply decide to leave the academy if they do not see their advisors as supportive. The associations between career support and career goals are ultimately probably a combination of all of the above factors. Again, advisors are very important for student experiences and outcomes. In addition, the relationship between advisor support for private research careers and students' private sector research goals was significantly mediated by climate; this finding indicates that paths toward private research careers may be especially influenced by departmental climate.

Students' tenure-track career goals were also found to vary in relation to a number of factors, including demographics, candidacy status, field of study, climate, advisor support for career goals, and advisor psychosocial and instrumental support. Overall, students were more likely to report tenure-track goals than NTT goals, though

this difference was not significant for URM students. Both men and women were more likely to report research university goals than 4-year college goals, but URM students were more likely to want to work at 4-year college than a research university.

Candidates were less interested in research university careers, and students in Engineering, the natural sciences, and Applied Social & Natural Sciences were less interested in tenure-track careers at both research universities and 4-year colleges.

These same students (by candidacy and field) were more interested in private sector research careers, indicating a general turn away from the academy for the NTT research analogue. Climate was also found to significantly relate to research university and 4-year college tenure-track career goals (Hypothesis 2e); but not to NTT careers. Given that the data were collected at a research university, it may be that students who perceive the climate in their existing program as positive may be more inclined to continue in the same or a similar setting, while those who perceive the climate as negative are not positively influenced toward remaining in a research university.

Alternatively, those with tenure-track career goals may accept or tolerate the climate as it is to a greater extent than those who plan to depart the academic setting. In addition, those with tenure-track career goals (research and 4-year institutions) had higher perceptions of advisor psychosocial and instrumental support. Taken together, the findings indicate that students who have more favorable and supportive experiences are more likely to desire to pursue tenure-track careers; in comparison, NTT students may be more likely to experience inequities in their experiences of their graduate programs and advisor support.

Advisor support for students' goals was also confirmed as a significant factor in students' tenure-track career goals (Hypothesis 2f). Career goals and advisor support were associated for each specific career tenure-track. In addition, support for each tenure-track career was associated with higher rates of the other tenure-track goal. In other words, tenure-track support extended across the domain of tenure-track careers (i.e., support for 4-year universities was associated with 4-year *and* research university goals). Within tenure-track goals, advisors are more supportive of students' research university goals than their 4-year college goals, overall and within each identity group (women, men, URM students, & non-URM students).

Diversity and Graduate Student Experiences

The climate for women and minorities was found to be less positive than for their more privileged counterparts (Hypothesis 4a) in mixed modeling. This pattern has been well-documented elsewhere (Gay, 2004; Gildersleeve, Croom, & Vasquez, 2011; Teranishi & Briscoe, 2006). In addition, the relationship between URM status and climate varies significantly by department – some departments have a stronger relationship between URM status and perceptions of climate than others. Structural racism and sexism are likely to be a contributing factor to this discrepancy, despite attempts at the University of Michigan to reform the institution toward equity. In addition, during the time of late-stage data collection and analysis, other activities on campus indicated gender and racial inequities: feminist students protested the mishandling of rape cases on college campuses nationwide, and the #BBUM (Being

Black at University of Michigan) Twitter campaign highlighted persisting experiences of racism and marginalization on campus. While undergraduate students spearheaded these activist efforts, many graduate students expressed solidarity with undergraduates' experiences and participated in the activism around these issues. In addition, several year-found graduate student organizations exist to support marginalized students, including Students of Color of Rackham, the Women's Caucus in the Political Science Department, and the IDEA workgroup.

Given the climate and career goal differences among women and URM students, it seemed likely that those same students would differ in their perceptions of advisor support for careers. However, advisor support for the careers of women and URM students was not lower than support for the careers of majority students in mixed modeling analyses (Hypothesis 4b). In fact, women perceived more support for careers at 4-year colleges than did men. However, female and URM students also perceived significantly less instrumental support from their advisors than did their more privileged counterparts. The combination of negative climate experiences and lower rates of crucial forms of advisor support point to a problem of inequity in experiences and support on multiple levels.

Attrition and Career Goals

Finally, analyses were conducted to determine whether there are relationships between departmental attrition rates and any of the career goal measures. Attrition was not found to be related to students' career goals (Hypothesis 5a) or levels of perceived

advisor support for career goals (Hypothesis 5b) in most cases. However, attrition trended toward a negative relationship with departmental averages of student perceptions of advisor support for students' NTT career goals, and attrition was negatively related to perceptions of support for students' non-profit or government career goals in particular. Support for this NTT career was associated with lower rates of attrition at the departmental level; perhaps studies or interventions that investigate the factors related to attrition could consider support for NTT careers as a potential vector of support against attrition.

Ultimately, most attrition hypotheses were not confirmed. This may be due to a problem of statistical resolution; attrition data were not available at the individual level, and therefore all analyses with attrition had to be conducted at the level of department averages, rather than individual outcomes. Using the departmental averages significantly decreases sample size, and therefore also statistical variation and power. In addition, the attrition measure is not assessed within groups, e.g., by race or gender, so the association between the departmental rate of attrition and department rate of representation of groups of students does not account for variation of attrition within groups, only within departments. Finally, the university also has a substantially lower rate of attrition than the national average, which is perhaps unsurprising given the presence of multiple on-campus programs to support recruitment and retention of diverse students and faculty, including the program that collected the individual-level and faculty-level data used in this dissertation.

Conclusion

Understanding pathways toward and away from tenure-track careers after graduation is of crucial importance for the graduate students who must navigate these decisions. A significant proportion of students reported NTT career goals, yet students reported lower levels of advisor support for NTT careers. In addition, female and underrepresented minority students were more likely to have a non-tenure-track career goal (non-profit/government), less likely to have positive perceptions of department climate, and perceived less instrumental support from their advisors. With regard to attrition, the findings point to the presence of URM faculty and perceived support for students' non-profit or government careers as factors that are negatively related to student attrition; both factors may be important forms of support for marginalized students. Taken together, these findings point toward existing inequities among marginalized students and further suggest potential or actual marginalization among those PhD students who intend to pursue non-tenure-track careers.

Limitations

A number of limitations constrain generalization from these analyses. First, all data were from a single university, and more specifically, from a university with unusually low attrition. Accordingly, these results are unlikely to be representative of PhD students generally, or even PhD students at top research universities. Second, limitations within available data meant that only departmental-level attrition data were available; analyses ultimately had less statistical power when conducted at the

departmental level rather than the individual level. Third, intersectional analyses of students' multiple identities could not responsibly be conducted given the low specificity of race-ethnicity measures, and a lack of theory to support specific predictions for intersectional variations in PhD students' career goals.

Future Directions

Individual-level analyses of the relationships between attrition and the other study variables would enable a more direct assessment of how attrition might relate to identity, climate, and so on. A full sample across the university would have provided more data and therefore a more robust analysis. An actual intersectional analysis that attended more precisely to students' identities in context would be incredibly worthwhile if the data were available. Other aspects of identity, such as sexual identity, have also been found to relate to educational outcomes for PhD students (ADVANCE, 2006), and would be worthwhile to assess in future analyses of attrition and career paths.

Future research using similar data might delve further into the influence of faculty on student outcomes, perhaps examining the role of faculty perception of department climate on students' outcomes. There may also be a relationship between attraction to a career goal and confidence in one's ability to perform that career. Analyses of actual job outcomes could be informative, as well. Analyses of attrition and career goals ought to attend to differences between the domestic and international student experiences.

Analyses of other institutions would be worthwhile for comparative purposes. Institutions with higher rates of attrition, other types of institution (private, public, flagship public; higher or lower rankings), or other types of students (MA, MD, JD) might highlight factors that are important in some contexts but not others, and point toward a more specific understanding of how institutional variation may relate to attrition.

Appendix A: Variables

Construct	Definition	Examples	Hypotheses (see Appendix B)
Gender	Self-identified gender		2b, 4a, 4b, 4c
URM Status	Self-identified race as Black, Latina/o, First Nations/ American Native, or Other		2a, 4a, 4b, 4c
Candidacy Status	Self-identified candidacy status		2c
Discipline	Field of study, by department	Engineering; Humanities	1c, 2d
Climate	Atmosphere of an academic environment	Isolated, Friendly, Diverse	1d, 2e, 4a
Career Goals	Attractiveness of post-graduation career tracks	Work independently; Professor at a top research university	2a, 2b, 2c, 2d, 2e, 2f, 5a
Advisor Support for Career Goals	Perceived supportiveness of student's advisor for post-graduation career tracks	Work independently; Professor at a top research university	2f, 3, 4b, 5b
Broad Advisor Support for Careers	Perceived supportiveness of student's advisor for any career that the student finds attractive	Advisor "would support me in any career path I might choose"	2f, 4b, 5b
Attrition	Number of admitted students (entered 2000-2004) who had officially withdrawn in 2012, per department		1a, 1b, 1c, 1d, 5a, 5c, 5c
URM Representation	Percentage of admitted students (entered 2000-2004) who identified as URM, per department		1a
Female Representation	Percentage of admitted students (entered 2000-2004) who identified as female, per department		1b
Faculty URM Representation	Percentage of faculty (2000-2004) who identified as URM, per department		Covariate
Faculty Female Representation	Percentage of faculty (2000-2004) who identified as female, per department		Covariate
Faculty Attrition	Percentage of faculty (2000-2004) who left the uni., per department		Covariate

Appendix B: Hypotheses

Number	Predicted Relationship	IV	DV	Analysis
1a	Higher URM representation should be related to higher rates of attrition.	Department % representation of URM students	Attrition	Correlation
1b	Higher female representation should be related to higher rates of attrition.	Department % representation of female students	Attrition	Correlation
1c	Attrition should be lower in STEM than other disciplines.	Discipline	Attrition	ANOVA
1d	Attrition should be higher in departments with lower ratings of climate.	Climate	Attrition	Regression
2a	I propose URM students will be less likely to have tenure-track career goals than majority students.	URM identity	Career goals	Mixed modeling
2b	I propose female students will be less likely to have tenure-track career goals than male students.	Female identity	Career goals	Mixed modeling
2c	Tenure-track career goals should be more prevalent among pre-candidates than doctoral candidates.	Candidacy status	Career goals	Mixed modeling
2d	Tenure-track career goals should be more prevalent in the humanities and social sciences.	Discipline	Career goals	Mixed modeling
2e	Lower ratings of climate should be associated with lower rates of tenure-track career goals.	Climate	Career goals	Mixed modeling
2f	Students' career goals should be more likely to match careers that advisors support than to be discrepant.	Advisor support for career goals	Career goals	Mixed modeling
3	I predict that advisors will generally be perceived as more supportive of tenure-track careers than NTT careers.	Advisor support for career goals	---	Pairwise t-test
4a	I predict that women and URM students will have lower ratings of climate than male and majority students.	Marginalized identity	Climate	Mixed modeling
4b	I predict that women and URM students will perceive lower	Marginalized	Advisor	Mixed

	advisor support for their careers than male and majority students.	identity	support for career goals	modeling
4c	I predict that women and URM students will be less likely to have congruency between their career goals and the career goals that they perceive their advisors to support.	Marginalized identity	Career goal-support congruency	Mixed modeling
5a	I predict that higher attrition will be associated with higher rates of NTT career goals among students.	NTT career goals	Attrition	ANOVA
5b	I predict that higher attrition will be associated with lower ratings of advisor support for students' careers.	Advisor support for career goals	Attrition	ANOVA
5c	I predict that higher attrition will be associated with lower rates of congruency between students' career goals and perceived advisor support for career goals.	Career goal-support congruency	Attrition	T-test

Appendix C: Descriptive Statistics

	URM Status				ANOVA
	URM		Majority		
	M	SD	M	SD	
CAREER GOALS					
TT Overall	5.99	1.44	5.99	1.52	ns
Research University	2.90	0.93	2.99	0.96	ns
4-Year College	3.08	0.83	3.00	0.85	ns
NTT Overall	5.79	1.37	5.63	1.33	ns
Private Sector					
Research	2.77	0.86	2.81	0.90	ns
Non-Profit or					
Government	3.01	0.81	2.82	0.84	F(1011)=6.45, p=.011
ADVISOR SUPPORT					
TT Overall	5.33	1.05	5.29	0.97	ns
Research University	2.74	0.52	2.75	0.48	ns
4-Year College	2.60	0.62	2.53	0.61	ns
NTT Overall	4.58	1.29	4.53	1.23	ns
Private Sector					
Research	2.34	0.71	2.33	0.69	ns
Non-Profit or					
Government	2.27	0.71	2.21	0.68	ns
Unconditional Career					
Support	3.17	0.83	3.05	0.77	ns
Instrumental	2.74	0.71	2.94	0.62	F(1)=11.90, p=.001
Psychosocial	3.12	0.71	3.17	0.63	ns
CLIMATE	3.58	0.95	3.87	0.65	F(1008)=21.51, p<.000

	Gender				ANOVA
	Female	SD	Male	SD	
	M		M		
CAREER GOALS					
TT Overall	5.97	1.51	5.99	1.55	ns
Research University	2.87	0.98	3.04	0.95	F(1101)=9.01, P=.003
4-Year College	3.10	0.82	2.94	0.87	F(1096)=10.01, p=.002
NTT Overall	5.69	1.33	5.63	1.36	ns
Private Sector					
Research	2.71	0.87	2.88	0.91	F(1078)=10.01, p=.002
Non-Profit or					
Government	2.99	0.81	2.75	0.84	F(946)=18.68, p<.000
ADVISOR SUPPORT					
TT Overall	5.42	0.92	5.19	1.00	F(1001)=13.38, p<.000
Research University	2.78	0.47	2.73	0.51	F(1031)=3.388, p=.066
4-Year College	2.64	0.57	2.47	0.64	F(1004)=18.61, p=.000
NTT Overall	4.45	1.29	4.60	1.20	ns
Private Sector					
Research	2.27	0.71	2.39	0.67	F(982)=6.93, P=.009
Non-Profit or					
Government	2.21	0.70	2.22	0.68	ns
Unconditional Career					
Support	3.04	0.80	3.11	0.75	ns
Instrumental	0.67	0.03	0.58	0.03	F(948)=12.52, P<.000
Psychosocial	0.66	0.03	0.63	0.03	ns
CLIMATE	3.74	0.75	3.93	0.65	F(968)=17.62, p<.000

	Candidacy				ANOVA
	Pre-Candidate		Candidate		
	M	SD	M	SD	
CAREER GOALS					
TT Overall	5.90	1.52	6.10	1.52	F(1107)=4.62, p=.032
Research University	2.92	0.98	3.05	0.94	F(1112)=4.56, p=.033
4-Year College	2.98	0.84	3.06	0.85	ns
NTT Overall	5.60	1.34	5.72	1.36	ns
Private Sector					
Research	2.76	0.88	2.86	0.92	F(1089)=3.306, p=.069
Non-Profit or					
Government	2.83	0.83	2.89	0.84	ns
ADVISOR SUPPORT					
TT Overall	5.28	0.98	5.31	0.97	ns
Research University	2.75	0.49	2.75	0.49	ns
4-Year College	2.53	0.63	2.56	0.59	ns
NTT Overall	4.46	1.26	4.62	1.21	F(843)=3.32, p-.069
Private Sector					
Research	2.31	0.71	2.37	0.67	ns
Non-Profit or					
Government	2.18	0.71	2.25	0.67	ns
Unconditional Career					
Support	3.04	0.79	3.11	0.74	ns
Instrumental	2.90	0.64	2.93	0.62	ns
Psychosocial	3.16	0.64	3.16	0.65	ns
CLIMATE	3.79	0.72	3.91	0.68	F(975)=7.03, p=.008

	Field											
	Humanities		Sciences		Engineering		Applied Social & Natural Sciences		Social Sciences		ANOVA	
	M	SD	M	SD	M	SD	M	SD	M	SD		
CAREER GOALS												
TT Overall	6.87	1.15	6.17	1.37	5.51	1.61	5.78	1.43	6.72	1.43	F(1159)=36.71, p<.000	
Research												
University	3.36	0.82	3.07	0.98	2.83	0.97	2.82	0.95	3.32	0.85	F(1165)=16.782, p<.000	
4-Year College	3.52	0.60	3.09	0.77	2.69	0.90	2.96	0.81	3.40	0.64	F(1159)=39.58, p<.000	
NTT Overall	4.86	1.31	5.43	1.24	6.09	1.22	5.60	1.34	5.38	1.32	F(1003)=24.98, p<.000	
Private Sector												
Research	2.20	0.87	2.74	0.84	3.25	0.76	2.71	0.84	2.45	0.87	F(1142)=51.98, p<.000	
Non-Profit or Government	2.66	0.81	2.69	0.74	2.85	0.89	2.95	0.81	2.93	0.77	F(1008)=3.81, p=.004	
ADVISOR SUPPORT												
TT Overall	5.68	0.72	5.29	0.94	5.06	1.00	5.32	1.02	5.50	0.83	F(1047)=12.22, p<.000	
Research												
University	2.85	0.38	2.82	0.44	2.68	0.51	2.75	0.51	2.79	0.49	F(1082)=4.13, p=.002	
4-Year College	2.82	0.40	2.47	0.64	2.38	0.64	2.57	0.64	2.71	0.49	F(1051)=16.715, p<.000	
NTT Overall	3.78	1.22	4.31	1.35	4.92	1.06	4.53	1.26	4.20	1.21	F(877)=22.24, p<.000	
Private Sector												
Research	1.89	0.71	2.18	0.71	2.58	0.58	2.32	0.70	2.11	0.67	F(1029)=29.75, p<.000	
Non-Profit or Government	1.89	0.66	2.14	0.71	2.34	0.65	2.26	0.67	2.11	0.71	F(885)=9.65, p<.000	
Unconditional Career Support	3.00	0.73	2.87	0.94	3.14	0.74	3.15	0.79	3.07	0.78	F(962)=4.68, p=.001	
Instrumental	2.76	0.67	3.07	0.60	3.02	0.58	2.78	0.67	2.87	0.62	F(1007)=9.28, p<.000	
Psychosocial	3.23	0.57	3.16	0.67	3.08	0.66	3.21	0.66	3.23	0.68	F(1002)=2.92, p=.021	
CLIMATE	3.96	0.61	3.98	0.63	3.91	0.68	3.69	0.80	3.64	0.70	F(1005)=8.93, p<.000	

Appendix D: Correlations Between Individual-Level Variables

	1	2	3	4	5	6
1. URM Status	---					
2. Gender	.123**	---				
3. Candidacy Status	-.022	-.003	---			
4. Climate	-.145**	-.134**	-.085**	---		
5. Psychosocial Support	-.019	-.044	-.002	.334**	---	
6. Instrumental Support	-.107**	-.114**	-.025	.388**	.679**	---
7. Goal: Private Sector Research	-.017	-.096**	-.055	.044	-.050	.084**
8. Goal: Non-Profit or Government	.080*	.139**	-.034	-.029	-.052	-.041
9. Goal: Research University	-.031	-.091**	-.063*	.182**	.249**	.208**
10. Goal: 4-Year College	.034	.095**	-.043	.040	.175**	.098**
11. Support: Private Sector Research	.003	-.084**	-.046	.191**	.320**	.333**
12. Support: Non-Profit or Government	.030	-.003	-.051	.199**	.387**	.323**
13. Support: Research University	-.008	.057	-.003	.195**	.408**	.359**
14. Support: 4-Year College	.037	.135**	-.021	.183**	.416**	.305**
15. Unconditional Advisor Support	.055	-.044	-.039	.236**	.546**	.346**

Note: * $p < .05$ ** $p < .01$ *** $p < .001$.

Correlations between variables 7-15 were previously reported in Table 9.

Appendix E: Equations

Equation 1, HLM Model Specifications

$$Y_{ij} = \gamma_{00} + \gamma_{10} * URM_{ij} + r_{ij}$$

Level 1

$$Y_{ij} = \beta_{0j} + \beta_{1j} * (URM_{ij}) + r_{ij}$$

Y_{ij} = Career goals for research universities for student i in department j

β_{0j} = Career goals for research universities, on average, for student i in department j

β_{1j} = Effect of URM status on research university career goals

URM_{ij} = Underrepresented minority (URM) status for student i in department j

r_{ij} = Standard deviation of student i in department j from estimated average research university career goals

Level 2

$$\beta_{0j} = \gamma_{00}$$

$$\beta_{1j} = \gamma_{10}$$

β_{0j} = Career goals for research universities, on average, for student i in department j

γ_{00} = Expected mean research university career goals across students within groups

β_{1j} = Effect of URM status on research university career goals

γ_{10} = Standard deviation of a student from expected mean across students within

Equation 2, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * URM_{ij} + r_{ij}$$

Y_{ij} = Career goals for 4-year colleges for student i in department j

URM_{ij} = Underrepresented minority (URM) status for student i in department j

Equation 3, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * URM_{ij} + r_{ij}$$

Y_{ij} = Career goals for non-profit or government work for student i in department j

URM_{ij} = Underrepresented minority (URM) status for student i in department j

Equation 4, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * URM_{ij} + r_{ij}$$

Y_{ij} = Career goals for private sector research for student i in department j

URM_{ij} = Underrepresented minority (URM) status for student i in department j

Equation 5, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * GENDER_{ij} + r_{ij}$$

Y_{ij} = Career goals for research universities for student i in department j
 $GENDER_{ij}$ = Gender for student i in department j

Equation 6, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * GENDER_{ij} + r_{ij}$$

Y_{ij} = Career goals for 4-year colleges for student i in department j
 $GENDER_{ij}$ = Gender for student i in department j

Equation 7, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * GENDER_{ij} + r_{ij}$$

Y_{ij} = Career goals for private sector research for student i in department j
 $GENDER_{ij}$ = Gender for student i in department j

Equation 8, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * GENDER_{ij} + r_{ij}$$

Y_{ij} = Career goals for non-profit or government work for student i in department j
 $GENDER_{ij}$ = Gender for student i in department j

Equation 9, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * CANDIDACY_{ij} + r_{ij}$$

Y_{ij} = Career goals for research universities for student i in department j
 $CANDIDACY_{ij}$ = Candidacy status for student i in department j

Equation 10, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * CANDIDACY_{ij} + r_{ij}$$

Y_{ij} = Career goals for 4-year colleges for student i in department j
 $CANDIDACY_{ij}$ = Candidacy status for student i in department j

Equation 11, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * CANDIDACY_{ij} + r_{ij}$$

Y_{ij} = Career goals for non-profit or government work for student i in department j
 $CANDIDACY_{ij}$ = Candidacy status for student i in department j

Equation 12, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * CANDIDACY_{ij} + r_{ij}$$

Y_{ij} = Career goals for private research for student i in department j
 $CANDIDACY_{ij}$ = Candidacy status for student i in department j

Equation 13, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{01} * FHUM_j + \gamma_{02} * FSCI_j + \gamma_{03} * FENG_j + \gamma_{04} * FAPP_j + r_{ij}$$

Y_{ij} = Career goals for student i in department j
 $FHUM_j$ = Dummy code for Field: Humanities
 $FSCI_j$ = Dummy code for Field: Natural Sciences
 $FENG_j$ = Dummy code for Field: Engineering
 $FAPP_j$ = Dummy code for Field: Applied Social & Natural Sciences

Equation 14, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * CLIMATE_{ij} + r_{ij}$$

Y_{ij} = Career goals for research universities for student i in department j
 $CLIMATE_{ij}$ = Climate perception for student i in department j

Equation 15, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * CLIMATE_{ij} + r_{ij}$$

Y_{ij} = Career goals for 4-year colleges for student i in department j
 $CLIMATE_{ij}$ = Climate perception for student i in department j

Equation 16, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * CLIMATE_{ij} + r_{ij}$$

Y_{ij} = Career goals for private research for student i in department j
 $CLIMATE_{ij}$ = Climate perception for student i in department j

Equation 17, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * CLIMATE_{ij} + r_{ij}$$

Y_{ij} = Career goals for non-profit or government work for student i in department j
 $CLIMATE_{ij}$ = Climate perception for student i in department j

Equation 18, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Research University Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for research universities for student i in department j

$\text{Research University Support}_{ij}$ = Perception of advisor support for research university careers for student i in department j

Equation 19, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{4Year College Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for 4-year colleges for student i in department j

$\text{4Year College Support}_{ij}$ = Perception of advisor support for 4-year college careers for student i in department j

Equation 20, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{4Year College Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for research universities for student i in department j

$\text{4Year College Support}_{ij}$ = Perception of advisor support for 4-year college careers for student i in department j

Equation 21, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Research University Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for 4-year colleges for student i in department j

$\text{Research University Support}_{ij}$ = Perception of advisor support for research university careers for student i in department j

Equation 22, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Private Research Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for private research for student i in department j

$\text{Private Research Support}_{ij}$ = Perception of advisor support for private research careers for student i in department j

Equation 23, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Nonprofit Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for non-profit or government work for student i in department j

$\text{Nonprofit Support}_{ij}$ = Perception of advisor support for non-profit or government careers for student i in department j

Equation 24, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Private Research Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for non-profit or government work for student i in department j
Private Research Support _{ij} = Perception of advisor support for private research careers for student i in department j

Equation 25, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Nonprofit Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for private research for student i in department j
Nonprofit Support _{ij} = Perception of advisor support for private research careers for student i in department j

Equation 26, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{4Year College Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for non-profit or government work for student i in department j
4Year College Support _{ij} = Perception of advisor support for 4-year college careers for student i in department j

Equation 27, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{4Year College Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for private research for student i in department j
4Year College Support _{ij} = Perception of advisor support for 4-year college careers for student i in department j

Equation 28, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Research University Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for private research for student i in department j
Research University Support _{ij} = Perception of advisor support for research university careers for student i in department j

Equation 29, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Research University Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for non-profit or government work for student i in department j
Research University Support _{ij} = Perception of advisor support for research university careers for student i in department j

Equation 30, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Nonprofit Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for 4-year colleges for student i in department j

$\text{Nonprofit Support}_{ij}$ = Perception of advisor support for private research careers for student i in department j

Equation 31, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Private Research Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for 4-year colleges for student i in department j

$\text{Private Research Support}_{ij}$ = Perception of advisor support for private research careers for student i in department j

Equation 32, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Private Research Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for research universities for student i in department j

$\text{Private Research Support}_{ij}$ = Perception of advisor support for private research careers for student i in department j

Equation 33, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{Nonprofit Support}_{ij} + r_{ij}$$

Y_{ij} = Career goals for research universities for student i in department j

$\text{Nonprofit Support}_{ij}$ = Perception of advisor support for private research careers for student i in department j

Equation 34, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{01} * \text{CLIM2}_j + \gamma_{10} * \text{ASRES}_{ij} + r_{ij}$$

Y_{ij} = Career goals for private research for student i in department j

CLIM2_j = Average departmental climate as a level-2 variable in department j

$\text{Private Research Support}_{ij}$ = Perception of advisor support for private research careers for student i in department j

Equation 35, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * \text{URM}_{ij} + r_{ij}$$

Y_{ij} = Climate rating for student i in department j

URM_{ij} = Underrepresented minority (URM) status for student i in department j

Equation 36, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * GENDER_{ij} + r_{ij}$$

Y_{ij} = Career goals for non-profit or government work for student i in department j
 $GENDER_{ij}$ = Gender for student i in department j

Equation 37, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * URM_{ij} + u_{0j} + r_{ij}$$

Y_{ij} = Perceived climate for student i in department j
 URM_{ij} = Underrepresented minority (URM) status for student i in department j
 u_{0j} = Standard deviation of the trajectory of department j from expected group level in mean research university career goals

Equation 38, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * URM_{ij} + r_{ij}$$

Y_{ij} = Perceived advisor support for research university careers for student i in department j
 URM_{ij} = Underrepresented minority (URM) status for student i in department j

Equation 39, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * URM_{ij} + r_{ij}$$

Y_{ij} = Perceived advisor support for 4-year college careers for student i in department j
 URM_{ij} = Underrepresented minority (URM) status for student i in department j

Equation 40, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * URM_{ij} + r_{ij}$$

Y_{ij} = Perceived advisor support for private research careers for student i in department j
 URM_{ij} = Underrepresented minority (URM) status for student i in department j

Equation 41, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * URM_{ij} + r_{ij}$$

Y_{ij} = Perceived advisor support for non-profit or government careers for student i in department j
 URM_{ij} = Underrepresented minority (URM) status for student i in department j

Equation 42, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * GENDER_{ij} + u_{0j} + r_{ij}$$

Y_{ij} = Perceived advisor support for research university careers for student i in department j

$GENDER_{ij}$ = Gender for student i in department j

Equation 43, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * GENDER_{ij} + r_{ij}$$

Y_{ij} = Perceived advisor support for 4-year college careers for student i in department j

$GENDER_{ij}$ = Gender for student i in department j

Equation 44, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * GENDER_{ij} + r_{ij}$$

Y_{ij} = Perceived advisor support for 4-year colleges for student i in department j

$GENDER_{ij}$ = Gender for student i in department j

Equation 45, Combined Model

$$Y_{ij} = \gamma_{00} + \gamma_{10} * GENDER_{ij} + r_{ij}$$

Y_{ij} = Perceived advisor support for non-profit or government careers for student i in department j

$GENDER_{ij}$ = Gender for student i in department j

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