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Advance to Graduate School in the US: How the Path is Different for Women in STEM

Yonghong Jade Xu

University of Memphis, USA

ABSTRACT
A national sample of United States college graduates was examined in order to gain a deeper understanding of gender-based differences in the pursuit of a STEM graduate degree. The findings revealed that a significantly higher percentage of women in STEM reported an aspiration for a doctoral degree, and their graduate enrollment rate was significantly higher than that of their male counterparts one year after college graduation. The results suggest that availability of financial aid contributes positively to STEM women's graduate enrollment, but women's likelihood of obtaining graduate assistantships, fellowships, and employer tuition assistance is substantially lower than for males. In the meantime, women in STEM are sensitive to cost-benefit calculation in their decision-making about graduate education. They are significantly less likely to pursue doctoral education if their earning at the labor market entry is in the bottom quartile. Marital status, academic performance, and other social and structural factors also influenced women's decisions about graduate education in STEM. The findings support that individuals' decision-making is conscious choice behavior, based on their internalized social values and personal beliefs that go beyond the cost and benefit calculation.

KEYWORDS
Women in STEM; graduate education; gender disparity

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INTRODUCTION

Rapid technological innovation and knowledge growth in recent decades have led to a global demand for a workforce with advanced education in science and technology (Melguizo & Wolniak, 2012). In many countries, a bachelor's education is becoming inadequate and graduate education is gaining value (Zhang, 2005). In contrast to the growing importance of graduate education, little change has been observed in the persistently low presence of women and minorities in graduate programs, particularly those in science, technology, engineering, and mathematics (STEM) disciplines (Xu, 2014; Perna, 2004; Sax, 2001). Previous works have identified a wide range of factors that may influence college graduates' advancement to graduate school (e.g., Baird, 1976; Ethington & Smart, 1986; Malcom & Dowd, 2012; Perna, 2004; Xu, 2014; Zhang, 2005), but the pivotal factors responsible for the gender disparity within STEM graduate programs still remain unclear. Thus, in this study, a national sample of college graduates in the United States was used to systematically examine the factors that may influence college graduates' decisions about post-baccalaureate education. The goals are to obtain a deeper understanding of gender-based differences in the pursuit of a STEM graduate degree as well as to identify potential interventions that may improve the participation and persistence of women in nontraditional fields. Comparisons are also made between STEM and non-STEM students in order to go beyond superficial patterns and gain specific knowledge of the experiences of different subgroups.

REVIEW OF LITERATURE

The underrepresentation of women in STEM graduate programs is partly due to limited supply, given the low numbers of females receiving bachelor-level education in STEM fields (Griffith, 2010; Perna, 2004; Zhao, Carini, & Kuh, 2005). Nonetheless, additional personal and contextual factors come into play during the transition between the completion of a bachelor's degree and choosing a path that eventually leads to social and financial independence; finding a job and enrolling in graduate school are two of the major options. Those who aspire to continue their education beyond the bachelor's degree must consider tuition and other costs incurred by graduate education, such as accumulation of additional debt and foregone earnings from potential employment opportunities. In addition, there are non-financial factors, including anticipated family responsibilities and choices between different types of graduate programs (Perna, 2004). Influenced by gender-specific social norms and personal calculation of costs and gains, men and women have exhibited different propensities to pursuing graduate education (Zhang, 2005).

Factors that influence the graduate education decision-making process have been carefully studied in education, sociology, and economics. Roughly six categories of variables have been captured in the literature: socioeconomic background, academic ability and performance, choice of undergraduate education, financial factors, educational/career aspirations, and demographic characteristics. For instance, socioeconomic factors, often represented by family income and parental education, have been found to exert indirect effects on graduate school enrollment through intellectual ability and educational experiences (Ethington & Smart, 1986; Mullen, Goyette, & Soares, 2003; Zhang, 2005). The proposition is that students from more affluent and better-educated families have higher test scores and are likely to attend more selective institutions. Subsequently, they have advantages in accessing graduate education (Mullen et al., 2003; Zhang, 2005).

Acknowledging that academic abilities are interrelated with socioeconomic factors, researchers have also been able to identify the unique and positive impact of academic performance on individuals' postgraduate enrollment net of family background (Griffith, 2010; Mullen et al., 2003; Schoon, 2014; Zhang, 2005). Furthermore, students' choice of college and academic major may impact educational continuation after college as well (Mullen et al., 2003). College graduates in different academic majors have varied probabilities of advancing to graduate education, and the chance of students pursuing graduate training is significantly lower in female-dominated disciplines (Roksa & Levey, 2010; Blau, Ferber, & Winkler, 2006). Additionally, institutions vary in quality and/or selectivity, and the quality of the attended undergraduate institution has a significantly positive effect on individuals' likelihood of advanced education (Ethington & Smart, 1986; Mullen et al., 2003; Zhang, 2005). Because students' choice of college and academic major is based partially on their academic performance, controlling for academic performance allows for more accurate estimates of the effects of other educational factors, such as major, and institutional selectivity, in studying the decision process related to the pursuit of graduate education.

The accessibility of graduate education has been examined from various financial perspectives, and the findings indicate that monetary support from parents, current employment, and financial aid (e.g., graduate assistantship or loans) are the major financial resources offsetting the direct costs of attending graduate school (Perna, 2004). Students from high-income families may rely on their parents to pay a portion of the expenses. Employer-supported tuition reimbursement programs, when available, are valuable resources for those who are employed (Perna, 2004; Stiber, 2000). In addition, numerous studies have examined the role of undergraduate debt in the transition to graduate school (e.g., Millett, 2003; Weiler, 1991). However, due to different sampling and analytic approaches, findings have been inconsistent regarding how debts impact students' likelihood of post-baccalaureate education. In the economic literature, another financial aspect often considered is the foregone earnings during the expected time to degree; this is seen as the indirect (opportunity) cost associated with graduate education (Andrieu & St. John, 1993; Perna, 2004). Starting salaries usually quantify foregone earnings for bachelor's degree recipients (Weiler, 1991).

Finally, differences in race/ethnicity, gender, and age subgroups are regularly examined because these demographic characteristics have strong influences on the pursuit of further academic training (Malcom & Dowd, 2012; Mullen et al., 2003; Perna, 2004; Staniec, 2004; Xu, 2014; Zhang, 2005). In particular, women and racial/ethnic minorities are often underrepresented in graduate programs. Also, individuals who complete their college degree at an older age have a lower likelihood of pursuing graduate education, possibly because they are reluctant to accumulate more educational debt with the anticipation of growing family responsibilities (Mullen et al., 2003). It is worth noting that demographic and family backgrounds further influence individuals' postgraduate choices through shaping their educational and career aspirations (Hearn, 1987). College graduates of different family and cultural/social backgrounds may place different levels of emphasis on financial reward, intellectual stimulation, and flexibility in regard to the ideal career (Mullen et al., 2003; Sax, 2001). Such differences lead to various levels of aspirations for graduate programs.

Theoretical Framework

In this study, the rational choice model from sociology, which can be considered as a marginal version of a utility-maximization theory (Huber, 1997; Lloyd, Leicht & Sullivan, 2008), is used to further understand the factors influencing individuals' pursuit of graduate education. The rational choice model postulates that human action is goal-directed and theorizes about how people make choices based on their values and beliefs (Huber, 1997; Marini, 1992). This theoretical model is unique in its postulation that social and structural values and norms provide incentives to influence individuals' calculation of utility maximization. However, rational choice theory is not limited to the economic constraints on utility maximizing decisions; rather, it is a "less restrictive model based on the assumption of purposive and conscious choice behavior" (Huber, 1997). The rational choice model has been used in higher education research to understand college choice and post-secondary planning as the outcome of individuals performing a cost-benefit analysis conditioned by social context (DesJardins & Toutkoushian, 2005; e.g., Wells & Lynch, 2012). In studies based on this theoretical approach, the dominant variables are the financial costs and benefits, such as education-related loan amount, monetary support from parents/family members, potential foregone earnings as the indirect cost of continuing education, and potential earning advantages after degree completion. Academic performance is another important factor in the calculus of rational choices as a measure of self-assessed readiness and competitiveness in educational pursuit (e.g., Wells & Lynch, 2012).

In addition, traditional socioeconomic status (SES) variables, including family income and parental education, are used to reflect inequalities in individuals' access to financial, informational, and other non-material resources (e.g., communication with parents and peers of rational expectations or support), with an overall pattern suggesting that students from low-SES backgrounds are disadvantaged in their educational choices (Lloyd et al., 2008; Wells & Lynch, 2012). Demographic variables, such as gender, race/ethnicity, and immigration status, are usually included because these factors partially convey the social norms that have been internalized by individuals and lead to different levels of aspiration to educational pursuit (Huber, 1997; e.g., Kao & Tienda, 1998; Schoon, 2014; Wells & Lynch, 2012). For example, industrial technology has induced changes in the last century and opened the labor market for females. In response to the transformed norms at the societal level, women are motivated to improve their situation by completing more years of education, working for pay, and having fewer children (Huber, 1997). Also, it has been found that racial minority students are more sensitive to outside contextual influences than their Caucasian counterparts in their rationalizations of educational prospects (Lloyd et al., 2008).

Another advantage of using the rational choice model as the theoretical framework is its implication of intersectionality, a perspective that highlights the joint effects of race/ethnicity, gender, and social class on outcomes such as personal development and educational participation (Cole, 2009). An individual almost always occupies multiple categories (gender, race, social class, etc.) simultaneously; by considering the multiple categories together in the study, it becomes possible to demonstrate that social categories depend on one another for meaning in their functionalities in personal choices.

Research Questions

The rational choice model brings awareness to how women's cost-benefit calculations of continuing education are affected by an institutional structure in which they have to maintain their competitiveness in a traditional STEM structure that often puts a premium on the value of the majority (i.e., white males). A recent national sample of college graduates is used to answer the following research questions:

1) What are the factors leading to the enrollment in graduate education for bachelor's degree holders? Are there systematic differences between males and females and between students in STEM and non-STEM disciplines?
2) What are the factors that negatively influence female students' enrollment in graduate programs in STEM disciplines? What can be done to improve their participation in graduate education?

METHOD

Data Sources

The restricted-use data of the Baccalaureate and Beyond Longitudinal Study were analyzed to answer the research questions (National Center of Education Statistics, 2012). The B&B: 2008 was a longitudinal survey study sponsored by the U.S. National Center of Educational Statistics that tracked students' education and work experiences after they received a bachelor's degree during the 2007-08 academic year. The initial 2008 cohort was a representative sample of approximately 19,000 graduating seniors (unweighted) in all majors. Participants in the B&B study were selected through a complex design and stratified sampling procedures. To ensure the validity and generalizability of the findings, data were weighted in the statistical analyses (Thomas & Heck, 2001).

In the B&B data set, a binary variable was made available to indicate whether a student was in a STEM major based on the undergraduate transcript. According to the B&B codebook, the definition of STEM was "adapted from the National Science and Mathematics Access to Retain Talent Grant (National SMART Grant) Program, 34 C.F.R. 691.17(d) and the categories are created using the 2010 Classification of Instructional Programs" (CIP, see http://nces.ed.gov/ipeds/cipcode/ for more information). The indicator of "STEM" majors was considered appropriate for the purpose of this study because it is also aligned with Biglan's (1973) classification of academic disciplines, in which majors of clearly delineated paradigm and quantitative orientation, including engineering, natural sciences, architecture, math, and the like, were classified into the "hard" (science) dimension. Note that a small amount of missing data in some variables (e.g., grade point average (GPA) in STEM/non-STEM courses) was imputed based on closely related measures. For the inferential analysis, the *weighted* sample consisted of 384 females and 695 males in STEM majors, and 3,972 females and 2,511 males in non-STEM majors.

Variables

The dependent variable was self-reported graduate enrollment status in the year 2009, categorized as follows: Did not enroll in graduate school, enrolled in a master's degree program, or enrolled in a doctoral program. A distinction between the "master's" and "PhD/first professional" degrees is needed given the large variety of academic majors included in the study and the variations in individuals' career and educational paths that shape educational aspirations at the time of graduation. Based on the rational choice model, the core independent variables were measures of the costs and benefits associated with graduate enrollment. First, the expected monetary contribution from parents in the academic year of 2007-08 and the accumulative loan amount were used to estimate the direct costs of graduate education. Second, initial employment earnings were used to quantify the potential foregone earnings and the indirect cost of attending a graduate program. The majority of college graduates reported income from a source of primary employment one year after graduation (in 2009) in the B&B sample, but this income may not be a fair indicator of initial labor market return due to the fact that many were working part-time, or self-identified as out of the labor force. As such, a two-step process was taken to obtain a less biased estimate of foregone earnings. First, the pay level was calculated as the ratio of an individual's annual income and the reported average number of hours worked per week. Second, the median pay levels of students who reported working full-time were identified within groups defined by gender and undergraduate major. The median values were used to replace the pay levels of students who were employed part-time or who were out of the labor force in the same gender/major combination.

Academic performance was used to indicate individuals' readiness for graduate education. In order to better examine the differences between STEM and non-STEM students, academic performance was indicated by GPA in undergraduate STEM and non-STEM courses. Additionally, measures of social influence were included as well as demographic characteristics to reflect individual differences in personal beliefs and value systems. Following examples in past studies, proxy measures of social influences from family included the following: Highest education completed by either parent, whether both parents were born in the U.S., and family income in 2006. The two proxy measures of peer influence in this study were the net cost of the undergraduate institution attended in the 2007-08 academic year and undergraduate institution selectivity. Inclusion of the two variables was based on the consideration that, first, the net cost of an undergraduate institution may be viewed as an indicator of the accessibility of the institution (Paulsen & St. John, 2002). Second, selectivity ratings from Barron's Profiles of American Colleges emphasize the academic competitiveness of an institution (Monks, 2000). Empirical evidence supports that institutional quality is interrelated with the social and organizational culture within (Gardner, 2010). Thus, the two measures were used to capture the general characteristics of peer interaction within an undergraduate institution, given that a student's social and academic interactions with peers may stimulate her/him toward different preferences and readiness levels for graduate education.

Individual differences were also characterized by student's gender, racial background, marital status, and age at the time of bachelor's degree completion (e.g., Perna, 2004; Roksa & Levey, 2010). Whether an individual had children was not included due to an extremely small percentage of respondents having minor dependents. All participants were categorized as White, Asian American, or underrepresented minorities (URM), with the notion that Asian Americans have distinctive patterns in graduate enrollment in comparison to other minorities groups.

Analytical Procedures

Because the study had a categorical outcome variable, multinomial logit regression was used for inferential analysis. Using one category of the dependent variable as the reference group, multinomial logit models estimate the log-odds of other single outcome categories occurring relative to the reference group. Multinomial logit regression is a special case of the general log-linear model and has been used widely in sociological, educational, and economic research (e.g., Mullen et al., 2003; Perna, 2004; Staniec, 2004; Xu, 2013). It is considered the most appropriate statistical approach for this study because 1) there is a relatively large number of independent variables as suggested by the rational choice model; and 2) it offers sufficient statistical capacity to untangle the complex impacts of multiple social categories as suggested by the intersectionality viewpoint. In order to meet the underlying assumptions of the maximum likelihood estimation of multinomial logit regression models, a number of highly skewed continuous variables were converted into an ordinal scale.

RESULTS

Descriptive information is presented in Table 1 that summarizes reasons college graduates did not attend graduate school, and for those who were enrolled in 2009, the types of financial aid they had. The information is presented for four separate groups as defined by the two genders and academic majors (STEM vs. non-STEM categories). In general, financial and employment circumstances appeared to be the dominant reasons for students deciding not to pursue graduate education immediately following the undergraduate degree. Note that females in STEM had the lowest probability of obtaining employer tuition assistance in all four groups. Additionally, only 80% of them had financial support (including grants/scholarships, employer tuition assistance, Research Assistant (RA)/Teaching Assistant (TA), and fellowships) if enrolled in doctoral/1st professional programs (shortened to "doctoral programs" hereafter) in comparison to 98% of their male counterparts. In particular, for those enrolled in doctoral programs, 24% of STEM females had TA or

RA, in contrast to 47% of their male counterparts; also, the percentage of females receiving fellowships was 14.6% versus 20.0% of males. Nonetheless, females did have a better chance of receiving grant/scholarships than their male counterparts (6.4% vs. 4.0%). STEM females had a graduate enrollment of 37% in 2009, which was significantly higher than that of the other subgroups.

Further analysis (a table presenting detailed numbers is omitted due to space limitation) showed that female graduates in STEM stood out from the other three subgroups in a few ways. First, they were relatively young when receiving their college degrees, with 62.9% at 22 years or younger versus approximately 50% in other groups. In addition, they showed better academic performance in college, with 28.9% reporting a GPA of 3.53 or higher in STEM courses and 41.4% reporting a GPA of 3.69 or higher in non-STEM courses compared to the other three groups. Finally, STEM females had the highest percentage of students (41.9%, in comparison to 27.8% of STEM males and 19.6% of non-STEM females) reporting an aspiration to pursue a doctoral degree. As a highlight of the income inequity, 42% of the STEM males, in contrast to lower than 20% in all of the other three groups, reported a top quartile pay level in 2009.

Since the descriptive analysis suggested gender-related differences for the STEM graduates and distinctive patterns in STEM and non-STEM majors, separated multinomial models were constructed for the two gender groups in STEM and non-STEM majors (Table 2). The dependent variable was measured by graduate enrollment status with those who were enrolled in doctoral programs as the baseline comparison group. The fit indices suggested that the same model structure fitted the STEM population better than the non-STEM students (see the bottom of Table 2) with model pseudo R^2 over .45 and classification accuracy for doctoral/1st professional degree enrollment of over 75%. Given the drastic differences in the weighted group sample sizes, interpretations of the findings were guided by both statistical significance as well as the actual values of the odds ratios (i.e., indications of effect size).

First, monetary factors played an active role in individuals' calculation of costs and gains. For females in STEM majors, lower family monetary contribution in 2007-08 was associated with much lower odds of being enrolled in doctoral programs, relative to their counterparts whose family contribution was $20K or more. For STEM males, lower family contribution (between $2K and $9K) only increased the odds of attending doctoral programs over master's programs (odds ratio = .162), relative to those who had family contributions of $20K or more. This pattern was absent for females in non-STEM majors. Differently, non-STEM males with family contributions between $9K and $20K had more than twice the likelihood of refraining from enrollment in graduate school (odds ratio = 2.120) and almost twice the likelihood of enrollment in a master's program (odds ratio = 1.790), relative to that of getting enrolled in doctoral programs in comparison to their counterparts with a family contribution of over $20K.

Table 1: Self-reported status on graduate enrollment and primary factors leading to the status

	STEM				Non-STEM			
	Female		Male		Female		Male	
Weighted n	384		696		2511		3972	
	Masters	Doctoral /1st prof.	Masters	Doctoral /1st prof.	Masters	Doctoral/ 1st prof.	Masters	Doctoral /1st prof.
% enrolled	19.3	17.7	17.8	12.8	21.5	4.1	17.2	5.9
% reporting each type of financial assistance								
Grant	31.7	41.6	23.7	30.2	22.6	36.0	21.2	32.3
Employer	5.9	0.015	11.3	0.5	5.5	2.2	9.0	0.7
RA/TA	22.3	24.0	26.1	47.3	6.9	17.2	9.3	6.4
Fellowship	6.4	14.6	4.0	20.0	3.0	7.4	2.5	3.4
% not enrolled	63.0		69.4		74.4		76.9	
Reason not enrolled								
Academic	22.6		24.3		19.1		22.6	
Financial	38.8		52.4		42.6		46.4	
Employment	41.4		44.3		45.3		42.8	
Other	24.9		23.1		30.0		26.4	

Note. All statistics are based on weighted samples.

Table 2: Factors Related to Graduate School Enrollment Status: College Graduates with a BA Degree in Non-STEM Major

	Odds ratios	Did not enroll in graduate school				Enrolled in master's degree program			
		STEM		Non-STEM		STEM		Non-STEM	
Variables	Characteristics	Female	Male	Female	Male	Female	Male	Female	Male
Race	URM	3.006	1.318	0.913	0.930	3.594	1.854	1.202	1.586
	Asian Americans	0.323	0.588	0.507	0.646	0.170**	0.752	0.593	0.696
	White (ref.)								
Marital status	Not married	0.031*	1.260	0.505	1.444	0.044*	1.682	0.601	1.115
	Married/partnered								
Age when received BA degree	22 and younger	0.017*	0.468	0.974	0.335**	0.009**	0.839	1.171	0.381*
	23 to 25 years old	0.080	0.748	1.307	0.526*	0.017*	0.742	1.203	0.558
	26 years and older								
Parents' highest education	HS equivalent or lower	2.120*	1.255	0.792	1.563*	2.549*	1.670	0.790	1.819*
	Bachelor's degree	1.244	2.341**	0.701	1.957**	1.761	3.144**	0.681	2.066**
	Advanced degree								
Parents born in the US	Both born in US	0.314*	1.055	1.235	0.464*	0.141***	1.264	1.430	0.547
	One/both non-US born (ref.)								
Family income in 2006	Lower than $20,000	0.502	1.337	2.034	0.758	0.374	4.179	2.217	0.917
	$20,000 to $39,999	1.538	2.005	3.003*	0.813	0.895	3.848	3.518*	0.906
	$40,000 to $59,000	3.399*	18.448**	1.416	0.649	1.629	46.030***	1.728	0.565
	$60,000 to $99,999	0.999	1.948	2.367**	0.659	0.534	1.203	2.066*	0.657
	$100,000 or more								
Expected family contribution in 2007-08	Lower than $2000	0.424	1.814	1.684	1.300	0.430	0.493	1.433	0.947
	$2000 to $8999	0.207*	0.745	1.195	0.881	0.230*	0.162*	1.110	0.918
	$9000 to 19,999	0.455	1.164	1.224	2.120*	0.245*	0.984	1.316	1.790*
	$20,000 or more								

	Odds ratios	Did not enroll in graduate school				Enrolled in master's degree program			
		STEM		Non-STEM		STEM		Non-STEM	
Variables	Characteristics	Female	Male	Female	Male	Female	Male	Female	Male
Cumulative undergrad loan through 2007-08	No debt	0.250**	0.737	0.876	0.644	0.493	0.496	0.752	0.611
	Lower than $10,000	0.526	0.593	0.842	0.555	0.552	0.291*	0.684	0.648
	$10,001 to $25,000	0.250**	0.984	0.989	0.813	0.364	0.685	0.759	0.699
	Above $25,000 (ref.)								
Net cost in 2007-08	Lower than $350	0.983	0.653	0.571*	0.369***	3.763**	0.824	0.946	0.703
	$350 to $3,499	3.449*	0.522	1.073	0.527*	4.651*	0.649	1.196	0.541*
	$3,500 to $7,999	0.906	0.410*	0.811	0.668	4.373**	0.939	0.986	0.821
	$8,000 and more								
Institution selectivity	Minimally selective	0.358*	5.280**	1.212	1.953*	0.136**	2.894	0.856	1.846
	Moderately selective	0.631	1.024	1.403	1.424	0.406*	1.079	1.185	1.460
	Very selective (ref.)								
GPA in undergrad STEM courses	Lower than 2.58	10.264**	5.528*	1.483	1.756	5.706*	6.780*	1.518	2.458*
	2.58 to 3.04	7.127***	2.035	1.398	1.385	3.630*	1.743	1.573	1.923*
	3.05 to 3.52	2.882*	1.808	1.428	1.304	2.525	4.120**	1.468	1.748
	3.53 and higher								
GPA in undergrad non-STEM courses	Lower than 3.0	1.900	1.851	2.687*	1.751	4.437	1.331	1.268	0.507
	3.00 to 3.36	2.042	1.113	1.714	2.531**	2.855	0.607	1.139	1.693
	3.37 to 3.68	1.108	0.625	1.242	1.809	1.879	0.742	1.048	1.058
	3.69 and higher								
Highest degree expected	Bachelor's	31.108***	129.017***	30.472***	22.611***	4.625	5.811	4.884**	2.710*
	Master's	32.590***	150.531***	20.018***	15.604***	38.337***	112.030***	12.801***	8.438***
	Doctorate or 1st prof.								
Potential foregone earnings	Bottom quartile	1.011	0.333*	0.979	0.568*	0.629	0.688	1.196	0.784
	2nd quartile	0.203**	0.285*	0.497*	0.777	0.213**	0.388	0.640	0.750

	Odds ratios	Did not enroll in graduate school				Enrolled in master's degree program			
		STEM		Non-STEM		STEM		Non-STEM	
Variables	Characteristics	Female	Male	Female	Male	Female	Male	Female	Male
	3rd quartile	0.844	0.112***	0.661	0.263***	1.047	0.082***	0.649	0.332***
	Top quartile								

STEM females: number of cases = 384, -2 log likelihood χ^2= 232.76*** (*df* = 68), Pseudo R^2 (Cox & Snell) = .47, % correctly classified = 75.0

STEM males: number of cases = 695, -2 log likelihood χ^2 =403.22*** (*df* = 68), Pseudo R^2 (Cox & Snell) = .45, % correctly classified = 80.2

Non-STEM females: number of cases = 3972, -2 log likelihood χ^2= 658.31*** (*df* = 68), Pseudo R^2 (Cox & Snell) = .16, % correctly classified = 75.5

Non-STEM females: number of cases = 2511, -2 log likelihood χ^2 =543.28*** (*df* = 68), Pseudo R^2 (Cox & Snell) = .21, % correctly classified = 78.4

Notes. 1. The baseline group is college graduates who were enrolled in doctoral program in 2009.
2. For the non-STEM model, * p < .05, ** p < .01, *** p < .005.
3. For the STEM models, * p < .10, ** p < .05, *** p < .01.
4. All statistics are based on weighted samples.

As a contrast, the function of accumulative undergraduate loan amounts on graduate enrollment was fairly consistent, with lower loan amounts being correlated with a higher likelihood of doctoral enrollment; nonetheless, the pattern is relatively stronger for STEM students. In particular, the odds were almost quadrupled for STEM females with no debt or a debt between $10K and $25K to be enrolled in terminal degree programs, relative to no graduate enrollment, compared to the same odds for STEM females who had a loan amount over $25K.

For males in both STEM and non-STEM, potential foregone earnings as an indirect cost of graduate enrollment were correlated with the likelihood of doctoral enrollment in a negative fashion, but the relationship appeared to be curvilinear. Relative to those whose potential earnings were in the top (4th) quartile, the likelihood of individuals with earnings in the 3rd quartile enrolling in terminal degree programs was over ten times higher (odds ratios = 0.112 for not enrolled, odds ratio = .082 for being enrolled in master's program) in STEM majors and at least three times higher (odds ratios = 0.263 for not enrolled, odds ratio = .332 for being enrolled in master's program) in non-STEM majors. Similarly, females with earnings in 2nd quartile appeared to be more likely to pursue a terminal degree compared to their counterparts in the top earning quartile.

Lower academic performance decreased the likelihood of graduate enrollment in general, and it had a stronger influence on STEM students. In particular, a cumulative GPA lower than 3.0 in undergraduate STEM courses increased the likelihood of refraining from enrollment in graduate programs by at least sevenfolds (odds ratio > 7.12) in relation to terminal degree enrollment for females in STEM in comparison to those whose GPA in STEM was higher than 3.5. For both males and females in STEM, students with low GPA also had a significantly higher likelihood of choosing master's programs (females odds ratio > 3.63 for females and odds ratio = 6.78 for males) rather than doctoral enrollment.

Regardless of academic majors, males were significantly less likely to enroll in terminal degree programs if the highest educational attainment of their parents was a bachelor's degree, relative to those whose parents completed advanced degrees (odds ratios = 2.341 and 1.957 for STEM and non-STEM, respectively, not enrolled in graduate programs; odds ratios = 3.144 and 2.066 for STEM and non-STEM, respectively, being enrolled in master's programs). Parental education did not influence graduate enrollment of females in non-STEM majors, whereas for the female STEM students, first generation college goers were twice as likely to refrain from enrollment in terminal degree programs, relative to those whose parents had advanced degrees (odds ratio = 2.120 for not enrolled and odds ratio = 2.549 for enrollment in master's program only). The last proxy measure of family influence was income in 2006, which showed a curvilinear relationship with graduate enrollment. If the family annual income was between $40K and $60K, STEM graduates had at least a tripled likelihood of refraining from pursuing terminal degrees right after college graduation (odds ratios = 3.399 and = 18.448 for females and males, respectively) in comparison to those whose family annual income was $100K or higher; however, no significant difference in likelihood of enrollment was found between individuals from bottom and top income families.

Two institutional variables were used as proxies for peer influence. First, a net attending cost in the 2007-08 academic year lower than $8K was associated with a roughly 50% increase in the likelihood of seeking a terminal degree for male college graduates, relative to those whose net costs were higher than $8K. However, for females in STEM, a net cost in the range of $350 to $3500 was associated with at least a tripled likelihood of refraining from pursuing a doctoral degree in comparison to their counterparts with a net cost of $8K or higher. The gender-based inconsistency was also found in the relationship between institutional selectivity and graduate enrollment status. For males in STEM, an undergraduate degree from a minimally selective institution decreased the likelihood of enrollment in doctoral programs (odd ratios = 5.280 for not enrolled and = 2.894 for enrolled in master's program only); however, a college degree from a minimally selective institution significantly increased the likelihood of females in STEM pursuing a terminal degree (odd ratios = 0.358 for not enrolled and = 0.136 for enrolled in master's program only), relative to those who graduated from very selective institutions.

Graduate enrollment status was also different with regards to demographic background. Asian American women had significantly higher likelihoods of being enrolled in doctoral programs in comparison to their URM counterpart. If not married, the odds of enrollment in a terminal degree program were more than twenty times the odds for married women in STEM, but this pattern was not nearly as strong for women in non-STEM disciplines and did not exist at all for men. Finally, educational aspiration, measured by the highest degree expected to be obtained by an individual, was the most salient predictor of graduate enrollment, even with all other factors taken into account.

DISCUSSION

The findings of this study reveal gender and major-related differences in pursuing advanced education within one year following college graduation. An encouraging sign is that the graduate enrollment rate for women in STEM was more than six percentage points higher than that of their male counterparts. A persistent problem is the low participation in STEM majors; out of the weighted samples of college graduates from all majors, only 8.8% of women had an undergraduate STEM major in comparison to 21.7% of men. The discussion below regarding the factors leading to graduate enrollment may shed light on improving women's participation in non-traditional fields.

The Economic Aspects of Graduate Education

Essential to the rational choice model is individuals' evaluation of the costs and anticipated benefits. The three economic factors, family contribution in 2007-08, cumulative loan amount in 2008, and potential foregone earnings in 2009, all influenced graduate enrollment status. Lower family contribution increased the likelihood of graduate enrollment for STEM students but seemed to have an opposite effect on non-STEM students. Given the availability of financial supports, as shown in Table 1, a speculative explanation for this contradictive pattern is that the relatively small number of STEM students meant much greater advantages in obtaining financial aid, such as fellowships, scholarships, and graduate assistantships, which reduced their dependence on support from family as a result.

It is easy to understand that a relatively low debt increased the likelihood of immediate entry into graduate school, particularly for STEM women pursuing a terminal degree. However, individuals' interpretation of gain from graduate education is not as clear. For male students, an unambiguous negative relationship appeared to exist between the earning potential at the initial employment stage and the likelihood of immediate enrollment in graduate studies. Understandably, individuals who had high earning potentials were more likely to lose the motivation to continue academic training for a few more years, whereas those who had an unsatisfactory income were more driven to further educational investment with the expectation of higher returns.

Nonetheless, the observed trend suggests that individuals in the middle earning levels had a stronger tendency to expect that the gain from advanced education would offset the potential costs, but fewer students in the bottom earning quartiles had comparably optimistic evaluations of the prospect of further education. In particular, no significant differences existed between women in the bottom earning quartile and their counterparts in the top earning quartile in regard to graduate enrollment; those in the 2^{nd} and 3^{rd} earning quartiles, however, had significantly higher likelihoods of graduate enrollment than the top-earners. A possible explanation for this curvilinear relationship between earning potential and graduate enrollment could be that individuals whose initial employment was in low-earning sectors felt disappointed at their economic gains after college graduation and started having doubts about the utility maximization through educational investment. As such, they were unwilling to make further investments in graduate education.

Academic and Demographic Factors

Educational aspiration was found to be the strongest predictor of immediate graduate enrollment for college students, regardless of major, which is not surprising, given that it has been empirically established as an important factor leading to future planning and academic attainment (Hearn, 1987; Isaac, Malaney & Karras, 1992; Kao & Tienda, 1998; Pascarella, 1984). Also, the importance of aspiration to the pursuit of graduate studies provides support to the rational choice model that human action is not simply a calculation of economic costs and gains, but is also guided by personal values and beliefs (Huber, 1997; Marini, 1992). That is, educational aspiration is a trait of personal value and academic expectation that is influenced directly by significant others (e.g., parents, teachers, and peers) and by socioeconomic status and cognitive ability (Lloyd et al., 2008; Nachmias, 1977). The critical role of educational aspiration in the pursuit of graduate education serves as indirect support to family and social influences on personal choices.

Even when educational aspiration was controlled, academic performance in undergraduate education remained a unique influence on graduate education status for students in STEM majors. The negative relationship between academic performance and likelihood of graduate enrollment was extremely strong for STEM females. Based on the rational choice model, this pattern confirms academic performance as a measure of self-assessed readiness and competitiveness in educational pursuit (e.g., Wells & Lynch, 2012). Women appear to be more self-conscious about their levels of performance than men when majoring in "non-traditional" disciplines (Zhao et al., 2005); as such, their decisions about continuing education are more strongly influenced by their self-perceived readiness. The descriptive information revealed that women in STEM had better academic performance on average than STEM males and non-STEM students, which could be part of the reason that they had a higher enrollment rate in graduate school than others. However, the patterns also suggest that women need to feel more qualified than their male counterparts in order to make a positive decision about graduate school enrollment. The percentage of women in STEM enrolled in graduate programs would be even higher if they were as confident about their academic ability and operated under the same personal standards as men.

Married women in STEM majors were extremely unlikely to start graduate, especially doctoral, education in comparison to their unmarried counterparts, but this pattern was statistically nonsignificant for non-STEM women. Taking into consideration that STEM women had the highest enrollment rate in graduate education among all groups, the role of family status is even more striking. Extant literature suggests that the unique institutional culture in STEM fields, "due to long term male dominance, tends to require total work commitment and exclude other life realms such as family responsibility" (Xu & Martin, 2011, p. 150; see also Zhao et al., 2005). According to the rational choice model, institutional structures produce systemic individual behaviors. It is possible that women in STEM anticipate an unreasonably demanding and family-unfriendly academic environment in graduate school that would be in great conflict with their family responsibility; as such, they had to choose between a full commitment to graduate education or family life because it is simply unrealistic to have both.

Social Influences from Family and Peers

Net of the educational aspiration, parental education still impacted the continuing education of college graduates. With the exception of non-STEM women, individuals having a parent with an advanced degree had significantly higher likelihoods of being enrolled in doctoral programs. The findings may indicate that parents with advanced educations expect their children to go to graduate school and convey their expectations through their regular involvement in children's academic choices (McNeal, 1999). Different from the role of parents' education, the curvilinear relationship between family income and graduate education is difficult to interpret. STEM students had the lowest likelihood of pursuing a terminal degree one year after college graduation if their family income was at $40K to $60K level, relative to their counterparts from affluent family backgrounds (annual income > 100K); however, no significant difference was identified in the likelihood of graduate enrollment between groups at the two ends of the income continuum. Probably, individuals from low income family backgrounds are more driven than those from medium income family backgrounds to pursue graduate education as the means to achieve socioeconomic upward mobility (Blau & Duncan, 1967; see also Huber, 1997); meanwhile, students from high-income families have greater access to social and educational resources and are better prepared for advanced education. This finding may indicate that the function of family income is unlikely to be about affordability of advanced education; rather, it is one of the fundamental social factors influencing individuals' purposive and utility maximization calculation regarding graduate school enrollment.

Peer influence was captured by the net cost and selectivity of the attended undergraduate institutions. In both measures, there appeared to be gender-based inconsistencies in their relations with graduate enrollment. Male students graduating from minimally selective institutions were much more likely to refrain from pursuing graduate education, but the opposite held for females in STEM. It is possible that males were more susceptible to the *academic* competitiveness in their undergraduate institutions and were driven towards graduate enrollment as influenced by peers if they graduated from very selective colleges. Lower attending cost (<$8K) tended to decrease the likelihood of females in STEM being enrolled in terminal degree programs, but the opposite trend was found with males in STEM. Further investigation is needed to understand such gender-based differences.

Overall, findings of this study suggest that individuals of varying gender, race, degree, age, marital status, family background, academic performance, and other contextual factors have different academic values and expectations. These socio-psychological differences are reflected in their distinctive patterns of rational decision making based on an individual's internalized beliefs about the economic and social values about graduate education (Lloyd et al., 2008). From the perspective of intersectionality, the findings offer a more nuanced understanding of how social categories of gender, race, and class simultaneously affect the perceptions, experiences, and opportunities of individuals in the educational system (Cole, 2009).

Implications and Potential Interventions

The higher rates of women in STEM advancing to graduate education discredits the argument that women are less likely to stay committed to a STEM path due to their gender-specific socialization (Bobbitt-Zeher, 2007; Blau & Kahn, 2007; Frehill, 1997). This trend shows a positive step toward gender equality in non-traditional fields, given that graduate education is gaining importance in recent years (Zhang, 2005). Interpretations of the findings based on the rational choice model lead to two recommendations for policymakers. First, it is important to understand that structural factors can provide incentives, or the lack thereof, to affect individual choices and aggregate behaviors. In order to reinforce and strengthen the newly observed positive trend of female participation in graduate STEM education, any structural factors that may divert women away from STEM paths should be identified and prevented.

As suggested by the findings, STEM women had an increased likelihood of pursuing advanced degrees if they did not need a large amount of monetary support from family and did not have overwhelming college loan debt. As such, the availability of financial aid would contribute positively to STEM women's graduate enrollment.

However, this study also suggests that women in STEM had substantially fewer opportunities to obtain graduate assistantships and fellowships in doctoral programs; in both master's and doctoral programs, they had significantly lower chances of receiving tuition assistance benefits from employers than their male counterparts. These disadvantages at the structural level work against the needs of women in STEM and are detrimental to the ongoing effort to increase female talents in the STEM workforce. Therefore, institutional administrators and policymakers need to identify and dissolve any potential obstacles and gender-biased evaluation procedures that make it more difficult for women to obtain graduate assistantships and/or fellowships.

Second, findings in the past and in the current study indicate that it is critical for policy makers to understand women's commitment to family as mothers and caretakers. The drastic differences in the likelihoods of married and unmarried women pursuing graduate education in STEM, and the absence of this trend for non-STEM women, suggests that systemic changes should occur, particularly within STEM programs. In order to attract and retain talented women in STEM fields, higher education institutions and academic units should appreciate and accept inherent gender differences and encourage an organizational STEM culture that can accommodate women's greater responsibility for the home and family (Hayes & Bigler, 2012; Sax, 2001). Policies and interventions that aim to help women to balance raising a family with demanding graduate training is one of the primary changes that would effectively improve the opportunities for women to stay and strive in STEM fields.

Last but not least, the findings also suggest different decision-making patterns between women and men. Women's strong concerns about financial readiness and family responsibility indicate that they are less likely to make a commitment for graduate education unless they feel a sufficient level of security about the required resources. This is consistent with the literature that women tend to be more cautious and experience a higher level of perceived risk than men in their decision-making process (Blais & Weber, 2001). This gender-based difference strengthens the argument that increasing women's chances of obtaining financial aid, offering programs to accommodate their domestic responsibilities, and providing other social supports to decrease their perceived risks associated with investment in graduate education would be effective in increasing the likelihood of continuing education for women in STEM.

Limitations and Future Directions

The possibility exists that college graduates with a degree in STEM majors may choose to attend a graduate program in non-STEM majors, and the chance for such "opt-out" could be greater for women. However, this complexity was not examined in this study because of the very small sample of STEM females, especially at the doctoral enrollment level; further division of the group into extremely limited sample sizes would invalidate inferential statistical analysis. Additional checks on the data showed that the number of females who "opt-out" of STEM majors was about the same as the number of females who "opt-in" (females with non-STEM undergraduate degrees enrolled in STEM graduate programs); this left the number of women attending STEM graduate programs unchanged.

Second, it would be more informative in regard to the status of women in non-traditional disciplines to exclude majors that have a fairly even presence of men and women (e.g., health/bioscience and architecture) and treat only academic majors with low female presence as "STEM." Unfortunately, this approach left a very small number of STEM females in the analysis, particularly for the doctoral enrollment, and multinomial analysis could not be performed. Third, the two proxy measures, institutional selectivity and net attendance cost, may not be the most appropriate indicators of peer influence, but they appeared to be the best choices given the available variables in the B&B survey. The hope is that once the economic factors are controlled for by including the measure of attendance cost, the institutional selectivity would reflect peer relationships more accurately. Fourth, the examination of students' advancement to graduate education was limited to the "immediate" transition during the first year following college graduation. Individuals' economic situations, values, and expectations may change with the accumulation of post-college experience. Additionally, there may be significant discipline-related differences in graduate school enrollment. In certain STEM fields, individuals may want to accumulate a number of years of work experience before considering graduate education. Therefore, for future research, longitudinal data that trace changes over time would deepen our understanding of individuals' pursuit of graduate education. Last, due to the limitations of secondary data sources, the study was unable to further explore discipline differences between STEM majors or investigate individual differences beyond the general patterns. Qualitative studies would be more informative for examining individual differences and studying major-specific factors in the pursuit of continuing education.

CONCLUSION

Using the most recent national data of college graduates in the U.S., this study may have identified the first signs that females are gaining force in STEM disciplines. Even though they are still the minority in the STEM areas, the trends suggest that those who were on the STEM track both outperform their male counterparts academically in college and have a greater likelihood of pursuing advanced degrees following college graduation (Zhao et al., 2005). With that being said, the educational and occupational systems still have a long way to go in attracting more girls and women into STEM disciplines and transforming the work culture in STEM occupations so that women can receive the respect, assistance, and credits that they deserve.

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