Advance to and Persistence in Graduate School:

Identifying the Influential Factors and Major-Based Differences

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Abstract

Structured within an expanded econometric theoretical framework, this study uses national data sources to identify the critical factors that influence college graduates' advance to and persistence in graduate education and to compare the systematic differences between students in the STEM and non-STEM majors. The findings indicate that there is a high attrition rate from graduate education in both STEM and non-STEM majors. Male, Caucasian, and students who received their bachelor degree at a traditional (younger) age are more likely to attend and complete graduate education, regardless of academic major. Major-based differences are apparent in the impact from variables including parents' education, total undergraduate debt, institution selectivity, and student's academic background measured by SAT/ACT scores and cumulative GPA in undergraduate major.

Abstract for JHE

This study identifies influential factors in college graduates' advance to and persistence in graduate education. The findings indicate that students' participation in graduate education is an individualized process dependent upon ability and preferences, as well as an evaluative outcome of contextual factors, including resources and supports available in the environment.

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The value and importance of a graduate education have grown significantly in recent decades. Reasons for this growth include that, primarily, college education is becoming inadequate for many occupations with the rapid knowledge growth and technological innovation (Zhang, 2005). Statistics and survey data have supported the argument that graduate or professional degrees are the prerequisite for the majority of top-ranked occupations (Bowen & Bok, 1998; Zhang, 2005). Also, empirical evidence shows that graduate education may provide as a fast track to many powerful and prestigious positions in the occupational distributions (Kingston & Clawson, 1986; Malcom & Dowd, 2012; Zhang, 2005). In contrast to the growing importance is the insufficient understanding of some critical aspects of graduate education. Extant scholarly efforts on students' pursuit of graduate education have outlined the gender and racial imbalances in graduate school enrollment, and identified a number of factors that may influence college graduates' attendance to graduate school (e.g., Malcom & Dowd, 2012; Perna, 2004). However, due to variations and limitations in data sources and theoretical groundings, questions remain largely unanswered in a few areas. One of them is the differences in decision-making regarding graduate education for students in various academic disciplines, even though there are acknowledgements that some majors have lower graduate school enrollment than others (Bowen & Rudenstine, 1992; Perna, 2004; Zhang, 2005). Another area that needs more scholarly attention is the student persistence once enrolled in graduate education, with national statistics showing around 40% attrition rate for graduate students (Council of Graduate Schools, 2004).

With the acknowledgement of these insufficiencies, this study uses a national data source to examine the impact of the factors, identified within a comprehensive theoretical framework, on college graduates' *enrollment* and *persistence* in graduate school and to compare how the influences of the identified factors may differ across academic majors.

Review of Literature

A steady line of research can be identified that studies the graduate education in the U.S. (e.g., Ethington & Smart, 1986; Golde, 2005; Millett, 2003; Perna, 2004; Sax, 2001; Smart, 1986; Zhang, 2005). One of the primary concerns of the extant literature is about the gender and racial imbalances in graduate school enrollment, and findings consistently suggest that women and minorities are underrepresented (Malcom & Dowd, 2012; Perna, 2004; Zhang, 2005), especially in STEM majors (Joy, 2000; Malcom & Dowd, 2012; Sax, 2001). A few other common trends have also been identified with regards to factors influential in individuals' decisions to pursue graduate education. For instance, high socioeconomic background is usually a positive predictor for attending graduate school (Baird, 1976; Ethington & Smart, 1986); academic ability and undergraduate performance of students effectively increases the individuals' likelihood of graduate enrollment (Weiler, 1991); selectivity, or the quality, of the undergraduate institution is found to have a strong positive effect on graduate school enrollment (Ethington & Smart, 1986; Smart, 1986; Zhang, 2005). Among popular financial factors, the amount of undergraduate loan debt was the focus of many studies in terms of its effect on students' transition to graduate school, but the findings have not been consistent (Malcom & Dowd, 2012; Millett, 2003).

A variety of other related factors that have been examined include parents' educational level, students' social and academic involvement in the undergraduate years, academic major,

and availability of financial aids awarded for graduate attendance (Ethington & Smart, 1986; Joy, 2000; Sax, 2001; Weiler, 1991; Zhang, 2005). Even though many published studies are anecdotal and descriptive, and few are theoretically based and methodologically rigorous (Perna, 2004), it seems reasonable to argue that an array of social, academic, institutional, and financial factors play a role in the decision-making process of graduate attendance, and individuals have different considerations and expectations in their post-baccalaureate choices (Griffith, 2010; Malcom & Dowd, 2012; Pascarella & Terenzini, 2005; Stoecker & Pascarella, 1991).

Still, many questions remain open for further examination. Among them is the lack of attention to graduate school persistence. Few studies differentiate graduate education attendance with graduate degree attainment, even though attrition in graduate schools remains a cause of concerns (Gardner, 2010; Golde, 2005). For example, statistics have shown that over 40% of doctoral students fail to complete the degree requirements, an attrition rate much higher than that observed at selective undergraduate institutions (Council of Graduate Schools, 2004; see also Gardner, 2010; Golde, 2005; Zhang, 2005). Attrition from graduate education carries economic, social, and emotional costs; however, up to date only a very limited number of studies examined the factors that influence student persistence to degree attainment in graduate education. Among them, the majority had an economic/financial perspective (e.g., Weiler, 1991; Zhang, 2005), and a few other studies have a limited focus on a single institution and/or few academic disciplines (Golde, 2005).

Understanding is also limited in terms of how students from various undergraduate majors may differ in their graduate enrollment and completion. Empirical evidence supports that the likelihood of attending and completing graduate school varies across undergraduate majors (Zhang, 2005). Speculations about major-related differences in graduate school enrollment

include higher attendance in low-paid majors, and delayed attendance in majors that value work experiences. Particularly troubling is the observation that women and minorities are more concentrated in certain academic disciplines, such as education and psychology, and severely underrepresented in STEM disciplines (Malcom & Dowd, 2012; Perna, 2004; Zhang, 2005). However, systematic examination of variations in students' graduate attendance across academic majors remains lacking, especially with regards to their persistence after enrollment.

Theoretical Framework

Research on graduate education has also taken on a variety of theoretical orientations. For example, academic and social integration rooted in Tinto's (1993) framework has been used to study the importance of institutional environment in doctoral student attrition (Golde, 2005). An "input-environment-outcome" model was adopted to count for preexisting differences and various environmental factors on individual graduate enrollment outcomes (Sax, 2001). From an economic perspective, graduate education is captured as "an integral stage" of accumulation and lead to greater monetary rewards within the human capital theories (Zhang, 2005). Among the variety of theoretical frameworks used in the published studies, an expanded econometric framework introduced by Perna (2004) in her study of graduate school enrollment seems to stand out from others in its comprehensiveness. The assumption of this framework is that "individuals make decisions by weighting the monetary and nonmonetary costs against the monetary and nonmonetary benefits for all possible alternatives and then selecting the alternative that maximizes utility with respect to individual preferences, tastes, and expectations" (Perna, 2004, p. 489). Relying on the argument that individuals most likely have to make decisions based on imperfect information (Ehrenberg, 1991), Perna used social and cultural capital as appropriate

proxies for "individual preferences, tastes, and expectations" in order to quantify the nonmonetary variables.

This expanded econometric theoretical framework is adopted in this study given its incorporation of critical components identified in both sociological- and econometric-centered theoretical views. Rather than assuming individuals have complete knowledge in the decision-making process to maximize personal benefits as suggested by the economic point of view, this framework takes into consideration the imbalance in information access, and models individuals' interpretation of costs and benefits in a contextually dependent fashion (Malcom & Dowd, 2012). In other words, the decision-making process is characterized with individual differences in their social and cultural capitals, which shape their experiences, expectations, and preferences, and interpretation of *costs* and *benefits*. The objective of this study, with this framework, is to gain a more comprehensive understanding of the decision-making in the process of graduate school enrollment and degree completion.

The use of social and cultural capital as proxies for "individual preferences, tastes, and expectations" is supported by notion that an individual's decision and action are not only internal springs from personal experiences and preferences, but also "shaped, redirected, constrained by the social context" (Coleman, 1988, p. S96). Cultural capital can be interpreted as an individual's family background and parent-related factors that define one's class status (Perna, 2004). It has been empirically connected with many aspects of academic and professional attainment, including students' academic mastery (Goyette & Mullne, 2006), social experience and career attainment (Stoecker & Pascarella, 1991), upward mobility (Lamont & Lareau, 1988), pursuit of graduate education (Ethington & Smart, 1986), and making choices on college major (Goyette & Mullne, 2006).

Social capital, on the other hand, refers to one's social networks and connections that an individual builds upon her/his relationships with others through social interactions or social structures (Morrow, 1999). For college graduates, their social environment and interactions in the undergraduate institution are found to be related to personal gains, persistence in undergraduate programs, continuation to graduate education, and career attainment (Griffith, 2010; Pascarella & Terenzini, 2005; Stoecker & Pascarella, 1991). Social capital emphasizes the instrumental values of the networks and organization to personal success, and permits analysis of individualized decision-making within social context (Coleman, 1988).

Research Questions

With a goal to promote equity in access to higher education, in this study, academic majors are separated into STEM vs. non-STEM groups given the acute imbalance of women and racial-ethnic minority groups in the two general academic areas (Malcom & Dowd, 2012; Perna, 2004). Relying on the expanded econometric theoretical framework, two research questions are addressed: 1) What are the important factors that impact college graduates advance to and persistence in graduate education? And 2) Whether and how do the influences of the identified factors differ between the STEM and non-STEM college graduates?

Data Sources

This study uses the restricted-use data of Baccalaureate and Beyond Longitudinal Study (B&B: 93/97/03), a longitudinal survey study sponsored by the National Center for Education Statistics (NCES) that tracks students' education and work experiences after they received a bachelor's degree during the 1992-93 academic year. The base-year B&B cohorts in 1993 had approximately 11,190 qualified students from another NCES survey, the National Postsecondary

Student Aid Survey (NPSAS:93), and were a representative sample of graduating seniors in all majors. The base-year cohort was followed up with surveys in 1994, 1997, and 2003.

Variables

The dependent variable is a student's experience with graduate education between college graduation in 1993 and the last survey follow-up in 2003. The variable has outcome values: one had no graduate enrollment; one was previously enrolled, but no degree attainment; and one was currently enrolled or had attained at least one graduate degree (master's, doctorate, or first professional) in 2003. The independent variables, in addition to demographic characteristics, include measures of the monetary costs and benefits associated with graduate education, and social and cultural capital that reflects individual preference and expectations.

Based on previous studies, four measures on demographic characteristics are considered, including gender, race, marital status in 1994, and parental status. Racial groups are separated into two categories, minorities vs. White, in order to avoid extremely small groups and empty cells in the later statistical analysis. Marital status has only two values, married vs. not married. Parental status is indicated by having dependents (yes vs. no) of three different age groups (i.e., younger than 5, between 5 and 17, and 18 years and older). Both marital and parental status may be part of the decision-making formula when one is assessing the cost and benefits of graduate enrollment (Perna, 2004).

Financial Factors and Considerations. The monetary costs are the financial factors related to post-baccalaureate education. These factors may include the amount of debt resulted from undergraduate education, financial support from parents, and potential income loss associated with delayed employment. Limited by the information in the data set, direct monetary contribution from parents in the academic year of 1992–93, student's total debt amount in 1994,

and student's pay rate at the 1994 job (the ratio of annual income and the reported average number of hours worked/week) are used as the proxy measures of financial resources and foregone earnings. Among them, the foregone earnings are a factor considered influential on persistence of graduate students in a few studies (e.g., Andrieu & St. John, 1993; Perna, 2004). In one of the studies by Perna (2004), categorization of academic majors was used as a proxy measure of expected earnings. However, the current study divides academic majors into STEM vs. non-STEM groups for comparisons, therefore the pay rate at the 1994 job seems to be a more appropriate indicator of expected earnings than a four-category of academic majors.

Cultural and social capital. Cultural and social capital are used in this study to reflect individuals' preference for and perceived values of graduate education as conditioned on their personal belief system and value system. For this purpose, three family background measures are included as proxy measures of cultural capital. First, parents' education attainment is the highest education completed by either parent, which has six categories in the B&B data: having no high school (HS) diploma or equivalent, having HS diploma or equivalent, some postsecondary education (PSE; less than 2 years), 2 years or more PSE (less than BA), bachelor's degree, and having one or more advanced degree. Second, family income, another measure regularly used to indicate one's socioeconomic status, has to be converted into a categorical measure with three group values, lower than $30,000, between $30,000 and $60,000, and higher than $60,000 (the reference group) due to its skewed distribution. Finally, whether both parents were born in the U.S. serves as a measure of cultural capital.

Since social capital has its values in certain aspects of social structure as resources assisting individuals to achieve their interests (Coleman, 1988), the two proxy measures of social capital in this study are the total tuition and fees cost of the attended undergraduate institution in

1992-93 academic year, and the selectivity of the undergraduate institution attended. Inclusion of the two variables is based on the consideration that, first, tuition and fees cost of the undergraduate institution in 1992-93 academic year can be viewed as an indicator of the accessibility and prestige of the institution. Along with selectivity, both reflect the quality of a higher education institution (Gardner, 2010; Monks, 2000; Sacks, 2010). Second, selectivity ratings from Barron's *Profiles of American Colleges* emphasize the academic competitiveness of an institution (Monks, 2000); whereas the total cost highlights the financial accessibility. Based on Gardner's study (2010) in which institutional prestige is associated to the socialization and organizational culture, the two measures are believed to convey the social environment, from different perspectives, of an undergraduate institution in which the social and academic interactions and integration may stimulate individuals toward different preferences and readiness levels for graduate education.

In addition, following Perna's example (2004), age when received bachelor's degree is used as an indicator of nonmonetary cost for college education, with the speculation that individuals who received their degree at older age may have a shorter time horizon to realize an increase in lifetime earnings (also see Roksa & Levey, 2010). Academic performance is used to indicate individuals' readiness for graduate education. In this study, it is measured by SAT/ACT quartiles and GPA in undergraduate major.

Method

Descriptive analysis of the data is used to show the distribution of three groups of individuals, defined as, by year 2003, 1) no graduate enrollment, 2) previously enrolled with no attainment, and 3) had graduate degree attainment or currently enrolled, by demographic factors and the major independent variables in the study. Summary information is made available separately for STEM and non-STEM college graduates. For inferential analysis, multinomial

logit regression (MLR) is used to answer the research questions. The three outcomes categories of graduate experience are predicted with the previously introduced independent variables that identify with the expanded economic framework. Also, MLR models of identical structure are constructed separately for STEM and non-STEM graduates to allow comparisons across academic majors.

MLR is a special case of the general log-linear regression model and was chosen for the statistical analysis because it is well suited for studies in which the dependent variable is categorical in nature (Peng et al., 2002). When multiple independent variables are included, the regression equation is expressed as

$$\ln\left(\frac{P}{1-P}\right) = \ logit = a + \ \beta_1 x_1 \ + \beta_2 x_2 \ + \cdots + \beta_k x_k$$

where P is the probability of a given outcome category of the dependent variable. Maximum likelihood is used to estimate the values of α and βs. Once a MLR model is formulated, its adequacy can be evaluated as overall model fit before the effect of individual independent variables is examined. The model shows overall fit by having an improvement beyond the intercept-only model (the null model), pseudo-R^2 values, and the percentage of cases that are correctly classified (Peng et al., 2002).

For models of adequate fit indices, evaluation of individual independent variables can be performed. Having one outcome category of the dependent variable as the reference group, MLR estimates the log-odds of other single outcome categories occurring relative to the reference group. For a single independent variable, the logistic coefficient β_i shows the change in the log-odds when the independent variable x_i changes by one unit. The interpretation of the coefficients is made easier with the exponentiation of the coefficient, the odds ratios. For example, with *White* being the reference group, holding other variables constant, a one-unit

change in race (i.e., the independent variable changes from White to minority) is associated with the dependent variable by a coefficient of -0.78 and the corresponding odd ratio of 2.191. It indicates that minority college graduates had more than double the likelihood to have never enrolled in a graduate program relative to the odds of being currently enrolled or having obtained a graduate degree (the reference group of the dependent variable) in comparison to their White counterparts. MLR has been used frequently in sociological, educational, and economic studies in the last couple of decades (e.g., Flyer, 1997; Peng et al., 2002; Perna, 2004; Staniec, 2004). For readers interested in more information, please see Hosmer and Lemeshow (2000), Pampel (2000), and Peng et al. (2002).

Given the stratified sampling procedures of the NPSAS:93 from which the B&B cohort was originated and the longitudinal data collection of the B&B surveys, data are weighted in the descriptive and inferential analyses to ensure the validity and generalizability of the findings (Thomas & Heck, 2001). Initially, a relative weight was generated from the panel weight in order to produce unbiased descriptive statistics. Further, the relative weight was adjusted for the design effect of the multistage cluster sampling procedure in order to produce correct standard errors for hypothesis testing (Thomas and Heck, 2001).

MLR is a large sample technique and estimates of the model parameters would be more reliable with sufficiently large samples (Hosmer & Lemeshow, 2000). To avoid significant reduction in sample size caused by listwise deletion, missing data were imputed using regression of closely related measures; when such measures were not available, mean imputation was used if appropriate. Finally, the maximum likelihood estimation requires normal distribution of continuous variables. MLR accepts both continuous and categorical independent variables; thus,

following examples in Perna (2004), a number of continuous variables were converted into ordinal scales due to severe departure from normality.

Results

Of out the total weighted sample of 2,250 STEM and 5,879 non-STEM college graduates, 802 (35.7%) and 1,636 (27.8%), respectively, attended graduate school sometimes during the ten years following their college degree attainment. However, the attrition rates from graduate programs were 40.5% among STEM-majored students and 54.8% among non-STEM majors. Based on the descriptive information in Table 1, the trends seem to be that, female students were more likely to discontinue their graduate studies before degree attainment than their male counterparts; students who scored higher on SAT/ACT, had higher GPA in college major, and from more selective undergraduate institutions were more likely to complete their graduate education.

The MLR models are presented in Tables 2 and 3. In Table 2, non-STEM major students who never enrolled in graduate programs and those who were previously enrolled but dropped out without degree attainment are compared with their counterparts that were either currently enrolled or had already completed a graduate degree in 2003 (the reference group). In Table 3, the same comparisons are made for STEM students. For both models, overall model fit indices are shown at the end of each Table. With the model χ^2 being significant at $p<.001$ level, each model explains the data significantly better than its corresponding intercept-only null model. The pseudo R^2 Cox-Snell is .096 for the non-STEM sample and .186 for STEM students. The overall classification rates are 72.2% and 68.1%, respectively. The fit indices suggest that models for both non-STEM and STEM groups fit the data well.

Effects of individual independent variables indicate that, holding other variables constant, race, gender, age when received baccalaureate degree, academic performance, and total institutional fee and cost had significant relationships with students' experience with graduate education regardless of their STEM or non-STEM majors. Racial minority students' likelihood of never attending graduate school within the ten years of college graduation was roughly double that of White students (non-STEM: odds ratio = 2.191; STEM: odds ratio = 1.745). Once enrolled, the likelihood of minority students to drop out of a graduate program was also significantly higher than their White counterparts (non-STEM: odds ratio = 1.875; STEM: odds ratio = 1.817). Once enrolled, female students were significantly less likely to attain a degree than male students of comparable characteristics (non-STEM: odds ratio = .565; STEM: odds ratio = 0.785), even though *no* significant gender difference was observed for the likelihood of graduate enrollment. Not having young children 1993 significantly lowered the likelihood of no graduate enrollment (non-STEM: odds ratio = .583; STEM: odds ratio = 0.736), and for non-STEM students, the likelihood of not completing the education (odds ratio = 0.528) once enrolled.

Of individuals who received a baccalaureate degree at 21 or younger, in comparison to those who received a college degree at 30 years or older (the reference group), the likelihoods of never having enrolled in graduate programs (non-STEM: odds ratio = .336; STEM: odds ratio = 0.373) and not completing a degree after enrollment (non-STEM: odds ratio = .318; STEM: odds ratio = 0.330) were reduced by approximately sixty percentage. For non-STEM students, the same pattern was also observed between students who received a baccalaureate degree at age 22 or 23 and those whose degree age was 30 years or older (odds ratio = 0.477 for never enrolled and odds ratio = 0.387 for enrollment without degree attainment). As expected, strong academic

performance in undergraduate study was associated with higher likelihood of enrollment and degree attainment. For non-STEM students, lower SAT/ACT scores and cumulative GPA in undergraduate major significantly increased the likelihood of never enrolling in graduate program and the likelihood of dropping out (see Table 2 for odds ratios). Within the STEM population, lower values on the two measures of academic performance significantly increased the likelihood of students never enrolling in a graduate program, but not their persistence once they had enrolled in a graduate program (see Table 3 for odds ratios).

Financial resources played a role in students' decision regarding graduate education as well, even though a consistent pattern is hard to identify. In particular, STEM students' advance to and persistence in graduate education were not related to their amount of undergraduate debt in 1994, but interestingly for non-STEM students, zero debt resulting from undergraduate education meant significantly increased likelihood of no enrollment in (odds ratio = 1.345) and attrition (odds ratio = 1.358) from graduate programs. Parents' monetary support in undergraduate years did not show an impact on the graduate choices of non-STEM students, however, generous support from parents (> $5,000 in 1993-93) might have decreased the likelihood of one's enrollment in graduate education for STEM students in comparison to their counterparts in the "no monetary support from parents" category. Non-STEM students whose pay rate was lower than the top quartile at the 1994 job were more likely to enroll in graduate studies; for STEM students, the relationship was shown as an association between the bottom-quartile pay rates, in reference to the top-quartile pay rates, and significantly higher likelihood of graduate enrollment and completion.

The two proxy measures of social capital, undergraduate institution selectivity and yearly total tuition and fees, were related to students' graduate education in different patterns. In

comparison to minimally selective institutions, highly selective institutions reduced the likelihood of students never enrolling in a graduate program (most selective: odds ratio = .411 for non-STEM students 0.444 for STEM students; very selective: odds ratio = .711 for non-STEM students 0.611 for STEM students). Non-STEM students who graduated from most selective undergraduate institutions also had a significant lower likelihood of not completing the degree program once enrolled (odds ratio = .465). STEM students whose undergraduate degree was obtained from institutions with total tuition and fees lower than $1,300 had a significant higher likelihood of no graduate enrollment in comparison to their counterparts from the most expensive institutions (odds ratio = 1.745). However, the likelihood of no graduate enrollment for non-STEM students who graduated from the most expensive institutions was higher than those who attended institutions of which the total tuition and fees were moderately reasonable (between $2,400 and $5,930 for 1992-93 academic year).

Cultural capital, as indicated by parents' highest education, income, and US-born status, exhibited some significant but inconsistent patterns with students' graduate choices. For non-STEM students, parents' education level is not associated with their graduate education experience. In general, STEM students whose parents had relatively fewer years of education may have a lower likelihood to pursue graduate training, and in rare cases may also have higher dropout rates from the enrolled graduate programs. In comparison to individuals from more affluent family background (> $60,000), STEM students whose parents had median level annual income ($30,000 - $60,000) were less likely to attend graduate school, whereas non-STEM students with parents' income lower than $30,000 may be more likely to discontinue their graduate studies. NonUS-born parent(s) may be a factor that increased the rate of dropping out of graduate programs for non-STEM students.

Discussion

Findings of this study provide confirmation for some of the conclusions of previous studies as well as new revelations regarding graduate school enrollment and persistence. First, attrition from graduate education is above 40% for graduate students in STEM areas, and close to in 55% for those in non-STEM majors. This statistic by itself is an alarming call for efforts to increase student persistence in graduate education. Of particular interest is significantly higher attrition rates of women graduate students, a pattern consistent with previous findings (Zhang, 2005), despite comparable likelihoods of women and men to start graduate education. Additionally, in all academic areas, underrepresentation of minority students in graduate programs and degree recipients remains progressive, and it is not only a result of low enrollment, but also a lower level of persistence relative to their White counterparts.

Influential Factors and Comparisons between STEM and non-STEM Students

Although marital status does not make a difference, having dependents, especially children at age 5 or younger, lowers the probability of enrolling in and completing the degree requirement of graduate education. The indication is that balancing academic commitments with family responsibility seems to be a major concern in making a decision to pursue a graduate degree regardless of STEM or non-STEM majors. Receiving one's bachelor's degree at a younger age is also positively related to an increased probability of graduate enrollment and degree attainment. Possibly, part of the reason is that younger students are less likely to have dependent children and associated family responsibilities.

Results of the study do not suggest cultural capital, as indicated by parents' education, income, and US-born status, has any meaningful impact on non-STEM college students' advance to graduate education. However, for students in STEM majors, parents with advanced degrees

helped to increase the chance for their enrollment in graduate programs. In contrast, the importance of social capital in graduate enrollment is supported by the findings related to the two proxy measures, undergraduate institution selectivity and total tuition and fees cost in 1992-93 academic year. Selectivity seems to have a greater predictive power about students' continuation to graduate school than the cost level of the undergraduate institutions. Highly selective institutions significantly increase students' enrollment probability in graduate programs, a pattern that may be explained by the fact that institution selectivity is an indicator of academic rigor, college quality, opportunities to interact with faculty, and strong emphasis on research (Malcom & Dowd, 2012; Zhang, 2005). The yearly total cost of undergraduate institution does not appear to have a linear relationship with students' preference to graduate education, especially for non-STEM students, for attending an extremely high cost undergraduate institution could lower their chance of going to graduate school. A speculative explanation is that students may bear a large loan amount from attending extremely costly colleges, resulting in a lower capacity to afford further education. However, the same pattern is not observed for their STEM counterparts.

Financial resources also work differently for STEM and non-STEM students. Non-STEM students with low or zero undergraduate debt in 1994 had significantly *decreased* likelihoods to enroll in and complete a graduate program, which appeared contradictory to some studies that link higher undergraduate debts to lower likelihood of graduate enrollment (Malcom & Dowd, 2012). A possible explanation is that non-STEM students' preference to graduate education was guided by the hope that advanced degrees would lead to increased income level and contribute to ease the debt burden in a long-term view. However, such a relationship between debt and graduate education was absent for STEM students. No monetary support from

parents during the last undergraduate year, as indication of financial support from parents, had no impact on non-STEM students' advance to graduate education, but STEM students' attendance to graduate school would have a significant difference between those who had no financial support and those had the maximum support (>$5,000 in 1992-93) from parents. The last monetary factor, students' pay rate at the 1994 job, as an indicator of foregone earnings, had a strong negative relationship with the likelihood of graduate enrollment for non-STEM students. However, for STEM students, the difference was only observed between the extremely low and high pay rate categories, with low pay related to increased likelihood of graduate enrollment and degree attainment.

Putting the financial pieces together, the findings suggest that STEM students may have a stronger reliance on parents' financial support in order to pursue graduate education than their non-STEM counterparts. With parents of sufficient income to offer financial support for their education, undergraduate debts and foregone income were not significant concerns for STEM students when making decisions regarding graduate education. However, given the lack of association between parents' income and monetary contribution to their undergraduate education, and the strong impact from undergraduate debt, non-STEM students are speculated to be more financially self-reliant and more reluctant to give up their income at work in the pursuit of graduate education.

Factors that Impact Enrollment and Persistence Differently

Except for significantly higher attrition rates of female students, the most striking difference between factors influencing graduate enrollment and persistence is the measures of academic performance of STEM students. Higher SAT/ACT scores and cumulative GPA in undergraduate major, rather than increasing the level of graduate enrollment and persistence as

they were for non-STEM students, were not associated with students persistence for STEM students after enrollment. It is also puzzling to see the lack of association between the selectivity of undergraduate institution and graduate persistence for STEM students.

For non-STEM students, their pay rate at the 1994 job was a major consideration in the graduate enrollment decision. Once enrolled in a graduate program, this factor exerted no impact on individuals' persistence. This difference may indicate that, since non-STEM students were more financially independent in their pursuit of graduate education, the enrollment decision was most likely made after sufficient financial resources were secured. Thus, once they started graduate study, income level at the previous job was no longer part of the consideration in the process toward degree attainment. However, it appears that parents' financial support became relatively important, for those whose parents had low income showed a significantly higher attrition likelihood in comparison to their counterparts from affluent family backgrounds.

Limitations and Future Research

Limited by space and model over-complexity, this study does not analyze possible interactions between some of the independent variables, such as gender, having dependents, and age at the baccalaureate's degree, minority status and parents' income level. Also limited by sample size, the enrollment and persistence were measured without differentiating among master's, doctoral, and first-professional degree programs. Student socialization within the graduate program has been studied for its role in reducing attrition, but the information is not available from B&B survey and was omitted in this study.

For future research, it would be informative to compare how the individual, institutional, and financial factors work differently to impact the enrollment and persistence patterns between fulltime and part-time graduate students. Given the identified importance of financial resources

in students' enrollment and persistence in graduate programs, the benefits of financial supports in the forms of graduate assistantships and educational benefits offered by employers also need to be examined as part of the effort to identify effective interventions to reduce graduate attrition rates.

Policy Implications

Knowing attrition from graduate education has economic, social, and emotional consequences (Golde, 2005), higher education administrators and policy makers have a few messages to carry away from this study. First, the attrition rates at about 50% in graduate education cannot be treated as a minor issue any longer. More scholarly efforts and administrative attentions are in demand in order to better understand the underlying causes and to identify effective interventions to reduce the attrition rates. The results of this study indicated that students' graduate enrollment and persistence were significantly related to their having young dependents; thus, offering a childcare facility on campus to assist students with family responsibility may be beneficial for reducing attrition. In addition, female students had significantly higher attrition rates than their male counterparts. Given that, traditionally, women assume greater responsibility in family and childrearing, availability of a childcare facility may also help to reduce the gender gap in attrition rate as well.

Second, the study confirms the underrepresentation of minority students and their low enrollment and high attrition in graduate programs. This pattern has been a long existing problem documented by numerous published studies in the literature and national statistics. Although many individual, academic, and social factors may contribute to the underlying causes, empirical evidence shows that institutional support can lead to better outcomes for minority students. For policymakers, it is important to identify structural barriers imposed by federal and

state policy and to promote the academic success of disadvantaged students. In this study, minority students were found to be disadvantaged in both graduate enrollment and degree attainment regardless of majors. Nonetheless, severe underrepresentation of minority students in STEM fields may be reduced with increased financial aid, because the findings of this study suggest that STEM graduate students had a stronger financial reliance on parents' support, and extant research have evidence to show that minority students are more likely to be from low SES backgrounds.

Finally, structured within a comprehensive theoretical framework, this study identifies individual (gender, race, age when received baccalaureate degree), academic, institutional, and financial factors that may impact graduate enrollment and persistence, and these factors work differently for students in STEM and non-STEM majors. With that said, institutional factors, as proxy measures of social capital, appear to be more critical than cultural capital in students' success in graduate education. Therefore, interventions provided within academic institutions need to be the focus of policymakers in order to improve graduate education and reduce attrition rates. With increased understanding of institutional support as guidance, changes can be made with the goals to increase academic quality, promote social integration, and offer financial assistance to students in need. College deans may serve as executives of the changes and interventions with knowledge about the specific needs of students in their academic fields.

Conclusions

The value of graduate education can be argued from both individual and societal perspectives (Zhang, 2005). Graduate education is valuable for individuals because it adds to human capital accumulation, provides access to prestigious professions and high social status, and offers professional and economic satisfaction. The dependence of modern society is ever

growing upon highly-educated professionals given the continuing accumulation and detailization of knowledge. Society benefits from individuals with advanced training because they provide "the critical links in the chain of institutions that transmit and codify the most complex information" (Zhang, 2005, p. 315). The focus of this study is to understand the factors influential in the enrollment and persistence of graduate students in STEM and non-STEM fields and to gain useful information that may guide policymakers and administrators in their effort to reduce high attrition rates and improve graduate education. The findings confirm that students' participation in graduate education is an individualized process dependent upon ability and preferences, as well as an evaluative result of many contextual factors, including resources and supports available in the environment (Malcom & Dowd, 2012; Perna, 2004). More research effort is called to unravel the mechanism that leads to individual and institutional success in graduate education.

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Table 1.

Descriptive Statistics

	Graduate options 0 (no graduate enrollment) 1 (previously enrolled, no attainment) 2 (currently enrolled or attained a degree)							
	Non-STEM undergrad major				STEM undergraduate major			
		0	1	2		0	1	2
	Total	4243	896	740	Total	1447	325	477
		Row percentage (%)				Row percentage (%)		
Gender								
1 Male	2329	73.8	13.4	12.7	1468	65.5	12.6	21.9
2 Female	3545	71.1	16.5	12.4	782	62.1	18.0	19.9
Racial minority in two categories								
0 Caucasians	4922	72.8	15.3	11.9	1821	66.0	14.6	19.3
1 Racial minorities	958	69.1	14.9	16.0	428	57.1	13.7	29.2
Age when received BA degree								
1 21 and younger	742	60.7	17.5	21.8	309	43.2	14.8	42.0
2 22 or 23 years old	2860	72.1	14.1	13.8	1208	64.4	13.9	21.7
3 24 to 29 years old	1189	76.3	15.4	8.3	476	74.6	13.4	12.0
4 30 years and older	1089	75.6	16.6	7.8	256	70.2	18.9	10.9
Having dependents younger than 5								
0 No	3698	70.7	14.9	14.4	1391	61.8	14.3	23.9
1 Yes	2727	74.7	15.8	9.6	858	68.5	14.7	16.8
Having dependents btw 5-17 years old								
0 No	4173	70.4	15.7	14.0	1678	61.2	14.5	24.3
1 Yes	1707	76.6	14.2	9.2	572	73.4	14.5	12.1
Total undergraduate debt in 1994								
0 No debt	3107	71.7	15.3	13.0	1160	63.7	13.2	23.1
1 Debt below $8,000	1440	74.4	15.1	10.5	574	63.6	16.5	19.9
2 Debt above $8,000	1332	70.9	15.3	13.9	516	66.6	15.0	18.4
Institution tuition & fees (92-93)								
1 Less than $1,300	1636	79.3	11.8	9.0	551	75.9	12.5	11.6
2 Between $1,300 and &2,400	1546	72.0	16.0	12.0	604	65.0	17.0	17.9
3 Between $2,401 and $5,930	1350	68.0	18.6	13.4	573	62.1	13.8	24.1
4 Above $5,930	1347	67.9	15.2	16.9	522	53.7	14.3	32.0
Pay rate at 1994 job								
1 No or low pay	1143	67.8	18.4	13.8	361	57.1	13.6	29.3
2 Relatively low	1274	68.3	18.0	13.7	361	67.6	13.0	19.4
3 Relatively high	2235	73.7	13.3	13.0	889	64.3	14.6	21.1
4 High	1227	77.3	13.1	9.6	639	66.6	15.5	17.9

	Graduate options 0 (no graduate enrollment) 1 (previously enrolled, no attainment) 2 (currently enrolled or attained a degree)							
	Non-STEM undergrad major				STEM undergraduate major			
		0	1	2		0	1	2
	Total	4243	896	740	Total	1447	325	477
		Row percentage (%)				Row percentage (%)		
Direct monetary support from parents (92-93)								
0 No parents support	4144	72.2	16.0	11.8	1472	64.2	15.6	20.2
1 Less than $5,000	812	74.8	11.9	13.3	402	65.4	13.2	21.4
2 More than $5,000	924	69.7	14.6	15.7	376	64.3	14.5	21.2
Parent's highest education								
1 Not HS graduate or equivalent	540	77.1	12.9	9.9	165	60.6	15.3	24.1
2 HS graduate or equivalent	1650	75.5	14.0	10.6	501	72.5	15.7	11.8
3 Some PSE, lt 2 years	576	74.3	15.7	10.0	215	67.6	13.3	19.1
4 2 years or more PSE, AA lt BA	469	72.3	16.9	10.9	188	75.4	12.5	12.1
5 Bachelor's degree	1392	69.9	15.8	14.3	568	65.0	11.9	23.2
6 Advanced degree	1252	67.2	16.5	16.3	612	53.5	16.7	29.9
Merged SAT and ACT score quartile								
0 Did not take SAT or ACT	1338	75.0	16.0	8.9	325	74.8	13.9	11.3
1 Bottom quartile SAT (or ACT if no SAT)	1327	79.6	12.6	7.8	255	74.1	12.8	13.1
2 Second quartile SAT (or ACT if no SAT)	1280	74.3	16.0	9.7	510	71.5	13.1	15.5
3 Third quartile SAT (or ACT if no SAT)	1121	67.9	16.5	15.6	540	62.6	16.0	21.3
4 Top quartile SAT (or ACT if no SAT)	814	57.9	15.3	26.8	619	50.4	15.2	34.4
Cumulative GPA in undergrad major								
1 Below 3.00	889	81.7	11.8	6.5	461	78.0	9.6	12.4
2 Between 3.00 and 3.49	2682	74.7	14.7	10.6	1065	65.5	14.9	19.7
3 3.50 and higher	2308	65.5	17.2	17.2	724	53.9	17.0	29.1
Institution selectivity								
1 Most selective	334	54.7	13.2	32.1	241	39.2	16.8	44.0
2 Very selective	1189	68.0	17.2	14.8	655	59.6	14.7	25.7
3 Moderately selective	3400	73.9	15.0	11.1	1096	70.9	13.5	15.6
4 Minimally selective	957	77.4	14.3	8.3	258	71.9	15.7	12.4

Notes. Statistics presented in the table are based weighted data.

Table 2.

Factors Related to College Graduates' Pursuit of Graduate Study: Non-STEM Majored Students

		Students never enrolled in graduate programs			Students previously enrolled but no attainment		
Variables	Characteristics	B	Std. Error	Exp(B)	B	Std. Error	Exp(B)
Gender	Male	-0.071	0.089	0.932	-0.242	0.109	0.785*
	Female (ref.)						
Racial minority	Caucasians	0.784	0.122	2.191***	0.629	0.151	1.875***
	Racial minorities						
Marital status	Not married	0.031	0.140	1.032	0.024	0.166	1.024
	Married (ref.)						
Having dependents younger than 5	No	-0.539	0.097	0.583***	-0.639	0.117	0.528***
	Yes (ref.)						
Having dependents btw 5-17 years old	No	-0.068	0.112	0.934	0.111	0.135	1.117
	Yes (ref.)						
Having dependents btw 18 years & older	No	-0.066	0.149	0.936	-0.136	0.176	0.873
	Yes (ref.)						
Age when received BA degree	21 and younger	-1.091	0.216	0.336***	-1.110	0.258	0.330***
	22 or 23 years old	-0.740	0.193	0.477***	-0.949	0.228	0.387***
	24 to 29 years old	-0.343	0.186	0.710	-0.431	0.218	0.650*
	30 years and older (ref.)						
Parent's highest education	Not HS graduate or equivalent	0.287	0.189	1.333	-0.108	0.231	0.897
	HS graduate or equivalent	0.154	0.128	1.167	-0.099	0.157	0.906
	Some PSE, lt 2 years	0.300	0.173	1.350	0.179	0.206	1.196
	2 years or more PSE, AA lt BA	0.214	0.182	1.238	0.265	0.215	1.303
	Bachelor's degree	0.059	0.119	1.061	0.023	0.145	1.024
	Advanced degree (ref.)						
Parents born in US	At least one parent not US born	0.248	0.132	1.282	0.339	0.159	1.403*
	Both parents born in US (ref.)						

		Students never enrolled in graduate programs			Students previously enrolled but no attainment		
Variables	Characteristics	B	Std. Error	Exp(B)	B	Std. Error	Exp(B)
Total undergraduate debt in 1994	No debt	0.296	0.111	1.345**	0.306	0.136	1.358*
	Debt below $8,000	0.339	0.128	1.403**	0.289	0.155	1.335
	Debt above $8,000 (ref.)						
Institution tuition & fees (92-93)	Less than $1,300	0.072	0.132	1.075	-0.193	0.165	0.825
	Between $1,300 and &2,400	-0.208	0.124	0.812	-0.093	0.153	0.911
	Between $2,401 and $5,930	-0.250	0.124	0.779*	0.069	0.150	1.072
	Above $5,930 (ref.)						
Parents' income	Less than $30,000	0.236	0.128	1.266	0.309	0.157	1.362*
	Between $30,000 and $60,000	0.124	0.113	1.132	0.115	0.140	1.122
	$60,000 and above (ref.)						
Pay rate at 1994 job	No or low pay	-0.412	0.143	0.662**	0.157	0.173	1.170
	Relatively low	-0.448	0.139	0.639**	0.108	0.168	1.114
	Relatively high	-0.284	0.126	0.752*	-0.163	0.155	0.850
	High (ref.)						
Direct monetary support from parents (92-93)	No parents support	-0.154	0.123	0.857	0.059	0.153	1.061
	Less than $5,000	-0.132	0.155	0.876	-0.309	0.199	0.734
	$5,000 or more (ref.)						
Merged SAT and ACT score quartile	Did not take SAT or ACT	0.622	0.164	1.862***	0.500	0.202	1.649*
	Bottom quartile SAT (or ACT)	1.076	0.150	2.933***	0.740	0.187	2.095***
	2nd quartile SAT (or ACT if no SAT)	0.870	0.137	2.386***	0.800	0.171	2.226***
	3rd quartile SAT (or ACT if no SAT)	0.482	0.126	1.619***	0.460	0.162	1.584**
	Top quartile SAT (or ACT) (ref.)						
Cumulative GPA in undergrad major	Below 3.00	1.171	0.158	3.225***	0.635	0.190	1.886***
	Between 3.00 and 3.49	0.604	0.093	1.829***	0.345	0.113	1.411**
	3.50 and higher (ref.)						
Institution selectivity	Most selective	-0.890	0.197	0.411***	-0.766	0.255	0.465**
	Very selective	-0.341	0.157	0.711*	-0.108	0.188	0.898
	Moderately selective	-0.210	0.135	0.811	-0.142	0.161	0.868
	Minimally selective (ref.)						

Number of cases	5879		
-2 log likelihood & *df*	8573	72***	
% correctly classified	98.6%		0%
Overall	72.2%		
Pseudo R^2 (Cox & Snell)	.096		

Note.

1. The baseline group is non-STEM college graduates who had successfully attained a graduate degree or were currently enrolled in a graduate program in 2003.
2. In the table, * indicates at significant level at p<0.05, ** indicates p < .01, and *** indicates p < .001.

Table 3.

Factors Related to College Graduates' Pursuit of Graduate Study: STEM Majored Students

		Students never enrolled in graduate programs			Students previously enrolled but no attainment		
Variables	Characteristics	B	Std. Error	Exp(B)	B	Std. Error	Exp(B)
Gender	Male	-0.183	0.130	0.833	-0.571	0.161	0.565***
	Female (ref.)						
Racial minority	Caucasians	0.729	0.175	2.073***	0.597	0.226	1.817**
	Racial minorities						
Marital status	Not married	-0.100	0.226	0.905	0.143	0.278	1.154
	Married (ref.)						
Having dependents younger than 5	No	-0.306	0.131	0.736*	-0.301	0.167	0.740
	Yes (ref.)						
Having dependents btw 5-17 years old	No	-0.332	0.169	0.718*	-0.269	0.209	0.764
	Yes (ref.)						
Having dependents btw 18 years & older	No	-0.309	0.252	0.734	0.036	0.325	1.036
	Yes (ref.)						
Age when received BA degree	21 and younger	-0.987	0.328	0.373**	-1.145	0.397	0.318**
	22 or 23 years old	-0.322	0.295	0.724	-0.666	0.350	0.514
	24 to 29 years old	0.260	0.301	1.297	-0.354	0.358	0.702
	30 years and older (ref.)						
Parent's highest education	Not HS graduate or equivalent	0.108	0.249	1.114	-0.196	0.312	0.822
	HS graduate or equivalent	0.821	0.189	2.272***	0.535	0.231	1.707*
	Some PSE, lt 2 years	0.375	0.222	1.455	-0.052	0.289	0.949
	2 years or more PSE, AA lt BA	0.952	0.268	2.591***	0.397	0.338	1.488
	Bachelor's degree	0.329	0.154	1.389*	-0.207	0.205	0.813
	Advanced degree (ref.)						
Parents born in US	At least one parent not US born	-0.005	0.178	0.995	0.142	0.224	1.152
	Both parents born in US (ref.)						

		Students never enrolled in graduate programs			Students previously enrolled but no attainment		
Variables	Characteristics	B	Std. Error	Exp(B)	B	Std. Error	Exp(B)
Total undergraduate debt in 1994	No debt	-0.167	0.162	0.846	-0.184	0.205	0.832
	Debt below $8,000	-0.156	0.180	0.856	0.037	0.224	1.038
	Debt above $8,000 (ref.)						
Institution tuition & fees (92-93)	Less than $1,300	0.557	0.199	1.745**	0.312	0.256	1.367
	Between $1,300 and &2,400	0.032	0.177	1.033	0.270	0.226	1.310
	Between $2,401 and $5,930	-0.116	0.170	0.891	-0.130	0.225	0.878
	Above $5,930 (ref.)						
Parents' income	Less than $30,000	0.072	0.179	1.074	0.319	0.230	1.376
	Between $30,000 and $60,000	0.393	0.162	1.482*	0.296	0.213	1.345
	$60,000 and above (ref.)						
Pay rate at 1994 job	No or low pay	-0.735	0.183	0.479***	-0.686	0.238	0.504**
	Relatively low	-0.232	0.193	0.793	-0.363	0.248	0.695
	Relatively high	-0.187	0.153	0.830	-0.195	0.191	0.823
	High (ref.)						
Direct monetary support from parents (92-93)	No parents support	-0.346	0.171	0.708*	0.072	0.232	1.075
	Less than $5,000	-0.319	0.204	0.727	-0.068	0.275	0.934
	$5,000 or more (ref.)						
Merged SAT and ACT score quartile	Did not take SAT or ACT	0.678	0.250	1.971**	0.185	0.310	1.203
	Bottom quartile SAT (or ACT)	0.706	0.242	2.026**	0.339	0.311	1.403
	2nd quartile SAT (or ACT if no SAT)	0.766	0.173	2.152***	0.395	0.224	1.484
	3rd quartile SAT (or ACT if no SAT)	0.386	0.159	1.472*	0.376	0.204	1.456
	Top quartile SAT (or ACT) (ref.)						
Cumulative GPA in undergrad major	Below 3.00	1.274	0.188	3.576***	0.434	0.248	1.544
	Between 3.00 and 3.49	0.517	0.132	1.677***	0.265	0.166	1.303
	3.50 and higher (ref.)						
Institution selectivity	Most selective	-0.812	0.282	0.444**	-0.300	0.346	0.741
	Very selective	-0.493	0.235	0.611*	-0.401	0.288	0.670
	Moderately selective	-0.077	0.228	0.926	-0.204	0.278	0.815
	Minimally selective (ref.)						

	Number of cases	2250		
	-2 log likelihood & *df*	3551	72***	
	% correctly classified	94.0%		2.0%
	Overall	68.1%		
	Pseudo R^2 (Cox & Snell)	.186		

Note.

1. The baseline group is STEM college graduates who had successfully attained a graduate degree or were currently enrolled in a graduate program in 2003.
2. In the table, * indicates at significant level at p<0.05, ** indicates p < .01, and *** indicates p < .001.