Who Goes to Graduate/Professional School?
The Importance of Economic Fluctuations, Undergraduate Field, and Ability

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Abstract

This study examines the impact of fluctuations in entry-level labor market conditions on the graduate school enrollment decisions of newly minted undergraduate degree holders. Using repeated cross-section data for recently graduated science and engineering undergraduates from the National Survey of Recent College Graduates, and state-level unemployment rates to measure entry-level labor market conditions, we find that advanced degree enrollment patterns vary across the business cycle by undergraduate major, GPA, gender, and advanced degree type.

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1. Introduction

There is a substantial literature examining the impact of the business cycle on the decision of individuals to complete high school and enroll in college in the United States (examples include Lehr and Newton 1978, Gustman and Steinmeier 1981, Corman 1983, Kane 1994, Betts and McFarland 1995, Neumark and Wascher 1995, Light 1996, Sakellaris and Spilimbergo 2000, Card and Lemieux 2000, Black and Sufi 2002, Berger and Kostal 2002, Dellas and Sakellaris 2003, and Dellas and Koubi 2003).[1] In general, these studies find that enrollment in high school and college increases when the unemployment rate rises. In other words, enrollment appears to be counter-cyclical. Exceptions to this finding include Corman (1983), Kane (1994), Card and Lemieux (2000), and Berger and Kostal (2002), none of which find a statistically significant impact of unemployment rates on college enrollment. However, Kane (1994) does find that college enrollment is lower when manufacturing wages are high, a likely employment option for non-college bound high school graduates.

While we are aware of several descriptive editorial/review articles that discuss the impact of the business cycle on graduate/professional school enrollment (examples include Ellis and Mulvey 1993, Farrell 2001, Leatherman 2001, Mangan 2001 and 2002, and the National Center for Education Statistics 1996), we are aware of no econometric study that examines the impact of the business cycle on advanced degree enrollment.[2] This is somewhat surprising since the cost of graduate education, in terms of lost wages, is substantially higher than high school or undergraduate education, and hence potentially more seriously impacted by economic booms and recessions. To the best of our knowledge, only two recent papers include graduate enrollment in their samples, Light (1996) and Dellas and Koubi (2003). While both studies find that enrollment increases during economic downturns, neither estimates the effect of the business cycle separately across education levels. As such, it is impossible to determine whether economic conditions differentially impact decisions to enroll in associate, undergraduate, or graduate degree programs.

[1] There is a similar literature examining the impact of the business cycle on the enrollment of individuals age 15 to 22 in the United Kingdom (see Pissarides 1981, 1982 and Rice 1987, 1999).

[2] There is, however, a related literature examining the characteristics of individuals who choose to attend graduate/professional school. See Ehrenberg (1992) for an excellent review of this literature up to 1992, and Black and Sufi (2002), Groen and Rizzo (2003), and Perna (2004) for more recent studies.

We view the general absence of empirical research regarding the impact of economic contractions on advanced degree enrollment as important for two related reasons. First, because a substantial fraction of the population now hold advanced degrees,[3] variation in the number of degree holders due to cyclical enrollment patterns may impact the wage structure across cohorts of highly educated workers. Secondly, individuals with different educational backgrounds or ability levels may be induced to enroll in advanced degree programs during different phases of the business cycle leading to inter-cohort skill differentials even within narrowly defined education categories. For example, if during recessions firms reduce the number of high-quality entry positions for 'talented' undergraduate degree (BSc)[4] holders, then talented individuals will be more attracted to advanced degree programs. On the other hand, if during recessions 'good' entry-level jobs continue to exist, but firms reduce the number of 'average' or 'low-end' entry-level positions, then recessions will have a bigger impact on the decision to enroll in advanced degree programs for less talented individuals; i.e. those with lower grade point averages (GPAs) or with BScs from less prestigious institutions. It is, of course, also possible that economic contractions encourage all types/ability BScs to enroll in advanced degree programs. Given the wide range of theoretical possibilities, the scenario that best describes reality is an empirical question.

We use data from the 1993 to 2001 National Survey of Recent College Graduates (NSRCG) and variation in state-level unemployment rates to explore these issues. Specifically, this study focuses on two questions: (1) How big is the 'recession effect' relative to the other determinants of advanced degree enrollment? (2) What types of students, as measured by BSc major and GPA, are more likely to enroll in advanced degree programs because they finished their BSc during an economic contraction?

The results indicate that among science and engineering BSc earners, advanced degree enrollment patterns vary across the business cycle by gender, GPA, and advanced degree type. In particular, male PhD enrollment is counter-cyclical, male Master's degree enrollment is procyclical, and female enrollment is generally acyclical across all

[3] According to the U.S. Census Bureau, as of 2004, 10 percent of the 25+ year-old population hold a Master's, professional, or Doctorate degree.
[4] For expositional ease, throughout the paper we use BSc to refer to all undergraduate degree holders, whether their degree is in the Arts, Fine Arts, Sciences, and so on. This acronym is used because our sample is restricted to science and engineering students (see Section 3).

advanced degree types. Further, there is some evidence that the counter-cyclicality of male PhD enrollment is driven by business cycle responses among high-GPA students, and physical science, life science, and computer science and mathematics majors.

The remainder of the paper is as follows. Section 2 begins by laying out a simple model of the impact of the business cycle on educational decisions. Section 3 describes the data. Section 4 details the empirical approach. The results are presented in Section 5. Section 6 concludes.

2. A simple theoretical framework

To motivate the empirical analysis, in this section we present a very simple and highly stylized human capital investment model as it pertains to a BSc holder's decision to enroll in an advanced degree program.[5] We assume that individuals evaluate the expected pecuniary and non-pecuniary returns associated with various educational paths and choose the option that maximizes their expected lifetime utility. For expositional ease, we assume that all individuals have a two period planning horizon beginning at BSc graduation ($t = 1, 2$) – these periods need not be of similar length – and that they can choose to complete an advanced degree program in period 1 and work in period 2, or work in both periods. Notice that we are specifically focusing on an individual's enrollment decision just after earning an undergraduate degree.

Define w_{it} as individual *i*'s wage in period *t* if he does not hold an advanced degree and w_{it}^{g} if he has completed graduate training. We similarly define the non-monetary amenity level obtained during graduate school as a_{i1}^{s}, in jobs available with only a BSc as a_{it}, and in jobs available with a graduate degree as a_{i2}^{g}. We further assume that current period wages are observable, but that future wages and amenity levels are unobservable and hence individuals must form expectations about them. While we allow wages, tuition (T), and graduate stipends (S_i) to vary over the business cycle, we assume that non-wage amenity levels are invariant to the business cycle. For simplicity we also assume that tuition is the same for all students in any given year and that all BSc holders

[5] See Rosen (1977), Willis (1986), Card and Lemieux (2000), or Dellas and Sakellaris (2003) for a more detailed discussion of the human capital model.

find it equally time consuming to complete an advanced degree.[6] Within this framework, individual *i* will complete an advanced degree in period 1 if,

$$EU(S_i - T + w_{i2}^{g}, a_{i1}^{s}, a_{i2}^{g}) > EU(w_{i1} + w_{i2}, a_{i1}, a_{i2}) \quad (1)$$

where expected utility is a function of lifetime earnings and the non-monetary amenity levels, and all wages are discounted present values. It is clear from equation (1) that the decision to enroll in a graduate/professional program depends on the expected advanced degree wage premium relative to the net educational cost incurred.

If all BSc holders face the same wage and net graduate school stipend, then equation (1) implies that all individuals will make the same educational choices. But if individuals differ in ability or educational background, and hence wage opportunities and/or graduate stipend offers, then individuals will be induced to make different choices.[7] Consider a recession during which all types of jobs are relatively scarce and hence wage offers are low.[8] In this case, the opportunity cost of attending graduate or professional school falls. However, increased competition for graduate/professional school spots should reduce stipend offers for all but the top ranked applicants, and hence counterbalance their incentive to enroll; rendering the impact on graduate school enrollment ambiguous for all but the most highly ranked undergraduates. It is also possible that tuition rates might rise during recessions, especially at public universities, which will increase the cost of obtaining an advanced degree and may therefore reduce its attractiveness.

Another possibility is that ‘average’ or ‘low-end’ jobs continue to exist during recessions, but that ‘good’ jobs disappear or offer lower wages. In this case, the opportunity cost of enrolling in graduate school falls for high ability BSc holders. However, since graduate stipends are generally offered to higher ranking prospective students, this implies lower and/or fewer stipends for all but the highest ranked applicants. In contrast, it is also possible that during an economic recession, ‘good’ jobs

[6] These assumptions can easily be relaxed and do not qualitatively alter the implications of the model.
[7] For example, Montgomery (2002) explores the factors important in selecting an MBA program. He finds that institutional ranking, starting salary, current employment status, work experience, expected employer financial assistance, children, and GMAT scores play important roles in attendance decisions.
[8] See Berman and Pfleeger (1997) for a descriptive analysis of the industries whose demand and employment are most sensitive to business cycle movements.

for BSc holders continue to exist, while relatively ‘low-end’ jobs disappear or offer even lower wages. In this case the enrollment rate of BSc holders with lower ability will rise relative to that of high ability students. Finally, it is, of course, also possible that there is no detectable business cycle enrollment response if short-run cost changes are sufficiently small relative to long-run wage and/or amenity differences to render them irrelevant for most people.

In a similar vein, it is possible that the business cycle has a greater impact on advanced degree enrollment decisions in some fields than in others.[9] For example, wages for undergraduate physical science majors may fluctuate more than for engineers. This might occur if firms are always looking to hire the most talented new engineers, regardless of the state of the economy, while talented new physical science BScs can earn high wages during economic expansions but much lower wages if they enter the labor market for the first time during a recession.

Given the myriad of possible business cycle responses, the existence and magnitude of any such impact is clearly an empirical question. Addressing this question is the primary task of this paper. In particular, we focus on identifying the types of graduate degrees that exhibit cyclical fluctuations and estimating the magnitude of ‘induced’ enrollment. Furthermore, we attempt to identify the types of students, as measured by BSc major and GPA, who are more likely to enroll in advanced degree programs because they complete their BSc during a recession.

3. Data

Estimating the impact of the business cycle on the decision of individuals with different ability levels to enter an advanced degree program requires detailed information about family background, individual attributes, educational history, ability, and the economic conditions over many years. Our primary data source is the 1993-2001 National Survey of Recent College Graduates (NSRCG) provided by the Scientists and Engineers Statistical Data System (SESTAT), which contains detailed information on recently graduated science and engineering Bachelor and Master’s students from 1990 through

[9] On a related note, Eide and Waehrer (1998) investigate how the expected returns from attending a graduate school impact undergraduate major choices.

2000. In order to measure state-level business cycle fluctuations, we supplement the NSRCG data with state-level unemployment rates from the Local Area Unemployment Statistics (LAUS) program of the Bureau of Labor Statistics (BLS).

3.1 The NSRCG

Conducted biennially since 1993, the NSRCG is a series of five nationally representative samples of recent science and engineering BSc and Master's graduates who earned a degree from a U.S. institution in the two academic years prior to the survey reference date. These surveys focus on science and engineering degrees, which are broadly classified into five categories: computer science and mathematics, life sciences (agricultural and food, biological, and environmental life sciences), physical sciences (chemistry except biochemistry, earth science, geology, oceanography, physics, and astronomy), social sciences (economics, political science, psychology, sociology, and anthropology), and engineering (aerospace, chemical, civil and architectural, electrical, industrial, and mechanical). The NSRCG does not contain data on non-science and engineering students; i.e. undergraduate business administration, arts, and humanities.

For consistency across surveys and to link individuals to the state-specific unemployment rate that they confront at undergraduate graduation, the sample is restricted to individuals who received their first BSc in one of the contiguous U.S. states between July 1, 1990 and June 30, 2000. As our ultimate objective is to run probit models for the probability that a BSc graduate enrolls in a PhD, professional,[10] or Master's program, we cannot include states where no students are enrolled in one or more of these programs. We therefore exclude undergraduates earning their BScs in Delaware, Idaho, Montana, Nevada, North Dakota, Vermont, West Virginia, and Wyoming. This reduces the sample by 698 observations. Given these requirements, the final sample includes 40,402 undergraduates; approximately 8,000 per survey.

Importantly, for our purposes, the NSRCG includes a rich set of measures regarding the respondent's academic history, family background, and current/recent educational involvement. In particular, the NSRCG reports undergraduate GPA, undergraduate major, the year and month in which the individual completed their BSc,

[10] Professional programs include JD, LLB, ThD, MD, and DDS.

the state in which their undergraduate institution is located, as well as current enrollment status and any degree which they are currently working toward or have completed since finishing their BSc. A primary strength of these data is that academic history information can be linked to individual and family attributes as well as local unemployment rates over time. This facilitates an examination of graduate school enrollment decisions over the business cycle.

Table 1 reports the summary statistics by gender for recent BSc graduates in the NSRCG. With detailed information on current enrollment status and the degree the individual is working toward, it is possible to identify graduate students, and more specifically those who are currently working toward a PhD, a professional degree, a Master's degree, or have completed one of these degrees during the survey window. These are reasonable measures of graduate school enrollment immediately after earning a BSc since the NSRCG is conducted one to three years after undergraduate completion. As reported in the first three rows of Table 1, 4, 7, and 18 percent of recent male science and engineering BScs are working toward a PhD, professional degree, and Master's degree, respectively. The comparable numbers for women are 3, 6, and 21 percent.

One of the notable features of Table 1 is the substantial difference in BSc majors across gender. In this sample, the most common undergraduate major for men is social science (38 percent), followed by engineering (25 percent), life science (18 percent), computer science and mathematics (13 percent), and physical science (6 percent). In contrast, among women the most common majors are social science (63 percent) and life science (20 percent), followed by computer science and mathematics (8 percent), engineering (6 percent), and physical science (4 percent). As we will see in Section 5, the extreme concentration of women in social science may make it difficult to detect business cycle driven graduate school enrollment in models with even limited business cycle-GPA or business cycle-undergraduate major interactions for women due to the small cell sizes for many of the undergraduate major state-year cells.

Given our interest in how different individuals are affected by the business cycle, it is essential to have a good measure of ability, or at least previous academic success. Therefore, all models include BSc GPA as a measure of observable ability. As undergraduate GPA is categorical in the NSRCG, all models include indicator variables for the individual's GPA being between 2.75-3.24, 3.25-3.74, and 3.75-4.00 (less than 2.75 is the omitted category).

With students distributed across the entire range of GPAs and all five undergraduate majors represented in the data, it is useful to look at the unadjusted proportion of BSc holders with different majors and GPAs who enroll in PhD, professional, and Master's programs. These data are presented in Table 2. Three features of the data warrant comment. First, for both men and women the fraction of physical science students entering PhD programs is substantially higher than for any other major. Secondly, computer science and mathematics and engineering undergraduate degree holders almost never enroll in PhD or professional programs. Finally, as one might expect, higher GPA students are more likely to enroll in all advanced degree programs. Notice however, that the impact is biggest for PhD and professional school enrollment.

Finally, in order to control for socioeconomic status and family background, the NSRCG also contains data on age, number of months since BSc graduation, ethnicity, state location of high school and BSc, an indicator for being married with a non-working spouse, an indicator for being married with an employed spouse, the number of children residing in the household, and their mother's educational attainment. Summary statistics for these variables are reported in the bottom half of Table 1. On average, individuals were surveyed 19 months after earning their BSc, are 26-years-old, and approximately a quarter of the sample is non-white.[11]

3.2 Entry-level labor market conditions

An accurate characterization of the economic conditions confronting recent graduates is of primary importance for this study. Unfortunately, the NSRCG only contains observable wage data for employed individuals during the reference period. Data on expected wages, potential wage opportunities, or other wage offers are therefore not available for the entire sample, or even a random subset of the sample since employment versus graduate enrollment versus other non-labor market options are clearly self-

[11] The average age is somewhat higher than one might expect due to a small fraction of graduates in their 30s and 40s. All results are similar if these individuals are excluded from the sample.

selected. As such, state-level unemployment rates are used to measure the economic opportunities faced by recent graduates. More specifically, we use the annual state unemployment rate for the civilian non-institutional population age 20 to 24 from the Bureau of Labor Statistics (BLS) Local Area Unemployment Statistics (LAUS) program. Annual state unemployment rates are assigned to individuals by year and state based on the state in which the individual completed their undergraduate training. For example, an individual who reported earning a BSc in California in 1993 is assigned a state unemployment rate of 12.4, the state annual unemployment rate for that year in that state for 20 to 24 year-olds.

While it is also possible to control for the unemployment rate in the individual's home state, i.e. the state in which they attended high school, our main specifications do not include this variable since it is not defined for students who attended high school outside of the United States.[12] Instead, all models reported in Tables 3-5 include an indicator for having attended high school in the U.S. but in a state other than the one in which they attended college, and an indicator for attending high school in another country.

Under the assumption that within state unemployment rate fluctuations are independent of the unobservable characteristics that determine advanced degree enrollment, we can identify the impact of economic fluctuations on graduate school enrollment. It is important to highlight the fact that the business cycle effect that we are estimating is a reduced form in the sense that it captures the net impact of changes in potential wage offers, tuition, and graduate stipend offers (see Section 4 for more detail). This identification strategy also requires adequate within state unemployment rate variation during the sample period. It is therefore worth noting that from 1990 through 2000 state-level unemployment rates exhibited substantial variation. For example, in 1993 the unemployment rate in California was 12.4 percent and dropped to 7.3 percent by 2000. Over the same period, the unemployment rate in New York fell from 12.3 to 8.9 percent. Across all years and states, our sample of recent graduates faced an average unemployment rate of 9 percent.

[12] Despite the loss of sample, all results are similar if the unemployment rate at undergraduate graduation in the home (high school) state is included in the model. These results are reported in the bottom panel of Appendix Tables 1-3.

4. Estimation

Consider a simple model of the determinants of entering an advanced degree program directly after college. Let the indicator variable $G_{it} = 1$ if individual i is enrolled in a particular type of graduate education program in the survey period directly after obtaining his BSc (denoted by t), and let $G_{it} = 0$ otherwise. The choice problem is then described by the following latent variable model:

$$G_{it}^{*} = \beta_1 UER_{it} + GPA_{it}\beta_2 + MAJ_{it}\beta_3 + T_t\phi + S_i\theta + X_{it}\gamma + \varepsilon_{it} \text{ and } G_{it} = \begin{cases} 1 \text{ if } G_{it}^{*} > 0 \\ 0 \text{ if } G_{it}^{*} \leq 0 \end{cases} \quad (2)$$

where G^{*} is the propensity to enter an advanced degree program directly after college, *UER* is the state-level unemployment rate, *GPA* is a set of three GPA indicator variables, *MAJ* is a set of dummy variables indicating the individual's undergraduate major, *T* is a vector of BSc graduation year indicators, *S* is a set of state of BSc graduation indicators, *X* represents observable individual characteristics, and ε is the usual error term. In all cases equation (2) is estimated using a probit model for PhD, professional program, and Master's degree enrollment separately, with all tables presented in Section 5 reporting marginal effects for continuous variables and average treatment effects for the discrete variables; evaluated at the means in all cases.

As discussed in Section 3, this reduced form model is estimated using a repeated cross-section from the NSRCG, with each individual observed only once. Further, all individuals earning a BSc in the same state and year are assigned the same state unemployment rate. Given this sampling structure, we therefore include unrestricted state and year indicators to capture time invariant state characteristics and national time trends, respectively. Identification of the impact of the business cycle on graduate enrollment is thus based on the assumptions that within state unemployment rate fluctuations are: (1) Independent of the unobservable characteristics that contribute to determining enrollment status (e.g. unobserved ability), and (2) Appropriately capture the entry-level labor market economic conditions at BSc graduation.

We should also note that equation (2) is a reduced form in the sense that the unemployment rate response reflects the combined response to potential wage and graduate stipend offers. In other words, the estimated unemployment rate effect is the net effect of the difference between the potential forgone wage and the potential graduate stipend offer. Neither of which can be measured directly since individuals who attend graduate school do not report a wage and individuals who choose to work do not report a stipend offer.[13]

5. Results

Using equation (2) and the repeated cross-section data described in Section 3, we can obtain an unbiased estimate of the impact of the business cycle, as measured by the unemployment rate, on graduate school enrollment. Table 3 reports the gender specific probit estimates for PhD, professional school, and Master's degree enrollment. The marginal effects for men are reported in columns (1)-(3) and the marginal effects for women are reported in columns (4)-(6). All standard errors are heteroskedastic consistent, allow for clustering at the state-year level, and are weighted by the SESTAT provided weights.[14] The primary variables of interest are listed in the top of the table. Row 1 reports the marginal effect for the unemployment rate,[15] rows 2-4 report the average treatment effects for GPA categories (an average GPA of less than 2.75 is the omitted category), and rows 5-8 report the average treatment effects for undergraduate major (physical science is the omitted category). All models also control for age, months since BSc graduation, race, foreign born, high school location (i.e. within the U.S. but in a different state than their BSc alma mater, or outside the U.S.), martial status, spousal employment, the presence of children in the household, maternal education, BSc graduation year indicators, and BSc state indicators.

As one might expect, for both men and women, the estimates reported in rows 2-4 indicate that individuals with higher GPAs are more likely to enroll in advanced degree

[13] In fact, the NSRCG does not even report realized stipends or tuition, only an indicator for having received a stipend.

[14] The SESTAT weights produce a nationally representative sample of science and engineering graduates. The weights are constructed as follows. (1) Construct an institutional base weight (the inverse of the probability that the institution is selected). (2) Adjust the base weight for institutional size, the number of graduates by degree and major, and non-response. (3) Generate student weights by multiplying the institution weights by the inverse of the probability of selecting the student within the institution. (4) Adjust the final weights for non-response (based on year of graduation, degree, and major field of study), as well as the possibility that a graduate could have been selected more than once during a survey period. See www.nsf.gov/statistics/srvyrecentgrads for more detail.

[15] Appendix Tables 1-3 replicate Tables 3-5 using the state-level unemployment rate for the civilian non-institutionalized population age 25-34 to check the sensitivity of the estimates to the unemployment rate definition. The results are similar in most cases.

programs. Further, consistent with the patterns described in Table 2, physical science majors are the most likely to enroll in PhD programs, but in contrast to Table 2, once we condition on the included control variables, computer science and mathematics and engineering majors are no longer the least likely to enroll in PhD programs.

For the purposes of the current study, the primary variable of interest is the unemployment rate. Based on equation (2), male PhD enrollment is counter-cyclical, male Master's degree enrollment is procyclical, female professional school enrollment is counter-cyclical, and all other enrollment appears to be acyclical. In particular, a one-percentage point increase in the unemployment rate increases male PhD enrollment by 0.151 percentage points, decreases male Master's enrollment by 0.579 percentage points, and increases female professional school enrollment by 0.213 percentage points. To put these in context, the average within state unemployment rate standard deviation is 1.8 percentage points. An increase of this magnitude implies a 0.3 percentage point increase in male PhD enrollment, a 1.0 percentage point decrease in male Master's enrollment, and a 0.4 percentage point increase in female professional school enrollment. Compared to mean enrollment rates of 4, 18, and 6 percent for male PhD, male Master's, and female professional programs, these translate into a 7.5 percent increase, 5.6 percent decrease, and 6.7 percent increase, respectively.

Before probing these results further to see if the patterns differ across GPA or undergraduate major, it is important to discuss the possible reasons for the procyclicality of male Master's degree enrollment and the acyclicality and/or imprecise unemployment rate estimates for so many graduate programs. While the explanations for some of these results remain elusive, the probable cause of others is understandable. First, the estimated procyclical enrollment pattern of Master's programs may reflect a substitution of Master's degrees for longer PhD programs during economic expansions, as well as a reduction in the number of employers paying for part-time Master's programs for employees during tight economic periods. Second, our inability to precisely estimate the impact of the business cycle on female PhD enrollment likely reflects the high degree of noise in the data due to having 7,476 fewer female observations than male observations in combination with the extreme concentration of women in the social science BSc major. Third, as we will see in Tables 4 and 5 and the appendix tables, even the one statistically significant unemployment rate effect for women, i.e. professional school enrollment, is sensitive to model specification and variable definitions. As such, our general finding is that there is no evidence of cyclicality for female enrollment in any advanced degree program.

In order to allow for the possibility that recessions impact individuals with different GPAs differentially, Table 4 generalizes equation (2) to allow for an interaction between GPA and the unemployment rate. However, due to cell size considerations we aggregate GPA into two categories. GPA is designated as *LOW* if it is below 3.25, and *HIGH* otherwise. This specification assigns approximately half of the students to the high category and half to the low category. The estimating equation is then given by:

$$G_{it}^{*} = \beta_1 UER_{it} + \beta_2 HIGH_{it} + MAJ_{it}\beta_3 + \beta_4 UER_{it} \times HIGH_{it} + T_t\phi + S_i\theta + X_{it}\gamma + \varepsilon_{it}. \qquad (3)$$

The estimated marginal effects for the unemployment rate for low and high GPA students are reported in Table 4. Notice that these are not the marginal effects reported by standard marginal effects econometrics package routines since the interaction effect in a non-linear model is not the same as the marginal effect of the interaction term. In particular, the marginal effect depends on all of the variables in the model and can even have different signs for different observations (see Ai and Norton 2003 for a detailed discussion). As such, we follow Ai and Norton (2003) in order to properly calculate the marginal effect evaluated at the means.

The only statistically significant unemployment rate responses are for male PhD and Master's enrollment. The added insight that is gained from Table 4 is that the counter-cyclicality of male PhD enrollment and procyclicality of male Master's enrollment are driven by the behavior patterns of individuals with GPAs above 3.25. There is no evidence of a business cycle response for low GPA students. In particular, a one-percentage point increase in the unemployment rate increases high GPA male PhD enrollment by 0.356 percentage points and decreases high GPA male Master's enrollment by 0.864 percentage points. To make the same comparison as in Table 3, a 1.8 percentage point increase in the unemployment rate, implies a 0.6 percentage point increase in high GPA male PhD enrollment and a 1.6 percentage point decrease in high GPA male Master's program enrollment. Compared to a mean high GPA male PhD enrollment rate of 6 percent and mean high GPA male Master's enrollment rate of 23 percent, these translate into a 10 percent increase and a 7 percent decrease, respectively.

As a final probe of the data, Table 5 generalizes equation (2) to allow for interactions between undergraduate major and the unemployment rate.[16] We should, however, point out that this specification is asking a lot of the data since many states and undergraduate majors have small samples – especially for women. With that in mind, the estimating equation is then given by:

$$G_{it}^{*} = \beta_1 UER_{it} + GPA_{it}\beta_2 + MAJ_{it}\beta_3 + UER_{it} \times MAJ_{it}\beta_4 + T_t\phi + S_i\theta + X_{it}\gamma + \varepsilon_{it}. \quad (4)$$

The estimated marginal unemployment rate effects evaluated at the means for physical science, computer science and mathematics, life science, social science, and engineering undergraduates are reported in Table 5. The results reported in this table once again show that any business cycle related cyclicality in advance degree enrollment is limited to male Master's and PhD enrollment. Although the estimates for male Master's enrollment are somewhat imprecise, they are all negative and fairly large; which leads to the more precise estimate reported in Table 3. In contrast, the unemployment rate responses are fairly precisely estimated for male PhDs, with physical science, life science, computer science and math majors appearing to be the most counter-cyclical. There are, however, two exceptions to the general finding that cyclicality is limited to male Master's and PhD enrollment that are important to note. First, although the female professional school estimates are quite noisy, with the exception of life science, the impact of the unemployment rate is very small. As such, the overall counter-cyclical estimate reported in Table 3 is clearly driven by life sciences alone. The second anomaly is the counter-cyclicality of professional school enrollment for physical science majors.

6. Conclusion

Overall, the results reported in this paper indicate that male and female graduate school enrollment decisions are differentially impacted by the business cycle. The impact of unemployment rate fluctuations appears to be almost entirely isolated to male Master's

[16] While it would be preferable to fully interact GPA, undergraduate major, and the unemployment rate, small cell sizes make such a strategy infeasible.

and PhD program enrollment decisions, with almost no evidence of cyclical behavior on the part of women. Further, business cycle responsiveness for these program choices appears to be driven by high GPA men, and in the case of PhD enrollment by physical science, life science, and computer science and mathematics majors.

While the objective of the current paper is to document any cyclicality in graduate enrollment decisions, rather than to explore the factors that explain the cyclicality, the reported results lead to an obvious question: Why are men more responsive to labor market fluctuations than women? Although we cannot answer this question within the confines of the current study, differential male/female sensitivity to opportunity costs, differential impacts of male/female labor market entry wages over the business cycle, and differential preferences over education accumulation all seem like potential contributing factors. This in turn has implications for the gender earnings gap. If men are more likely than women to change education paths to take advantage of earnings advantages when they present themselves, then we should expect men to earn higher wages.

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Table 1. Summary Statistics

	Men		Women	
	Mean	Standard Deviation	Mean	Standard Deviation
Graduate School Enrollment				
PhD	0.04	0.18	0.03	0.18
Professional	0.07	0.26	0.06	0.24
Masters	0.18	0.39	0.21	0.41
Entry-Level Labor Market Conditions				
State Unemployment Rate (UER)	0.09	0.02	0.09	0.02
BSc GPA				
<2.75	0.15	0.35	0.09	0.29
2.75 - 3.24	0.43	0.49	0.37	0.48
3.25 - 3.74	0.32	0.47	0.39	0.49
3.75+	0.11	0.31	0.16	0.36
BSc Major				
Physical Science	0.06	0.24	0.04	0.19
Computer Science and Math	0.13	0.34	0.08	0.26
Life Science	0.18	0.38	0.20	0.40
Social Science	0.38	0.49	0.63	0.48
Engineer	0.25	0.44	0.06	0.23
Socioeconomics				
Current Age	26.27	4.67	26.47	6.14
Months Since BSc Graduation	18.88	6.82	18.67	6.73
Black	0.05	0.23	0.09	0.28
Hispanic	0.05	0.22	0.07	0.25
Asian	0.10	0.30	0.09	0.28
Native	0.01	0.07	0.01	0.09
Foreign	0.13	0.33	0.11	0.32
HS and BSc State Do Not Match	0.30	0.46	0.30	0.46
Went to a Foreign High School	0.05	0.22	0.04	0.19
Non-working Spouse	0.06	0.23	0.02	0.13
Working Spouse	0.17	0.37	0.21	0.41
Resident Children	0.10	0.30	0.14	0.35
Maternal Education				
HS Graduate	0.34	0.47	0.32	0.47
Some College	0.18	0.38	0.21	0.41
BSc	0.27	0.44	0.24	0.43
Graduate School	0.16	0.37	0.17	0.38
Sample Size	23,939		16,463	

Weighted by the SESTAT provided weights.

Table 2. Advanced Degree Enrollment by GPA and BSc Major

	Men			Women		
	PhD	Professional	Masters	PhD	Professional	Masters
	(1)	(2)	(3)	(4)	(5)	(6)
GPA						
<2.75	0.01	0.02	0.11	0.01	0.02	0.16
2.75-3.24	0.02	0.04	0.16	0.01	0.03	0.18
3.25-3.74	0.05	0.11	0.23	0.04	0.08	0.24
3.75+	0.11	0.18	0.23	0.07	0.12	0.26
BSc Major						
Physical Science	0.15	0.06	0.20	0.13	0.09	0.22
Computer Science and Math	0.02	0.01	0.15	0.02	0.00	0.18
Life Science	0.06	0.19	0.15	0.06	0.12	0.17
Social Science	0.02	0.09	0.17	0.02	0.06	0.22
Engineer	0.02	0.01	0.24	0.02	0.01	0.26

Weighted by the SESTAT provided weights.

Table 3. The Impact of the Unemployment Rate on Advanced Degree Enrollment

	Men			Women		
	PhD (1)	Professional (2)	Masters (3)	PhD (4)	Professional (5)	Masters (6)
UER	**0.151**	-0.066	**-0.579**	0.007	**0.213**	0.064
	(0.071)	(0.106)	(0.298)	(0.092)	(0.126)	(0.327)
GPA 2.75 - 3.24	**0.020**	**0.031**	**0.069**	**0.013**	**0.022**	**0.034**
	(0.005)	(0.007)	(0.011)	(0.007)	(0.009)	(0.016)
GPA 3.25 - 3.74	**0.055**	**0.105**	**0.148**	**0.039**	**0.072**	**0.106**
	(0.009)	(0.011)	(0.013)	(0.008)	(0.011)	(0.016)
GPA 3.75+	**0.159**	**0.247**	**0.169**	**0.117**	**0.173**	**0.131**
	(0.025)	(0.025)	(0.019)	(0.023)	(0.024)	(0.022)
Computer Science and Math	**-0.021**	**-0.031**	**-0.060**	**-0.020**	**-0.041**	**-0.045**
	(0.001)	(0.003)	(0.011)	(0.001)	(0.002)	(0.015)
Life Science	**-0.016**	**0.073**	**-0.048**	**-0.016**	**0.019**	**-0.041**
	(0.001)	(0.010)	(0.011)	(0.002)	(0.007)	(0.014)
Social Science	**-0.037**	**0.020**	**-0.025**	**-0.060**	**-0.013**	0.008
	(0.002)	(0.005)	(0.010)	(0.006)	(0.006)	(0.014)
Engineer	**-0.030**	**-0.038**	**0.028**	**-0.017**	**-0.034**	**0.053**
	(0.002)	(0.003)	(0.010)	(0.001)	(0.002)	(0.018)
Current Age	**-0.002**	**-0.004**	0.001	**-0.001**	**-0.003**	**0.003**
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)
Months Since BSc Graduation	**0.005**	**0.006**	**0.043**	**0.006**	0.005	**0.053**
	(0.002)	(0.003)	(0.006)	(0.002)	(0.003)	(0.010)
Black	0.002	**0.030**	**0.051**	-0.001	**0.035**	**0.057**
	(0.004)	(0.008)	(0.012)	(0.003)	(0.008)	(0.015)
Hispanic	0.003	**0.021**	-0.008	-0.001	**0.034**	0.018
	(0.005)	(0.008)	(0.011)	(0.004)	(0.008)	(0.016)
Asian	-0.004	**0.028**	-0.005	-0.002	**0.012**	-0.004
	(0.003)	(0.008)	(0.013)	(0.004)	(0.007)	(0.016)
Native	**0.037**	0.027	-0.025	**-0.013**	0.032	-0.029
	(0.028)	(0.032)	(0.034)	(0.003)	(0.028)	(0.037)
Foreign	0.001	0.003	0.009	0.002	**0.012**	0.003
	(0.003)	(0.006)	(0.012)	(0.004)	(0.007)	(0.013)
HS and BSc State Do Not Match	**0.005**	**0.007**	-0.008	0.004	**0.012**	**-0.028**
	(0.002)	(0.004)	(0.008)	(0.003)	(0.004)	(0.009)
Went to a Foreign High School	**0.009**	**-0.018**	**0.112**	**0.014**	**-0.020**	**0.044**
	(0.006)	(0.005)	(0.020)	(0.009)	(0.005)	(0.025)
Non-working Spouse	-0.004	**-0.012**	**-0.036**	-0.008	-0.002	-0.010
	(0.004)	(0.006)	(0.013)	(0.005)	(0.011)	(0.031)
Working Spouse	0.000	-0.007	-0.016	**-0.007**	**-0.021**	-0.013
	(0.003)	(0.004)	(0.009)	(0.002)	(0.004)	(0.011)
Resident Children	**-0.011**	-0.005	0.005	-0.002	**-0.018**	**-0.023**
	(0.002)	(0.006)	(0.014)	(0.004)	(0.004)	(0.011)
HS Graduate Mother	0.001	0.002	-0.019	-0.003	0.000	0.011
	(0.005)	(0.008)	(0.014)	(0.004)	(0.008)	(0.017)
Some College Mother	0.002	-0.004	-0.013	-0.001	0.004	0.021
	(0.006)	(0.008)	(0.014)	(0.005)	(0.008)	(0.019)
BSc Mother	0.006	0.008	-0.028	-0.003	0.013	0.014
	(0.006)	(0.009)	(0.015)	(0.004)	(0.009)	(0.018)
Graduate School Mother	0.006	0.011	-0.017	0.002	**0.025**	0.028
	(0.006)	(0.010)	(0.016)	(0.005)	(0.010)	(0.022)

Weighted by the SESTAT provided weights. Standard errors are in parentheses and are heteroskedastic consistent and clustered at the state-year level. All models also include unrestricted state and year indicators. There are 23,939 men in columns 1-3 and 16,463 women in columns 4-6.

Table 4. The Impact of the UER on Advanced Degree Enrollment for High and Low GPA Students

	Men			Women		
	PhD (1)	Professional (2)	Masters (3)	PhD (4)	Professional (5)	Masters (6)
Low	0.061	-0.035	-0.392	-0.055	0.097	0.414
	(0.049)	(0.074)	(0.296)	(0.063)	(0.082)	(0.334)
High	**0.356**	-0.145	**-0.864**	0.084	0.386	-0.217
	(0.178)	(0.270)	(0.384)	(0.217)	(0.252)	(0.408)

Weighted by the SESTAT provided weights. Standard errors are in parentheses and are heteroskedastic consistent and clustered at the state-year level. In addition to the interaction between GPA and the unemployment rate, all models also include all of the variables listed in Table 3. There are 23,939 men in columns 1-3 and 16,463 women in columns 4-6.

Table 5. The Impact of the UER on Advanced Degree Enrollment by BSc Major

	Men			Women		
	PhD (1)	Professional (2)	Masters (3)	PhD (4)	Professional (5)	Masters (6)
Physical Science	**0.755**	**-0.379**	-0.062	-0.032	0.234	0.498
	(0.381)	(0.170)	(0.433)	(0.523)	(0.345)	(0.604)
Computer Science and Math	**0.294**	-0.001	-0.438	-0.020	-0.002	-0.344
	(0.081)	(0.043)	(0.322)	(0.066)	(0.017)	(0.489)
Life Science	**0.440**	0.209	-0.425	-0.150	**0.911**	0.413
	(0.164)	(0.430)	(0.339)	(0.236)	(0.458)	(0.498)
Social Science	0.014	-0.160	**-0.935**	0.047	0.126	-0.055
	(0.062)	(0.248)	(0.374)	(0.085)	(0.246)	(0.578)
Engineer	0.084	-0.046	-0.329	-0.024	0.033	0.415
	(0.050)	(0.038)	(0.448)	(0.115)	(0.053)	(0.649)

Weighted by the SESTAT provided weights. Standard errors are in parentheses and are heteroskedastic consistent and clustered at the state-year level. In addition to the interaction between major and the unemployment rate, all models also include all of the variables listed in Table 3. There are 23,939 men in columns 1-3 and 16,463 women in columns 4-6.

Appendix Table 1. The Impact of the Unemployment Rate on Advanced Degree Enrollment

	Men			Women		
	PhD (1)	Professional (2)	Masters (3)	PhD (4)	Professional (5)	Masters (6)
Panel A: UER for Population Aged 25-34						
UER	**0.292**	**-0.257**	-0.642	0.029	0.265	-0.364
	(0.104)	(0.152)	(0.501)	(0.145)	(0.183)	(0.494)
GPA 2.75 - 3.24	**0.020**	**0.031**	**0.069**	**0.013**	**0.022**	**0.034**
	(0.005)	(0.007)	(0.011)	(0.007)	(0.009)	(0.016)
GPA 3.25 - 3.74	**0.054**	**0.105**	**0.148**	**0.039**	**0.072**	**0.107**
	(0.009)	(0.011)	(0.013)	(0.008)	(0.011)	(0.016)
GPA 3.75+	**0.159**	**0.247**	**0.168**	**0.117**	**0.174**	**0.131**
	(0.025)	(0.025)	(0.019)	(0.023)	(0.024)	(0.022)
Computer Science and Math	**-0.021**	**-0.031**	**-0.060**	**-0.020**	**-0.041**	**-0.045**
	(0.001)	(0.003)	(0.011)	(0.001)	(0.002)	(0.015)
Life Science	**-0.016**	**0.073**	**-0.048**	**-0.016**	**0.019**	**-0.041**
	(0.001)	(0.010)	(0.011)	(0.002)	(0.007)	(0.014)
Social Science	**-0.037**	**0.020**	**-0.025**	**-0.060**	**-0.013**	0.008
	(0.002)	(0.005)	(0.010)	(0.006)	(0.006)	(0.014)
Engineer	**-0.030**	**-0.038**	**0.028**	**-0.017**	**-0.034**	**0.053**
	(0.002)	(0.003)	(0.010)	(0.001)	(0.002)	(0.018)
Panel B: Including Home (High School) State UER						
BSc UER	**0.148**	**-0.201**	**-0.570**	-0.019	0.096	0.028
	(0.085)	(0.123)	(0.307)	(0.101)	(0.142)	(0.371)
HS UER	0.029	**0.199**	0.041	0.039	0.161	0.311
	(0.070)	(0.106)	(0.214)	(0.065)	(0.111)	(0.296)
GPA 2.75 - 3.24	**0.022**	**0.033**	**0.067**	**0.014**	**0.023**	**0.034**
	(0.006)	(0.007)	(0.011)	(0.007)	(0.009)	(0.016)
GPA 3.25 - 3.74	**0.058**	**0.111**	**0.142**	**0.040**	**0.075**	**0.104**
	(0.009)	(0.011)	(0.013)	(0.009)	(0.011)	(0.017)
GPA 3.75+	**0.169**	**0.262**	**0.160**	**0.116**	**0.179**	**0.132**
	(0.026)	(0.026)	(0.019)	(0.024)	(0.025)	(0.023)
Computer Science and Math	**-0.020**	**-0.031**	**-0.061**	**-0.020**	**-0.041**	**-0.036**
	(0.001)	(0.003)	(0.011)	(0.001)	(0.003)	(0.015)
Life Science	**-0.016**	**0.074**	**-0.047**	**-0.016**	**0.021**	**-0.034**
	(0.001)	(0.010)	(0.011)	(0.002)	(0.008)	(0.014)
Social Science	**-0.039**	**0.020**	**-0.024**	**-0.062**	**-0.011**	0.013
	(0.003)	(0.005)	(0.010)	(0.006)	(0.006)	(0.014)
Engineer	**-0.029**	**-0.039**	**0.024**	**-0.017**	**-0.034**	**0.049**
	(0.002)	(0.003)	(0.010)	(0.001)	(0.003)	(0.018)

Weighted by the SESTAT provided weights. Standard errors are in parentheses and are heteroskedastic consistent and clustered at the state-year level. All models include the variables described in Table 3. There are 23,939 men in columns 1-3 and 16,463 women in columns 4-6 in Panel A. Panel B replicates Table 3 with the addition of the unemployment rate in the home (high school) state at the time of undergraduate graduation. There are 22,585 men in columns 1-3 and 15,764 women in columns 4-6 in Panel B.

Appendix Table 2. The Impact of the UER on Advanced Degree Enrollment for High and Low GPA Students

	Men			Women		
	PhD (1)	Professional (2)	Masters (3)	PhD (4)	Professional (5)	Masters (6)
Panel A: UER for Population Aged 25-34						
Low	**0.147**	-0.115	-0.323	-0.060	0.103	0.258
	(0.070)	(0.099)	(0.479)	(0.089)	(0.125)	(0.481)
High	**0.594**	-0.657	-1.134	0.162	0.460	-0.900
	(0.264)	(0.371)	(0.636)	(0.313)	(0.391)	(0.599)
Panel B: Including Home (High School) State UER						
Low	0.061	-0.103	-0.402	-0.070	0.020	0.392
	(0.057)	(0.082)	(0.309)	(0.065)	(0.089)	(0.378)
High	**0.376**	-0.427	**-0.793**	0.031	0.200	-0.250
	(0.207)	(0.307)	(0.402)	(0.229)	(0.283)	(0.463)

Weighted by the SESTAT provided weights. Standard errors are in parentheses and are heteroskedastic consistent and clustered at the state-year level. All models include the variables described in Table 3. There are 23,939 men in columns 1-3 and 16,463 women in columns 4-6 in Panel A. Panel B replicates Table 3 with the addition of the unemployment rate in the home (high school) state at the time of undergraduate graduation. There are 22,585 men in columns 1-3 and 15,764 women in columns 4-6 in Panel B.

Appendix Table 3. The Impact of the UER on Advanced Degree Enrollment by BSc Major

	Men			Women		
	PhD (1)	Professional (2)	Masters (3)	PhD (4)	Professional (5)	Masters (6)
<u>Panel A: UER for Population Aged 25-34</u>						
Physical Science	**1.449**	**-0.612**	0.146	0.480	-0.133	0.443
	(0.557)	(0.247)	(0.635)	(0.796)	(0.468)	(0.858)
Computer Science and Math	**0.444**	0.014	-0.273	0.085	-0.002	0.459
	(0.121)	(0.064)	(0.481)	(0.103)	(0.024)	(0.714)
Life Science	**0.743**	-0.083	-0.800	-0.190	**1.110**	0.105
	(0.248)	(0.649)	(0.510)	(0.371)	(0.630)	(0.729)
Social Science	0.094	-0.576	-0.951	0.055	0.189	-0.699
	(0.092)	(0.372)	(0.562)	(0.135)	(0.342)	(0.849)
Engineer	**0.204**	-0.094	-0.307	-0.031	-0.063	0.479
	(0.075)	(0.057)	(0.674)	(0.183)	(0.069)	(0.955)
<u>Panel B: Including Home (High School) State UER</u>						
Physical Science	0.716	**-0.526**	-0.014	-0.263	0.265	0.393
	(0.436)	(0.191)	(0.459)	(0.584)	(0.348)	(0.629)
Computer Science and Math	**0.315**	-0.021	-0.279	0.066	-0.011	-0.009
	(0.095)	(0.049)	(0.333)	(0.055)	(0.020)	(0.528)
Life Science	**0.401**	-0.171	-0.470	-0.208	0.603	0.397
	(0.185)	(0.479)	(0.357)	(0.249)	(0.483)	(0.531)
Social Science	0.015	-0.366	**-1.000**	0.022	0.009	-0.129
	(0.068)	(0.279)	(0.397)	(0.092)	(0.264)	(0.613)
Engineer	0.095	**-0.091**	-0.214	-0.075	-0.004	0.348
	(0.060)	(0.043)	(0.471)	(0.134)	(0.057)	(0.674)

Weighted by the SESTAT provided weights. Standard errors are in parentheses and are heteroskedastic consistent and clustered at the state-year level. All models include the variables described in Table 3. There are 23,939 men in columns 1-3 and 16,463 women in columns 4-6 in Panel A. Panel B replicates Table 3 with the addition of the unemployment rate in the home (high school) state at the time of undergraduate graduation. There are 22,585 men in columns 1-3 and 15,764 women in columns 4-6 in Panel B.