Assessing the Effects of Undergraduate Borrowing on Graduate Degree Attainment and Potential Deferral

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Abstract

How, if at all, does undergraduate debt affect the likelihood of graduate degree attainment and timing of further education? This paper uses a decade's worth of data from the National Survey of College Graduates to estimate the changes in both the likelihood of graduate degree attainment and deferred degree attainment in response to various amounts of undergraduate borrowing. I find a statistically significant negative correlation where the probability of graduate education decreases as debt increases, with evidence of non-linearity in this trend. I also find that these results only hold for more recent students, hinting at an increase in the sensitivity toward undergraduate debt that remains largely similar across various family backgrounds and fields of study. Furthermore, I identify evidence which supports the hypothesis that debt affects graduate school timing among those who choose to go, both in the choice to delay and the number of years delayed. However, there is insufficient evidence to draw conclusions about the decision to not attend over the decision to defer. The analysis in this paper contributes to the broader discussions on the determinants of graduate degree attainment and sheds light on an alternative pathway to post-baccalaureate investments in education.

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1 Introduction

As average college tuition rises, outpacing the wage growth of recent graduates (Federal Reserve Bank of New York 2024; National Center for Education Statistics 2023), costs associated with higher education are often cited as the greatest determinants of post-secondary enrollment (Cengage Group 2021; Gallup and Lumina Foundation 2023). Understanding the factors which affect graduate school enrollment is important at both the individual level and the macroeconomic level. The expenses of college may affect the decision of if and when to go to graduate school, especially if the student faces credit constraints. Assuming graduate education generates positive spillovers to the economy through improved labor force efficiency and productivity, any barriers which deter graduate school enrollment can have negative feedback effects.

Upon the completion of a bachelor's program, an individual makes the decision to continue their education or to enter the workforce. At some fixed level of undergraduate debt, the individual could choose to continue their education in hopes of later attaining a better paying job. Alternatively, this individual could decide to immediately enter the workforce, taking a relatively lower paying job and forgoing further education. If costs and borrowing continue to rise for bachelor's programs, it is reasonable to predict that students will be less likely to invest in graduate education. While there is a long-established literature which studies the impact of debt on post-baccalaureate outcomes (Millett (2003), Malcom and Dowd (2012), and Chen and Bahr (2020) among others), very few recent papers consider endowment or degree returns in assessing the extent that undergraduate borrowing influences graduate degree attainment. To my knowledge, this is also one of the first studies to evaluate the potential impacts to the timing of graduate education.

This paper studies the relationship between undergraduate debt and the choice to enroll in a graduate program and obtain a graduate degree. How are borrowing patterns different across different profiles of people? Is there evidence which establishes a correlation between

borrowing and decisions to invest in further education? If so, has this correlation changed over time in reaction to the upward trend in outstanding student loans? Can delays in further schooling investment provide insight into an alternate pathway to higher education? Broadly, this paper finds differing borrowing patterns across groups split on family background and field of study, as well as a negative correlation between the amount of undergraduate loans and the likelihood of obtaining a graduate degree which is only present for more recent students. I also find a positive correlation in the number of years that graduate school might be delayed among those who choose to invest in further schooling, but no significant effect which differentiates the likelihood of ever pursuing graduate education and the likelihood of deferral.

Prior to obtaining these results, I first motivate the theoretical premise of this paper with a stylized model for investment in education by presenting three potential decision paths and discussing the optimal choices under the context of perfect and imperfect credit markets to introduce several testable implications. Following the theory provided by the model, I evaluate borrowing trends present in several iterations of the National Survey of College Graduates (NSCG) to establish a connection to graduate degree rates. I implement several empirical methods on the NSCG to draw conclusions about the negative correlation between undergraduate borrowing and graduate education decisions: I use a binary choice model to estimate the change in the likelihood of graduate degree attainment as a function of loans taken at the undergraduate level while controlling for several demographic and education-related characteristics. I then extend this model to a multinomial choice model with separate choices to go to graduate school shortly after obtaining a bachelor's degree, or to delay further schooling.

My analysis suggests that there is a broad negative correlation between graduate degree attainment and any level of undergraduate debt and that debt has only become a disincentive to graduate degree attainment for more recent college graduates. I find that sensitivity

toward the amount of loans is generally similar across subsets by parental education and field of study, but that individuals with differing parental endowments and across degree fields have different probabilities of graduate degree attainment conditional on similar borrowing levels. Furthermore, my analysis provides initial evidence that students are more likely to delay their plans for further education as the amount of debt they carry increases, hinting at the presence of credit constraints. The results from the multinomial logit substantiate the hypothesis that debt affects graduate education timing.

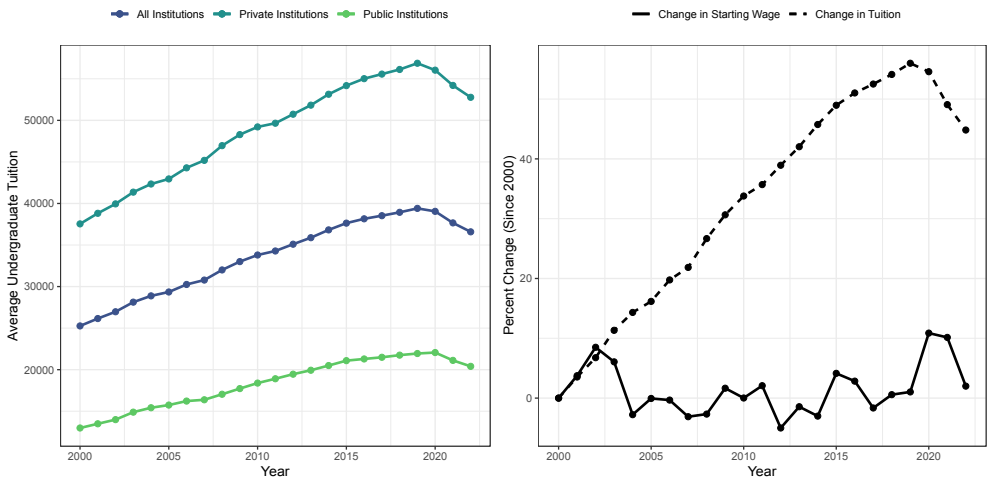
The remainder of this paper proceeds as follows: Section 2 presents some background on the borrowing landscape in the United States and discusses several pieces of relevant literature. Section 3 describes a stylized model used to introduce testable implications under a framework of utility maximization. Section 4 introduces the dataset used in this paper and notable observed trends related to borrowing and graduate degree attainment. In Section 5, I outline the primary methods used to estimate the effect of undergraduate borrowing on graduate degree attainment, and Section 6 summarizes the results obtained. The paper concludes with Section 7 which provides a discussion about the broader implications, limitations on the results achieved, and concluding remarks.

2 Background

2.1 Institutional Context

Across all institutions in the United States, the average total cost has experienced an upward trend, increasing from about $25,263 to $36,587 between 2000 and 2023, measured in constant 2023 dollars. This rise is the largest for private institutions: the average cost in 2000-2001 academic year was $37,542, while the average cost in the 2022-2023 academic year was $52,773, measured in constant 2023 dollars (National Center for Education Statistics 2023).

Figure 2.1: Average undergraduate tuition (left), and change in average tuition and median wages (right).



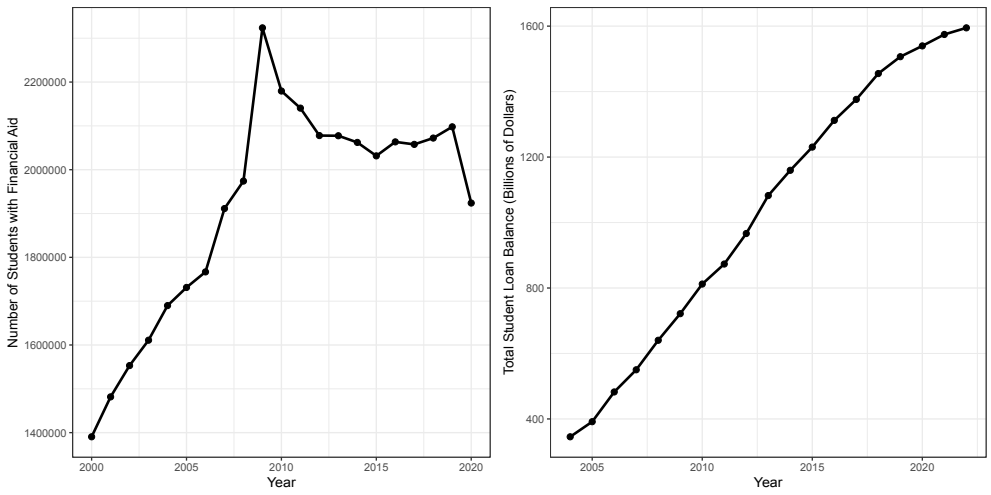
Notes: The left figure depicts the average undergraduate tuition, including fees, room, and board, measured in constant 2023 dollars for different types of institutions using data sourced from National Center for Education Statistics (2023). The line representing all institutions averages public and non-profit private institutions. The right figure depicts the percent change in average tuition and the percent change in starting wage for college graduates. Tuition across US-institutions tend to have few outliers, so the mean is typically representative and used to compute change since 2000. The calculation for change in wages uses median earnings for bachelor's degree holders aged 22 to 27 years source from Federal Reserve Bank of New York (2024); wages tend to be more sensitive to outliers, so the median is selected.

Loan holding trends match the trends observed in the costs of college. The significant majority of student loans are administered through the Department of Education, where the outstanding federal student loan debt currently sits around $1.6 trillion, in contrast to about $350 billion dollars in 2004 (Mangrum, Scally, and Wang 2022). The substantial increase in the last several decades is driven by a combination in an increase in the number of borrowers, overall higher amounts borrowed, lower levels of repayment, and the rising costs of tuition.

2.2 Related Literature

The related literature is largely separable into three categories: models of decision-making in post-graduate outcomes, evidence of credit constraints for human capital investment, and empirical analyses of student loan and graduate enrollment data. Weiler (1994) constructs

Figure 2.2: Number of students with financial aid (left), and total outstanding student loan balances (right).



Notes: The left figure depicts the number of students awarded financial aid across all institutions each year since 2000 using data sourced from National Center for Education Statistics (2023). The right figure depicts the outstanding student loan debt in the United States since 2004 using data source from Mangrum, Scally, and Wang (2022) of the Federal Reserve Bank of New York.

a model which assumes that the decision for further schooling after a bachelor's degree occurs in a series of stages, rather than all at once, as information is made more available to the individual making the decision. He concludes that an increase in undergraduate debt significantly reduces the likelihood of graduate school by estimating the model outlined on a small sample. English and Umbach (2016) also model post-baccalaureate decision-making but use a model which accounts for both individual-specific character traits and context-dependent variables which are developed over the course of an individual's undergraduate education. Their estimation on the 2000 Baccalaureate and Beyond Longitudinal Study yields results which indicates undergraduate debt has no effect on graduate school choice, accounting for the other elements in the model. Although not a direct model of graduate school outcomes, Rothstein and Rouse (2010) model occupational choice as a function of undergraduate debt and concludes, via a natural experiment, that higher levels of debt induces graduates to choose higher paying jobs. Several other works model graduate school enrollment through other education-related and financial characteristics besides undergraduate

borrowing. Mullen, Goyette, and Soares (2003) find significant indirect effects of parental education on graduate school enrollment through their impacts on students' education. Zhang (2005) derives a model of college quality based on selectivity, rankings, grade point average, and acceptance rate before estimating the probability of graduate school enrollment subject to college quality. Using the 1997 Baccalaureate and Beyond survey, he finds that individuals who hold bachelor's degrees from high-quality public and private colleges are more likely to pursue graduate studies, relative to those who graduated from low-quality public colleges. Seibert et al. (2013) design a model which focuses on early career shocks. They find that monetary incentives from a job as well as negative shocks may deter applications to graduate school. Both Bedard and Herman (2008) and Johnson (2013) study the effects of business cycle fluctuations through unemployment on graduate school enrollment, although they reach differing conclusions on the cyclical patterns for men and women.

Literature on credit constraints in post-secondary education is well established. Carneiro and Heckman (2002) argue that while credit constraints exist and influence a small portion of the population, the long-run consequences of family income are significantly more influential in determining college participation. That is, family circumstances drive the abilities which are required to succeed in higher education. Cameron and Taber (2004) use models of schooling returns and schooling choices and find no evidence that borrowing constraints impede schooling progression at the undergraduate level. Works such as Lochner and Monge-Naranjo (2011) explicitly link credit access to individual ability and additional schooling before discussing the impacts of various exogenous factors which limit student loans. Hai and Heckman (2017) develop a lifecycle model accounting for the risk in additional human capital investment to conclude that significant lifecycle constraints are present in human capital investment. These constraints primarily burden those who are permanently poor and those who experience such constraints early in life, despite endowment or ability. Finally, Sun and Yannelis (2016) determine the effects of lifting banking restrictions as a means to alleviating credit constraints. They find that college enrollment and completion increase

substantially as a result.

Several studies have directly attempted to estimate the effects of undergraduate borrowing on graduate program enrollment. For example, Millett (2003) uses the Baccalaureate and Beyond Longitudinal Study for 1993 college graduates in a logistic regression model to conclude that students who hold $5,000 or more in undergraduate debt are significantly less likely to enroll in a post-baccalaureate program. Contrastingly, Kim and Eyermann (2006) present results obtained from a logistic regression model for graduate school enrollment that indicate a positive effect of borrowing in the context of the Higher Education Amendments of 1992, particularly for middle income students. Malcom and Dowd (2012) attempt to find a pattern between undergraduate debt and graduate enrollment with a specific focus on individual demographics, including race, ethnicity, family income, and first generation status. Using data obtained from the 2003 iteration of the National Survey of Recent College Graduates and a propensity score matching technique, they find that debt negatively impacts graduate school enrollment for every racial-ethnic group analyzed at typical debt levels, although the effect disappears for certain groups at significantly high levels of borrowing. More recently, Chen and Bahr (2020) use a stratification-based marginal mean weighting method on the 2008-2012 Baccalaureate and Beyond Survey to find minimal effects of undergraduate debt on post-graduate attendance with no differences across several major demographics, despite finding that historically disadvantaged groups tend to accumulate higher levels of debt.

Interestingly, the literature in this subject is inconclusive; some authors find a significant effect and others find no impact for individuals carrying undergraduate loans. While previous work establishes substantial evidence on credit constraints and provides insight into the effect of undergraduate borrowing on graduate school enrollment, there is a noticeable lack of analyses using recent data which disentangles differing returns by degree field and illustrates its interaction with parental endowment. I also contribute to the literature in this area by evaluating the likelihood of graduate school deferral, which introduces different monetary

motivations in schooling considerations by accounting for the possibility of intermediary repayments to debt between periods of investment in education.

3 Modeling Choice in Educational Investment

In this section, I introduce a stylized model for the decision to go to graduate school as a utility maximization objective, which ties consumption to income. The model is then used to discuss how credit constraints may affect decision-making in order to present several motivating testable implications.

3.1 A Utility Maximization Model

Consider an intertemporal model of investment in education after college where an individual can make a decision to attend graduate school. The individual-specific three-period objective defined as:

$$\max_{\{c_t\}_{t=1}^{3}} \left[\sum_{t=1}^{3} \beta^{t-1} u(c_t) \right] + \xi, \tag{3.1}$$

where c_t represents consumption in period t, $\beta \in (0, 1)$ is a discount factor, and $\xi > 0$ is a constant accounting for non-monetary tastes in schooling. The utility function $u(\cdot)$ is assumed to be a continuously differentiable function satisfying Inada conditions. Individuals may choose to attend graduate school in the first or second period, but the third period represents the remainder of the individual's lifetime and assumes labor force participation.

Per period consumption is primarily subject to savings decisions in conjunction with wage and debt repayment, which are dependent on schooling choices. This model further assumes that an individual is able to achieve higher levels of consumption and utility with graduate school attendance through a potential higher wage. As non-monetary tastes are assumed to always be positive, an optimal solution which maximizes the present discounted utility over three periods will maximize the overall objective function.

3.2 Debt as a Constraint to Consumption

An individual conforming to this model obtains a bachelor's degree in period $t = 0$, possibly accumulating some level of debt to finance this degree. After college, an individual can make three choices: (1) he can enter the labor force and remain there for all periods; (2) he can immediately enroll in graduate school; or (3) he can work for one period and enroll in graduate school at a later time.

3.2.1 No Further Investment in Education

An individual who chooses to conclude his education upon obtaining a bachelor's degree enters the labor force and receives an income for all three periods in this model. Without additional schooling, this individual does not incur any further education-related debt and only needs to repay the amount borrowed to pay for his bachelor's degree, but never receives the higher wage afforded to individuals with a graduate degree.

These constraints are summarized through the following relationships:

$$\begin{aligned} c_1 &= \theta + w^{(b)} - p_1 - s_2, \\ c_2 &= w^{(b)} + (1+r)s_2 - p_2 - s_3, \\ c_3 &= w^{(b)} + (1+r)s_3 - p_3. \end{aligned} \tag{3.2}$$

Here, $\theta > 0$ represents the individual's initial endowment which can be thought of as an aggregation of parental wealth, childhood investments, and personal ability. $w^{(b)}$ is the wage earned when the individual only holds a bachelor's degree. p_t is a variable which represents repayment toward the individual's debt holdings, s_t is a variable for per period savings allocation, and r is the interest rate on both savings and borrowing. The model considers savings in period $t = 3$ to be zero; the individual consumes all of his savings during the last period in his lifetime, and there are no bequests.

In order to prevent individuals from accumulating debt without bound and failing to

repay any amount borrowed, I include the additional constraint that debt must clear at the end of the lifetime:

$$p_1 + \left(\frac{1}{1+r}\right) p_2 + \left(\frac{1}{1+r}\right)^2 p_3 = d^{(b)}, \tag{3.3}$$

where $d^{(b)}$ represents the total amount borrowed for the individual's undergraduate education. Later, we introduce credit constraints to this model.

3.2.2 Immediate Investment in Further Education

If an individual chooses to continue his education and attend graduate school immediately, he forgoes the wage he would have earned from obtaining a job and possibly incurs greater debt to finance a graduate degree in the first period. However, this individual eventually earns a higher wage in the latter two periods from a job that is only available to graduate degree holders. Thus, consumption constraints are altered as follows:

$$\begin{aligned} c_1 &= \theta - p_1 - s_2, \\ c_2 &= w^{(g)} + (1+r)s_2 - p_2 - s_3, \\ c_3 &= w^{(g)} + (1+r)s_3 - p_3. \end{aligned} \tag{3.4}$$

Variables defined previously remain the same. The new wage $w^{(g)} > w^{(b)}$ is the wage earned when the individual holds a graduate degree. This relationship between the different wages provides an analog to the higher returns to education associated with post-baccalaureate degrees. The additional schooling also changes the repayment constraint:

$$p_1 + \left(\frac{1}{1+r}\right) p_2 + \left(\frac{1}{1+r}\right)^2 p_3 = d^{(b)} + d^{(g)}. \tag{3.5}$$

Here, $d^{(g)}$ represents the amount borrowed to cover the costs of the individual's graduate program. The individual must repay both undergraduate and graduate loans by the end of his lifetime.

3.2.3 Deferred Investment in Further Education

On occasion, an individual chooses to invest further in his education, but chooses to spend a period in the labor force prior to entering a graduate program. In doing so, he earns a period of wages in the first period at the lower wage for individuals with only a bachelor's degree. Schooling occurs in the second period, and the individual is able to earn the higher wage for graduate degree holders in the last period of his lifetime. These constraints are summarized as:

$$\begin{aligned} c_1 &= \theta + w^{(b)} - p_1 - s_2, \\ c_2 &= (1+r)s_2 - p_2 - s_3, \\ c_3 &= w^{(g)} + (1+r)s_3 - p_3. \end{aligned} \tag{3.6}$$

The individual faces the same repayment constraint specified by Equation (3.5).

3.3 Theoretical Implications

Although this model makes significant generalizations, it grounds several hypotheses which I test empirically in the remainder of this paper.

3.3.1 Unlimited Borrowing in Perfect Credit Markets

If the individual has the ability to borrow from his future wealth, the model implies that the individual simply equates marginal utility in period t with marginal utility in period $t+1$, subject to savings in period $t+1$. Under this market, individuals who are guaranteed a higher wage by completing a graduate program will choose continued investment in education, provided that the tuition required to do so does not prevent the individual from achieving higher levels of utility. Furthermore, in this model without credit constraints, individuals will enroll in graduate school in period $t = 1$; $w^{(g)} > w^{(b)}$, so the choice to go to earn a graduate degree earlier implies that these individuals will receive a higher wage for more time periods.

It is easy to observe that this case does not hold in reality by looking for individuals who have a substantial gap between the year they finish their bachelor's degree and the year they obtain a graduate degree. However, it raises a key question that this paper seeks to answer: How are decisions to invest in further education impacted when individuals are constrained by debt or borrowing limits?

3.3.2 Restrictions in Savings

Unlimited borrowing from the future is unrealistic, but it is reasonable to assume that an individual can increase future consumption by carrying savings into the future; present consumption decreases in favor of elevating future consumption. Adjusting the model to better represent savings constraints, I impose the additional condition that savings must be non-negative in every time period, denoted $s_t \geq 0$. When savings are non-negative, present marginal utility is greater than future marginal utility by some factor. Decision paths which do not yield the maximal income become feasible as a result.

I evaluate these implications by not only looking at the presence of loans, but the amount of student debt incurred to obtain a bachelor's degree. I hypothesize that further investment in education becomes less probable as debt increases, due to the opportunity cost of loosing time periods to accumulate wages.

3.3.3 Caps on Student Loans

Lochner and Monge-Naranjo (2011) introduce a simple yet practical credit constraint to human capital investment through an upper bound to the amount of debt an individual can borrow when financing his education. Applying the idea to this model, I alter the repayment constraint by limiting the total to a suboptimal level of borrowing $\bar{d}$:

$$p_1 + \left(\frac{1}{1+r}\right) p_2 + \left(\frac{1}{1+r}\right)^2 p_3 = \bar{d} < d^{(b)} + d^{(g)}. \tag{3.7}$$

When this condition is binding, it becomes more likely for individuals to defer further education over immediate enrollment, a departure from perfect credit markets. The additional upfront period of wages can be thought to supplement the gap left by this constraint when the individual enters a graduate program and forgoes wages in the second period. If the constraint is severe, an individual may forgo graduate school altogether.

3.3.4 Returns to Field of Study

Another implication of the three decision paths arises from the observation that the consumption constraint for period $t = 1$ is the same for both the option of no further investment and the option for deferred investment in education. If we continue to assume that an individual cannot pull forth his future savings and that there may be a cap on the amount of external borrowing which imposes a significant financing barrier, a rational consumer who prefers additional schooling will defer a graduate program. However, this decision is most likely influenced by the magnitude of differences between the graduate and bachelor's wage, or the returns to the degrees. If the wage difference between $w^{(b)}$ and $w^{(g)}$ is sufficiently large enough to eventually recover utility from a period of forgone wages and additional debt, the prediction holds. When these returns are less obvious, there may be an increased likelihood for the individual to conclude his education, especially if we start to introduce additional factors, such as preferences for leisure or uncertainty in wages.

If we use expected income as a measure of returns to education, stratification is clear across different fields of study. In particular, engineering and science degree holders typically have higher average starting salaries, while arts and humanities degree holders have lower average starting salaries. Some degrees, such as those that qualify as pre-med or pre-law, only realize significant returns if a professional degree is obtained. Thus, an important aspect in considering the influence of debt in further education is the choice of major; in later sections of the paper, I extend the empirical analysis from a representative population sample to focus on subsets of the sample by field of study.

3.3.5 Endowment Related Impacts

Endowment, specifically parental investment, enters the model through its ability to lessen potential debt accumulation from continued schooling. With less overall debt, the optimal repayments in each period are also lower, thereby increasing the overall attainable utility and better facilitating immediate investment in graduate education. Holding all other factors, the level of initial endowment may determine which of the three decision paths that an individual chooses. I test these implications by identifying trends between parental wealth (estimated via a proxy), debt, and graduate degree attainment. Furthermore, I look at different combinations for parental wealth and field of study and evaluate whether the two factors push borrowing in the same direction, or whether the two have the potential to counteract each other in their effects on borrowing.

4 Data: The National Survey of College Graduates

I use portions of the 2013, 2015, 2017, 2019, and 2021 iterations of the National Survey of College Graduates (NSCG) (National Center for Science and Engineering Statistics 2024), a survey sponsored by the National Science Foundation (NSF) and administered by the U.S. Census Bureau focusing on individuals with education and employment in science and engineering, although those with arts or humanities degrees also serve as respondents. The survey is structured in a rotating multi-panel design; a new sample is drawn from the American Community Survey (ACS) conducted two years prior, and returning samples are drawn from older iterations of the ACS or from the National Survey of Recent College Graduates (NSRCG). A detailed breakdown of the returning samples and new samples of each survey iteration is provided in Table A.1. The full data from the 2013 iteration of the survey is included. For every year after, only the new samples are included in the final dataset to prevent non-unique observations. The original constructed dataset contains 236,779 observations.

The primary variable of interest is the amount borrowed to finance an undergraduate de-

gree. The survey captures undergraduate loan information through categories: respondents choose from "no loans", $10,000 incremental categories, or $90,001 and more. I create an undergraduate loan indicator equal to 1 if the observation responds with any answer that is not "no loans". The survey requires respondents to include all forms of loans, including those with no expectation of repayment (termed "informal loans"). Such informal loans include financial support from family members, tuition waivers, fellowships, grants, and scholarships. Without the expectation of repayment, these informal loans are likely to have little influence on considerations in further education investment. From a theoretical perspective, an individual with only informal loans face repayment amounts of zero, and per period consumption is no longer constrained by the amount borrowed to finance undergraduate schooling. Thus, observations with only informal loans are dropped from the dataset[1].

Furthermore, I drop individuals whose highest degree is a doctorate degree. While graduate degrees are likely pursued in order to obtain higher paying jobs, preferences in pursuing doctorate degrees are more significantly confounded with non-monetary preferences, making it more difficult to isolate the effects of undergraduate loans. The dataset is restricted to respondents between the ages of 26 and 56, allowing for respondents who are old enough to have attended graduate school if they chose to, but excluding older respondents who may not have faced costs to education representative of the modern average. Individuals who attended a non-US institution for the bachelor's degree are excluded due to the significant differences in schooling costs between US and non-US institutions. Any remaining observations which answer "logical skip" in a variable used for analysis are dropped as well.

The outcome variable is measured as graduate degree attainment, an indicator variable which is equal to 1 if the individual holds a master's or professional degree as his highest level of education. Individuals who hold only a bachelor's degree have a value of 0 for this indicator variable, including those who hold multiple bachelor's degrees. I also derive

[1]An alternative to the exclusion of observations with only informal loans involves adjusting the loan amount for these individuals to be zero. The estimates produced for the regression specifications in this paper under this alternative are only slightly less negative, although not at a statistically significant level.

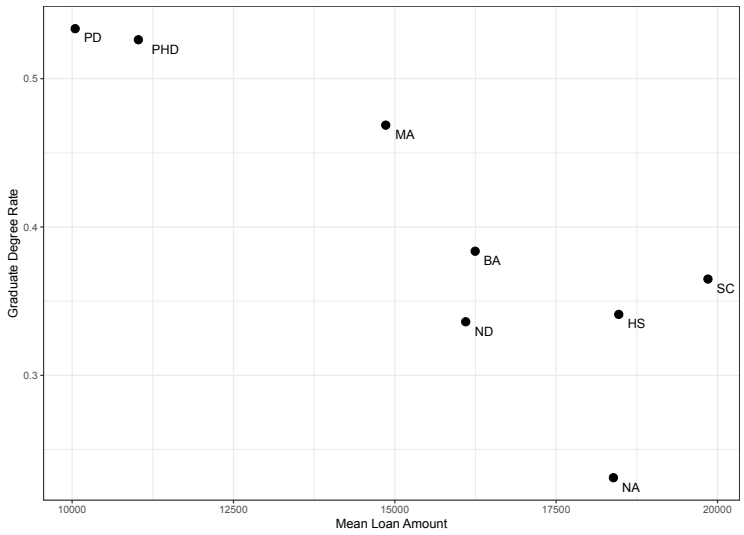
a categorical variable of graduate school deferral. Respondents who obtain a master's or professional degree within six years, which is considered immediate enrollment, are assigned a value of 1, and those who obtain their degree after six years are assigned a value of 2. Individuals who only hold a bachelor's degree are again assigned a value of 0.

The resulting dataset contains 119,195 observations. The proportion of men and women are relatively balanced, with female observations making up 49.258% of the total. By survey design, there is a slight skew toward younger respondents; the median age is 34 years, while the average age observed in the dataset is 37.321 years. Roughly 73.521% of the respondents were white, and 12.313% of the respondents were Hispanic. In regard to the education of the respondents, 59.726% of the final dataset hold a bachelor's degree as their highest level of education attained. The original survey is designed to focus on individuals with a science or engineering background, and 78.799% of the respondents obtained their first bachelor's degree in a science or engineering related field. About 42.736% of the observations obtained this bachelor's degree without the use of any formal loans, and about one-third borrowed $30,000 or less.

The data also presents some indication about what types of individuals borrow when financing a bachelor's degree. We observe that individuals with parents who hold at least a bachelor's degree borrow significantly less than individuals whose parents hold less than a bachelor's degree, as seen in Figure 4.1. At the same time, graduate degree attainment of the observed individuals also appears to increase with parental education; individuals who have parents who hold a master's, professional, or doctorate degree are more likely on average to also attain a graduate degree.

Borrowing trends are less evident when the dataset is split by field of study; there is no clear correlation between the mean loan amount and the average graduate degree attainment rate, as seen in Figure 4.2. Some fields of study, such as "mathematics and statistics" (labeled "12"), experience high graduate degree rates and low mean borrowing. Other fields such as

Figure 4.1: Average graduate rate by mean loan value, split on parental education.

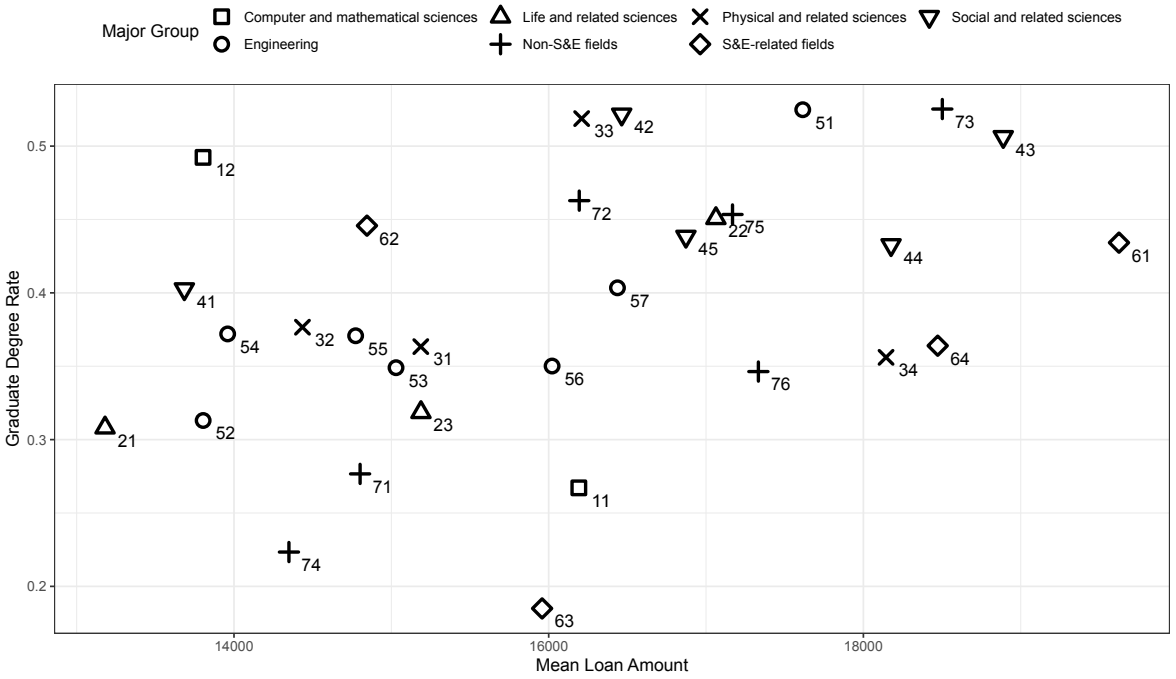


Notes: This figure depicts the proportion of individuals with a graduate degree within each parental education group compared to the average loan amount calculated by using the loan variable approximation derived from the categorical variable. Labels on each point estimate correspond to: (ND) Less than high school completed; (HS) High school diploma or equivalent; (SC) Some college, vocational, or trade school; (BA) Bachelor's degree (e.g. BA, BS, AB); (MA) Master's degree (e.g. MA, MS, MBA); (PD) Professional degree (e.g. JD, LLB, MD, DDS); (PHD) Doctorate (e.g. PhD, DSc, EdD); and (NA) Not applicable. The numerical estimates are presented in Table A.5.

"sales and marketing" (labeled "74") see much lower graduate degree rates coupled with low mean borrowing. We also observe fields of study, as in "physics and astronomy" (labeled "33") and "political and related sciences" (labeled "42"), where graduate degree rate is among the highest but coupled with moderate to high loans. Furthermore, we see that even fields of study within the same major grouping are scattered as well.

For those in the dataset who hold a graduate degree, the vast majority hold a master's degree, with 9.353% holding professional degrees. About 28.164% of the observations deferred their education. This represents 11.343% in the overall dataset. While deferred investment in graduate school is less popular than immediate investment, the spread of the number of years delayed is quite large, ranging from 7 years to 38 years.

Figure 4.2: Average graduate rate by mean loan value, split on field of study.



Notes: This figure depicts the proportion of individuals with a graduate degree within each field of study group compared to the average loan amount calculated using the loan variable approximated derived from the categorical variable. Numerical labels on each point estimate correspond to the minor groupings for field of study, as defined by the survey. The shape of each point estimate corresponds to the major groupings for field of study. Labels on each point estimate correspond to: (11) Computer and information sciences; (12) Mathematics and statistics; (21) Agricultural and food sciences; (22) Biological sciences; (23) Environmental life sciences; (31) Chemistry, except biochemistry; (32) Earth, atmospheric, and ocean sciences; (33) Physics and astronomy; (34) Other physical sciences; (41) Economics; (42) Political and related sciences; (43) Psychology; (44) Sociology and anthropology; (45) Other social sciences; (51) Aerospace, aeronautical, and astronautical engineering; (52) Chemical engineering; (53) Civil and architectural engineering; (54) Electrical and computer engineering; (55) Industrial engineering; (56) Mechanical engineering; (57) Other engineering; (61) Health; (62) Science and mathematics teacher education; (63) Technology and technical fields; (71) Management and administration fields; (72) Education, except science and math teacher education; (73) Social service and related fields; (74) Sales and marketing fields; (75) Art and humanities fields; and (76) Other non-science and engineering fields. The numerical estimates are presented in Table A.6.

5 Empirical Methodology

5.1 Exploratory Analyses

To better quantify the trends observed for borrowing in relation to parental education and field of study, I run several exploratory regressions. Although loan data is observed in categories, I create an estimated continuous version of the variable by taking the middle value of the category for each individual. That is, if an individual borrows $10,000 to $20,000, I assign $15,000 to *LoanAmount*.

$$LoanAmount_i = \beta_0 + ParentalEducation_i'\beta_1 + u_i, \tag{5.1}$$

$$LoanAmount_i = \beta_0 + DegreeField_i'\beta_2 + u_i, \tag{5.2}$$

$$LoanAmount_i = \beta_0 + ParentalEducation_i'\beta_1 + DegreeField_i'\beta_2 + u_i. \tag{5.3}$$

In Equation (5.1) and Equation (5.3), *ParentalEducation* represents a vector of dummies for the highest level of education attained by at least one parent, created by combining the columns for father's education and mother's education[2]. Generally, household income increases with more educated parents as earnings are strongly linked to educational attainment. Throughout this paper, I employ parental education as a proxy for parental income and potential wealth passed down to children. *DegreeField* represents a vector of dummy variables for each different field of study[3] in Equation (5.2) and Equation (5.3).

Individuals who have parents with higher levels of income may borrow at lower levels, compared to their counterparts who have parents with lower levels of income. With a higher initial endowment, these individuals need to supplement their consumption less with loans. Impacts from field of study are harder to predict. On one hand, degrees which are perceived

[2]There are eight different categories for education, and a bachelor's level education is taken as the reference level. These categories include "Less than high school completed", "High school diploma or equivalent", "Some college, vocational, or trade school", "Bachelor's degree", "Master's degree", "Professional degree", "Doctorate", and "Not applicable".

[3]The field of study is a categorical variable, represented as a vector of length 30 where the leave out group is "Biological sciences". The full list of fields of study are given in Table A.6

to bring about higher returns might induce an individual to take on more loans with the expectation that he will recoup the costs at a future date. On the other hand, several degrees with lower perceived returns require a post-baccalaureate degree, to realize higher returns. Examples of such degrees include the history and law degree pair or the psychology and medical degree pair. Thus, individuals who pursue these fields of study might borrow at higher levels as well. The final regression described in Equation (5.3) includes both parental education and field of study to identify how estimates for the level of borrowing varies with different combinations of the two regressors.

5.2 Graduate Degree Likelihood

Graduate degree attainment is initially modeled as a binary choice; an individual either chooses to obtain a master's or professional degree at some point after the completion of a bachelor's degree, or the individual chooses not to. The conditional probability of graduate degree attainment is estimated with the following logistic model:

$$\begin{aligned}\ln\left(\tfrac{P}{1-P}\right) = \beta_0 &+ LoanCategory_i'\beta_1 + \beta_2 Age_i + \beta_3 Age_i^2 + \beta_4 Male_i + Race_i'\beta_5 \\ &+ \beta_6 Hispanic_i + FathersEducation_i'\beta_7 + MothersEducation_i'\beta_8 \\ &+ \beta_9 BachelorsYear_i + InstitutionStatus_i'\beta_{10} + DegreeField_i'\beta_{11} + u_i,\end{aligned} \tag{5.4}$$

where P is the probability that individual i possesses a master's or professional degree, conditioned on all the regressors included in the model. As described previously, the outcome variable is an indicator variable equal to 1 if the individual holds a graduate degree. The primary variable of interest is the loan amount category, or $LoanCategory$ in Equation (5.4).

I control for several additional variables, separated into demographic controls and education controls. Demographic controls include age, gender, race, and ethnicity of the individual[4]. I also include the value of age squared to capture possible non-linear relationship which

[4]Age is an integer-valued variable; the remaining demographic controls are categorical variables. Because there are only two categories in the dataset for gender, the control is treated as a single dummy variable equal to 1 if the individual is male. Race is a vector of dummy variables for "American Indian/Alaska Native",

may be present in the data with respect to age. Education controls include both parents' educational background[5]; once again, I assume that parental education is a strong determinant for parental wealth which ultimately influences the amount of loans a child might need to take to finance a bachelor's degree. Other education controls include the year when the bachelor's degree was obtained, the public or private status of an institution, and the individual's field of study[6].

Estimation of Equation (5.4) yields coefficients which are in the form of log odds. Aside from the sign of the coefficient, this estimation does not lend itself directly to interpretation. Instead, I also estimate marginal effects, or the effect of moving out of the loan category at any non-zero amount to no loans, holding all other factors the same. Because the regression relies on many categorical regressors, I compute this value by evaluating the partial effect for each observation and averaging over all observations, rather than taking the partial effect at representative values for the specification's other regressors[7]. Overall, I predict the sign of β_1 and the corresponding marginal effects to be negative; undergraduate debt is expected to act as a deterrent to further education. I also predict the marginal effects on higher loan categories to be slightly greater in magnitude. Those with higher levels of debt reasonably avoid additional opportunities to incur debt, especially if the increase in returns are minimal, and favor entering the labor force as a means to facilitate repayment.

I also try a specification which replaces the categorical loan variable with *LoanAmount* and its corresponding squared term, as defined in Section 5.1 and scaled down by a factor

"Black", "White", "Native Hawaiian/Other Pacific Islander", and "Multiple race", with "Asian" as the leave out group. Hispanic is also a two category variable treated as a singular dummy, where the regressor is equal to 1 if the individual is Hispanic.

[5]Education levels for each parent uses the same levels as the combined parental education variable. Here, each parent's education is kept separately.

[6]Year of bachelor's attainment is an integer-valued variable. Institutional status is another two category variable; the dummy is equal to 1 if the institution is privately controlled. Field of study is the same variable defined previously.

[7]Marginal effects are computed using `logitmfx` from the `mfx` package (Fernihough 2019) and validated with the package `marginaleffects` (Arel-Bundock 2023).

of $10,000:

$$\begin{aligned}\ln\left(\tfrac{P}{1-P}\right) = \beta_0 &+ \beta_1 LoanAmount_i + \beta_2 LoanAmount_i^2 + \beta_3 Age_i + \beta_4 Age_i^2 + \beta_5 Male_i \\ &+ Race_i'\beta_6 + \beta_7 Hispanic_i + FathersEducation_i'\beta_8 + MothersEducation_i'\beta_9 \\ &+ \beta_{10} BachelorsYear_i + InstitutionStatus_i'\beta_{11} + DegreeField_i'\beta_{12} + u_i.\end{aligned} \tag{5.5}$$

This specification facilitates the estimation of a marginal effect for the change in the outcome variable if the loan amount is increased by $10,000.

One dimension of interest unaccounted for by this logit model is the observed changes in borrowing over time, discussed in Section 2. To evaluate the differences in the marginal effects over time, I split the dataset roughly in half and estimate Equation (5.4) on each subset. If the resulting difference between the β_1 coefficients is large enough at a statistically significant level, then there is some evidence that sensitivity toward undergraduate borrowing has changed over time.

5.3 Degree Deferral Likelihood

5.3.1 Years Delayed

Although Equation (5.4) establishes the association of undergraduate borrowing on graduate degree attainment within any time frame, one relevant question this paper seeks to answer is whether the constraints imposed by undergraduate loans induce students to delay graduate school. Conditioning on the group in the dataset who have a graduate degree, I estimate the following linear regression to model the number of years an individual might delay further investments in education:

$$\begin{aligned}BetweenYears_i = \beta_0 &+ \beta_1 LoanAmount_i + \beta_2 LoanAmount_i^2 + \beta_3 Age_i + \beta_4 Age_i^2 + \beta_5 Male_i \\ &+ Race_i'\beta_6 + \beta_7 Hispanic_i + FathersEducation_i'\beta_8 + MothersEducation_i'\beta_9 \\ &+ \beta_{10} BachelorsYear_i + InstitutionStatus_i'\beta_{11} + DegreeField_i'\beta_{12} + u_i,\end{aligned} \tag{5.6}$$

The coefficient on $LoanAmount$, β_1, represents the expected change in the number of years an individual might delay if he intends to go to graduate school. Assuming a negative trend in graduate degree rate is observed for higher loan levels, I expect the value for β_1 to be positive.

5.3.2 Extending the Choice Set for Schooling

Using the categorical variable defined previously for deferred graduate degree attainment, I estimate the following multinomial logit regression[8], taking "no further education beyond a bachelor's degree" as the baseline category:

$$\begin{aligned}\ln\left(\frac{P_j}{P_{j^*}}\right) = \beta_{0,j} &+ LoanCategory_i'\beta_{1,j} + \beta_{2,j}Age_i + \beta_{3,j}Age_i^2 + \beta_{4,j}Male_i + Race_i'\beta_{5,j} \\ &+ \beta_{6,j}Hispanic_i + FathersEducation_i'\beta_{7,j} + MothersEducation_i'\beta_{8,j} \\ &+ \beta_{9,j}BachelorsYear_i + InstitutionStatus_i'\beta_{10,j} + DegreeField_i'\beta_{11,j} + u_i.\end{aligned} \tag{5.7}$$

j^* denotes the baseline category, and j denotes either the choice for immediate schooling ($j = 1$) or deferred schooling ($j = 2$). Thus, P_j represents the probability that individual i chooses choice j, conditioned on the regressors included in the model. I expect that the general relationship between borrowing and graduate school investment will remain the same for the category for immediate continued schooling. However, I predict that it may be possible for the coefficients on each loan category to be near zero or slightly positive for the choice of deferred continued schooling. If an individual has sufficient incentive in the form of potential wages and preference for higher education, he could be more likely to earn a graduate degree after recouping any costs incurred when financing a bachelor's degree.

[8]Coefficients are computed with the `mlogit` package (Croissant 2020) and validated with the `multinom` function in the `nnet` package (Venables and Ripley 2002).

5.4 Robustness

5.4.1 Combining Parents' Education

In estimating the borrowing patterns as determined by parental education, I combine both parents' education into one variable. This reduces the dimensionality of the regression and makes estimated coefficients easier to interpret, but makes the assumption that only the highest education level has significance. It does not account for the likely differences between the two parents. To verify that the combined variable does not introduce a large amount of bias, I re-run regressions substituting in the combined variable where parental education is separated. If the coefficients on the loan categories or loan amount are approximately equal to the original estimates, then I conclude that the generalization remains representative in its effect on the outcome.

5.4.2 Expected Earnings Index

Although a person's field of study provides a general idea for the expected returns on a bachelor's degree, I construct an expected earnings index from the observations in the data who choose not to invest in any additional education beyond a bachelor's degree. In other words, I subset the data for observations who do not hold a graduate degree and estimate the following linear regression:

$$Income_i = \beta_0 + \beta_1 Age_i + \beta_2 Age_i^2 + DegreeField_i'\beta_3 + SurveyOrigin_i'\beta_4 + u_i. \tag{5.8}$$

Using the resulting coefficients, I predict the expected earnings for the entire dataset in a new variable $ExpectedIncome$ and replace $DegreeField$ in Equation (5.4) with this earnings

index, so that the model for graduate school choice becomes:

$$\begin{aligned}\ln\left(\tfrac{P}{1-P}\right) = \beta_0 &+ LoanCategory_i'\beta_1 + \beta_2 Age_i + \beta_3 Age_i^2 + \beta_4 Male_i + Race_i'\beta_5 \\ &+ \beta_6 Hispanic_i + FathersEducation_i'\beta_7 + MothersEducation_i'\beta_8 \\ &+ \beta_9 BachelorsYear_i + InstitutionStatus_i'\beta_{10} + \beta_{11} ExpectedIncome_i + u_i.\end{aligned} \tag{5.9}$$

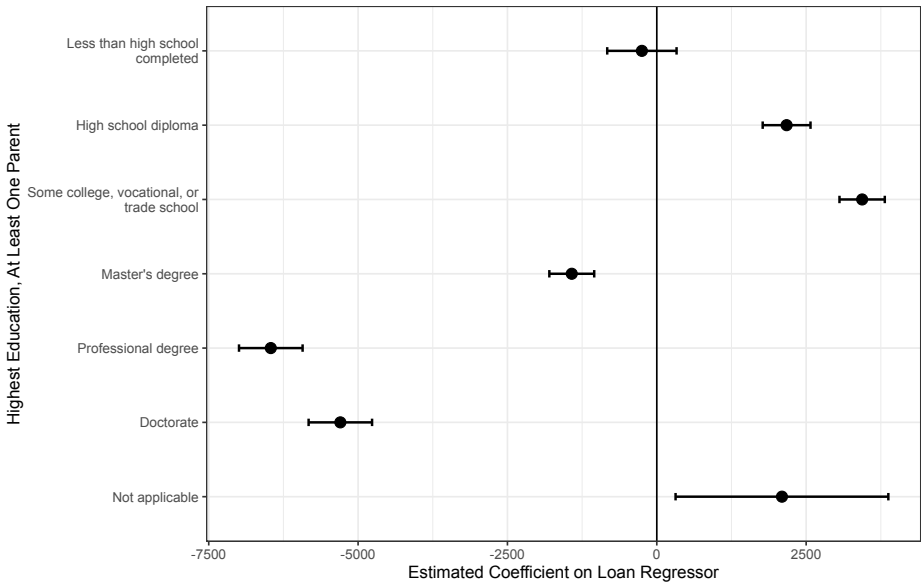
If the β_1 coefficient obtained from this regression is approximately equal to the one obtained from Equation (5.4), then it is reasonable to interpret an individual's field of study as a variable for expected returns on a degree in that field, and thus, individuals make decisions based in part on the perception of future wealth.

6 Results

6.1 Borrowing Patterns

Figure 6.1 depicts estimates for the coefficients on the parental education categories in Equation (5.3). Estimates are overall lower compared to the regression model specified by Equation (5.1) which contains only parental education without controlling for the field of study. Providing some evidence in support of my original hypothesis, the results indicate that individuals with parents whose highest educational attainment is less than a bachelor's degree tend to borrow more. In particular, individuals with parents who hold at most a high school diploma borrow approximately $2,172.86 more than individuals with parents who hold bachelor's degrees; individuals with parents who have attained some college, vocational, or trade school education tend to borrow about $3,437.25 more. On the other hand, parents who hold a post-baccalaureate degree (master's, professional, or doctorate) have children who borrow between $1,423.19 and $6,461.13 less. Put together, parental education appears to be a valid proxy for parental income, assuming this income is passed on in the form of endowments and that higher endowments imply the need to borrow less.

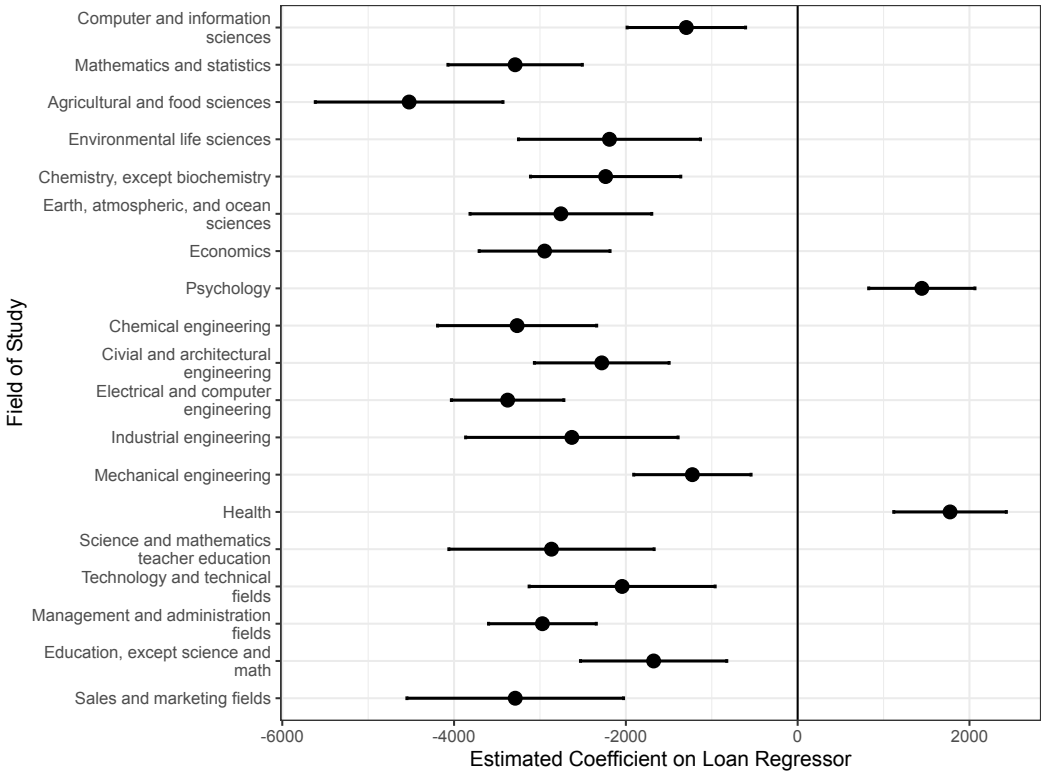
Figure 6.1: Estimated coefficients on the parental education categories in Equation (5.3).



Notes: This figure depicts coefficients on each parental education category in Equation (5.3) which are estimated in reference to the base category of "Bachelor's degree". The error bars represent the 95% confidence interval. Numerical estimates are presented in Table A.7.

The estimates for the coefficients on the field of study categories in Equation (5.3) depicted in Figure 6.2 lends support to conclude that borrowing varies significantly across different majors. Compared to individuals who studied biological sciences, individuals who majored in psychology or health borrow an additional $1,445.46 and $1,774.10, respectively. Any other statistically significant field of study category borrowed much less. If we assume that biological sciences is a major with unrealized returns (or returns that are not realized until a post-baccalaureate degree is obtained), then these estimates indicate that individuals who study a major which yields higher returns borrow at lower amounts. However, these results should likely be interpreted with caution; despite the lower levels of borrowing by specific majors, it is also possible that this borrowing is offset by a lower initial endowment granted by parents who have lower educational attainment, thus illustrating a complex interaction between parental endowment and field of study as determinants of borrowing. I consider both of these factors when estimating the likelihood of graduate degree attainment.

Figure 6.2: Estimated coefficients on the field of study categories in Equation (5.3).



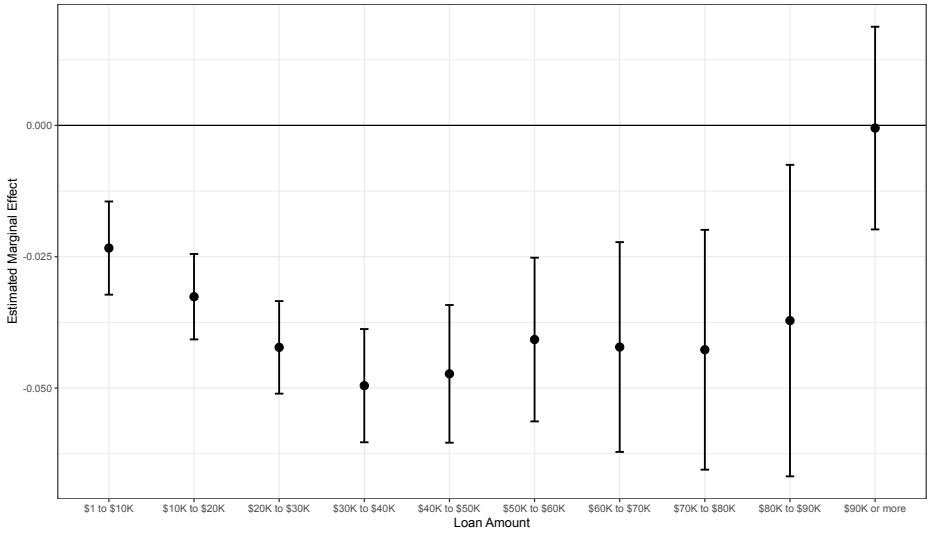
Notes: This figure depicts coefficients on each field of study category in Equation (5.3) which are estimated in reference to the base category of "Biological sciences". The subset of fields of study represented in the figure correspond to only the ones with statistically significant estimates; the remaining are dropped for clarity. The error bars represent the 95% confidence interval. Numerical estimates are presented in Table A.8.

6.2 Probability of Graduate Degree Attainment

Figure 6.3 depicts the average marginal effects on graduate degree attainment for an observation which moves from the zero debt category to any of the non-zero categories, estimated from Equation (5.4). The smallest effect occurs for the category of loans between $1 and $10,000, which lowers graduate degree attainment by approximately 2.34 points. The magnitude of this effect increases with larger amounts of borrowing, reaching 4.96 points for loans between $40,001 and $50,000 before leveling off. The "curvature" produced by the estimates in Figure 6.3 also hint at non-linear effects for the loan amount on graduate degree attainment. That is, increasing the amount borrowed initially reduces the likelihood that an individual will attain a graduate degree, but the change in this effect decreases at higher levels of borrowing. This is verified by computing the regression in Equation (5.5). The coefficient on the continuous loan variable is negative, as expected, while the coefficient on the squared term is slightly positive; the marginal effect of increasing the amount of borrowing by $10,000 equates to a reduction of about 1.93 points in the likelihood of graduate degree attainment. Furthermore, replacing the field of study categorical variable with the expected earnings index constructed as outlined by Equation (5.8) and Equation (5.9) changes the estimated coefficients on each loan category very little. This implies that there is validity in interpreting an individual's major as the potential future returns on a bachelor's degree. In estimating Equation (5.9), I also find that a $10,000 increase in expected earnings is tied to a 1.35 point reduction in the probability of graduate degree attainment. This serves to substantiate the hypothesis that a smaller margin between bachelor's and graduate wages deters investment in further education.

The only loan category that does not produce a statistically significant marginal effect is the highest category, "$90,001 or more". The most plausible interpretation for this result is the perceived future returns on a degree, despite the variation in majors within this category. For degrees which yield relatively higher expected wages and greater repayment ability,

Figure 6.3: Estimated marginal effects on the loan categories for Equation (5.4).



Notes: This figure depicts the estimated marginal effects on each loan category in Equation (5.4) which are computed accounting for all demographic and education controls. The error bars represent the 95% confidence interval. Numerical estimates are presented in Table A.9.

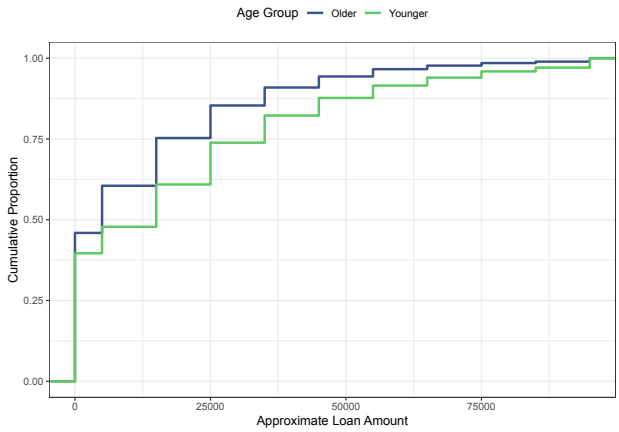
students are less likely to be affected or to feel constrained by undergraduate borrowing, with or without a graduate degree. On the other hand, those pursuing degrees with unrealized returns may be committed to investing in further education with the expectation of much higher future earnings upon obtaining a graduate degree. In either case, borrowing at this level has little influence in the investment decision for higher education.

Notably, the marginal effect fails to meet statistical significance when moving sequentially by $10,000 between non-zero loan categories, and the effects are only significant moving sequentially by $20,000 up to the loan category for $40,000. This implies that students are more sensitive to the presence of any amount of borrowing, rather than the actual amount, when making the decision to enroll in graduate school, especially in regard to higher levels of debt.

6.2.1 By Age

As described in Section 2.1, borrowing for education has changed drastically over the past several decades as students borrow more to meet the rising costs of education. Within the dataset, observations older than 34 years tend to take on fewer loans than those younger than 34 years; the cumulative proportion of each group as loans increase is depicted in Figure 6.4.

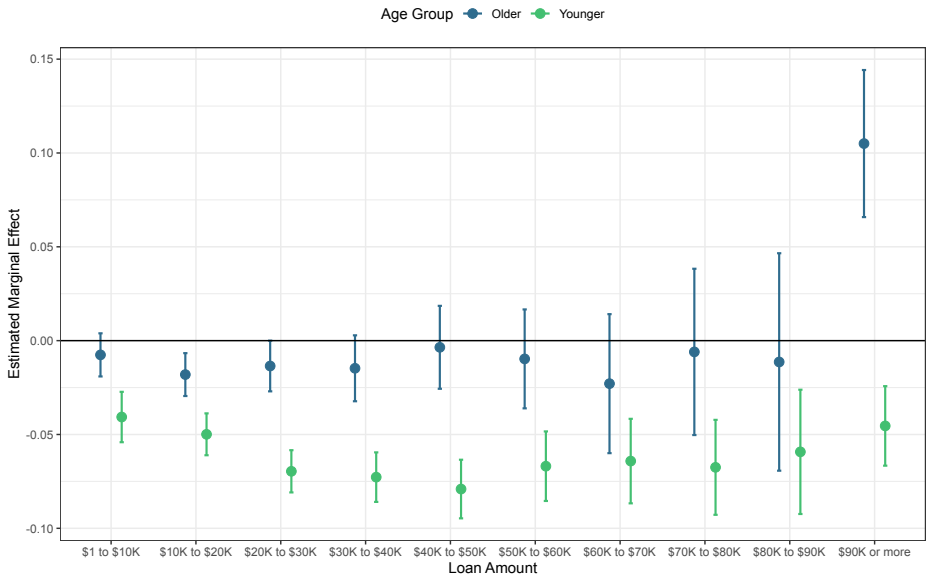
Figure 6.4: Cumulative proportion by increasing loan amounts, split on age.



Notes: This figure depicts the proportion of each group who hold a certain amount of loans or less, where the loan amount is taken to be the approximation derived from the loan categories. The dataset is split roughly in half by taking the younger subset of individuals to be observations who are 34 years or younger and the older subset to be observations who are older than 34 years.

Consequently, it is reasonable to predict that decision-making in relation to debt and further education has changed in conjunction, so I estimate Equation (5.4) on a younger and older subset by dividing the dataset roughly in half. Figure 6.5 displays the resulting marginal effects. The marginal effects for each loan category aside from the $10,001 to $20,000 and $20,001 to $30,000 categories lose their significance for the older subset, and it appears that the negative effect of borrowing only acts on observations younger than age 34 in the dataset. The smallest negative effect remains on the category for borrowing between $1 and $10,000, though the magnitude of the effect for this category increases to a 4.07 point reduction in the likelihood of graduate degree attainment.

Figure 6.5: Estimated marginal effects on the loan categories for Equation (5.4), split along an age threshold.



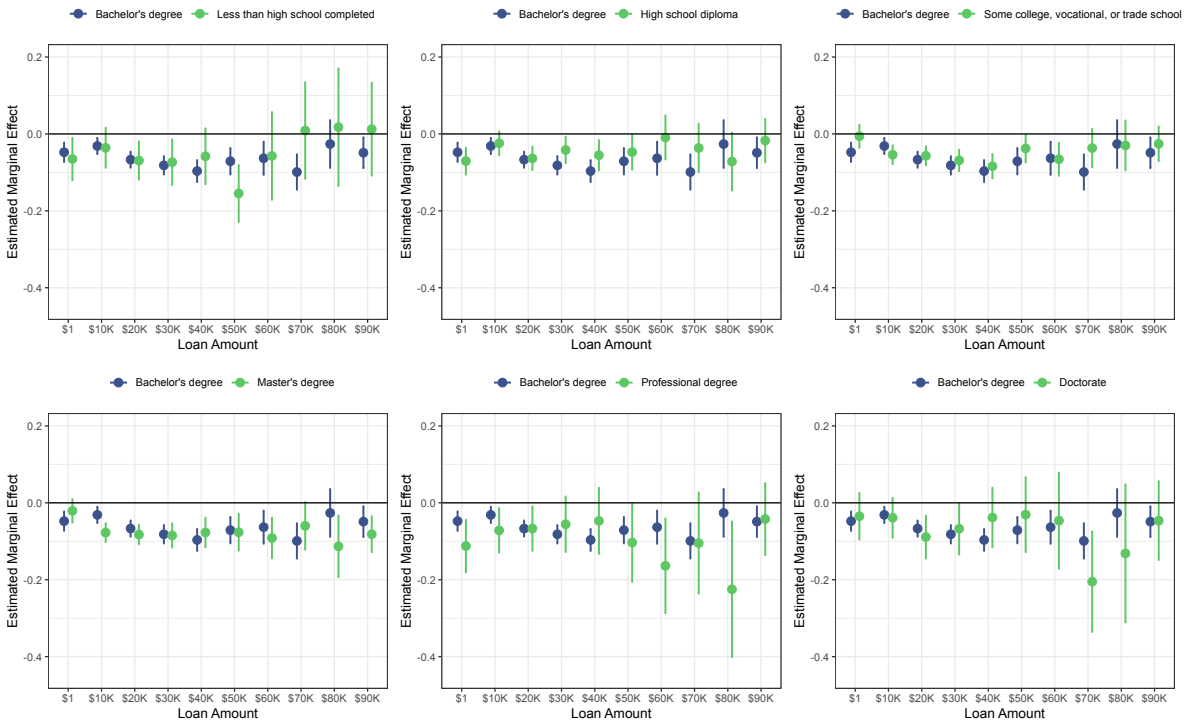
Notes: The figure depicts the estimated marginal effects on each loan category in Equation (5.4) which are computed along age division, accounting for all demographic and education controls. The age groups are divided as discussed in Figure 6.4. The error bars represent the 95% confidence interval. Numerical estimates are presented in Table A.10.

These results suggest that sensitivity toward undergraduate borrowing has increased; outstanding loans have become more of a deterrent to further investments in education in recent years. As the effects seem to be much more significant for the younger group, there is motivation to restrict the analyses in Section 6.2.2 and Section 6.2.3 to this group only.

6.2.2 By Parental Education

Although there are clear borrowing differences along different parental education groups, estimation for the marginal effects on each loan category conditioned on the highest degree attained by at least one parent does not provide sufficient evidence that there are differences in the effect on each category, as depicted in Figure 6.6. The effects across all subsets and most categories remain largely negative, serving as additional evidence that undergraduate borrowing deters investments in higher education.

Figure 6.6: Estimated marginal effects on the loan categories for Equation (5.4), conditioned on combined parental education.

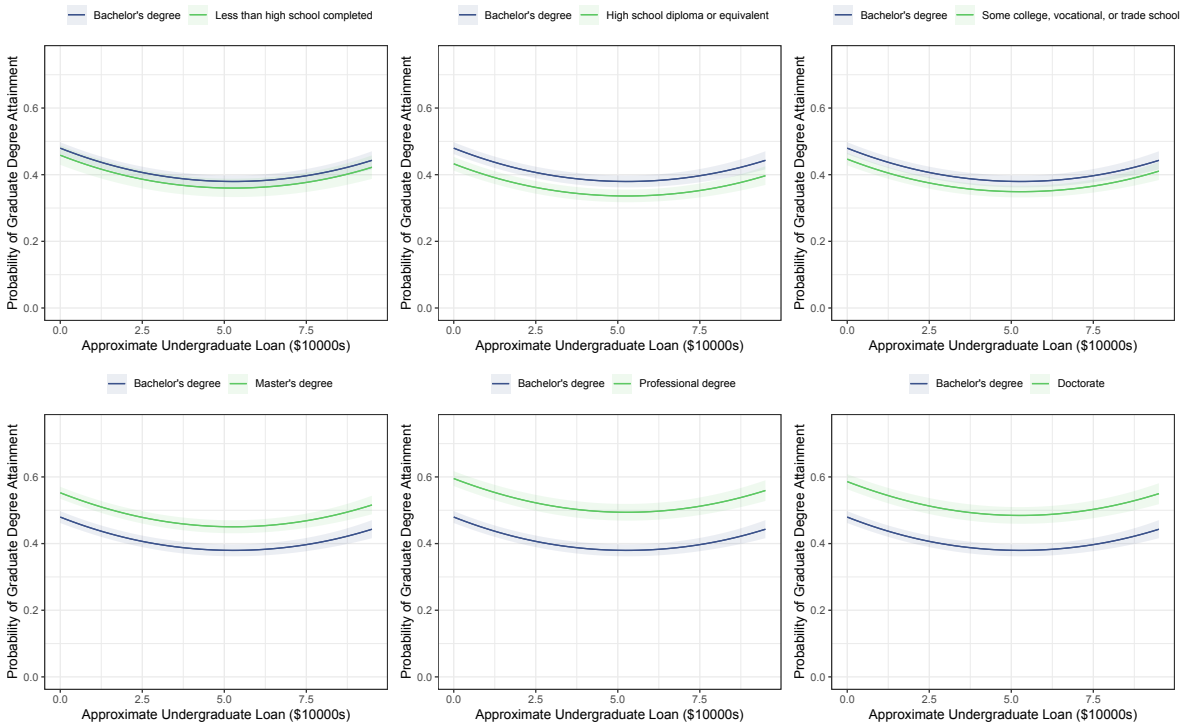


Notes: This figure depicts the estimated marginal effects for each loan category in Equation (5.4). The dataset is divided along the combined parental education variable, and each individual parent's education remains included in the model. Labels along the x-axis refer to the starting value for the respective loan category. The error bars represent the 95% confidence interval. Numerical estimates are presented in Table A.11.

Fixing all other factors, two individuals who differ in the education attained by their parents react to undergraduate debt in a fairly similar manner. The impact of parental education manifests not in changing the effects of each loan category but on the probability that an individual within the group attains a graduate degree. Figure 6.7 depicts the predicted probability that each group, split by parental education, invests in further education as a function of the amount borrowed for a bachelor's degree. The reference category for parents' education is "Bachelor's degree", and we observe that these predicted trends mirror the initial borrowing trends established for each group. That is, individuals with parents who hold a degree less than a bachelor's degree are consistently less likely to attain a graduate degree.

Coupled with the prevalence of higher borrowing for such individuals, there is evidence that graduate attainment is driven lower.

Figure 6.7: Predictions on the probability of graduate degree attainment as a function of undergraduate borrowing, conditioned on highest education achieved by at least one parent.



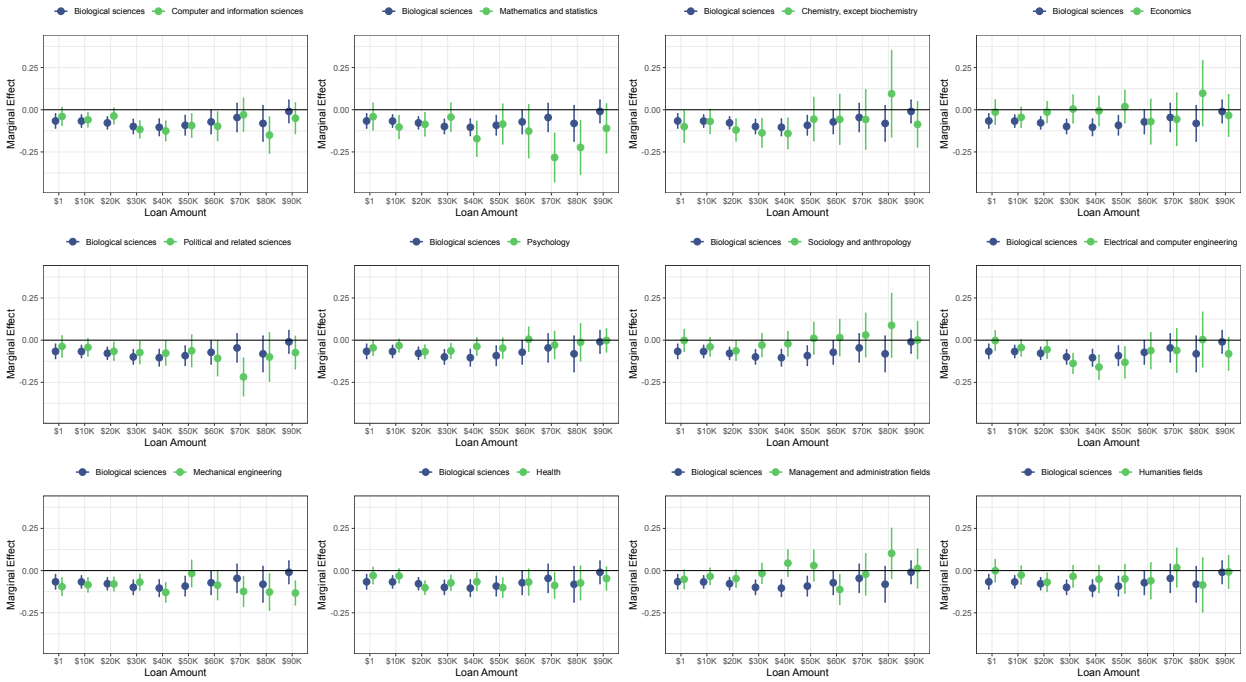
Notes: This figure depicts predictions on the likelihood of graduate degree attainment. Values are generated using Equation (5.5) and the estimated coefficients, conditional on each category of combined parental education. The loan amount is varied, and every other variable, aside from a specified value for highest parents' education, is fixed at its mean or mode.

Although we do not observe information on potential caps to borrowing, these predictions can serve as a simulated outcome for such borrowing limits. For example, an individual whose parents have at most a bachelor's degree is roughly 11.56% less likely to obtain a graduate degree than a similar counterpart whose parents have a professional degree if both are restricted to borrowing about $25,000.

6.2.3 By Field of Study

When splitting the dataset by field of study, we observe an analogous pattern to the one in Section 6.2.2 when the dataset is split by the highest educational attainment of parents. Estimation for the marginal effect on each loan category conditioned on the field of study yields negative results, but fails to produce sufficient evidence that these effects are different across majors, as shown in Figure 6.8.

Figure 6.8: Estimated marginal effects on the loan categories for Equation (5.4), conditioned on field of study.

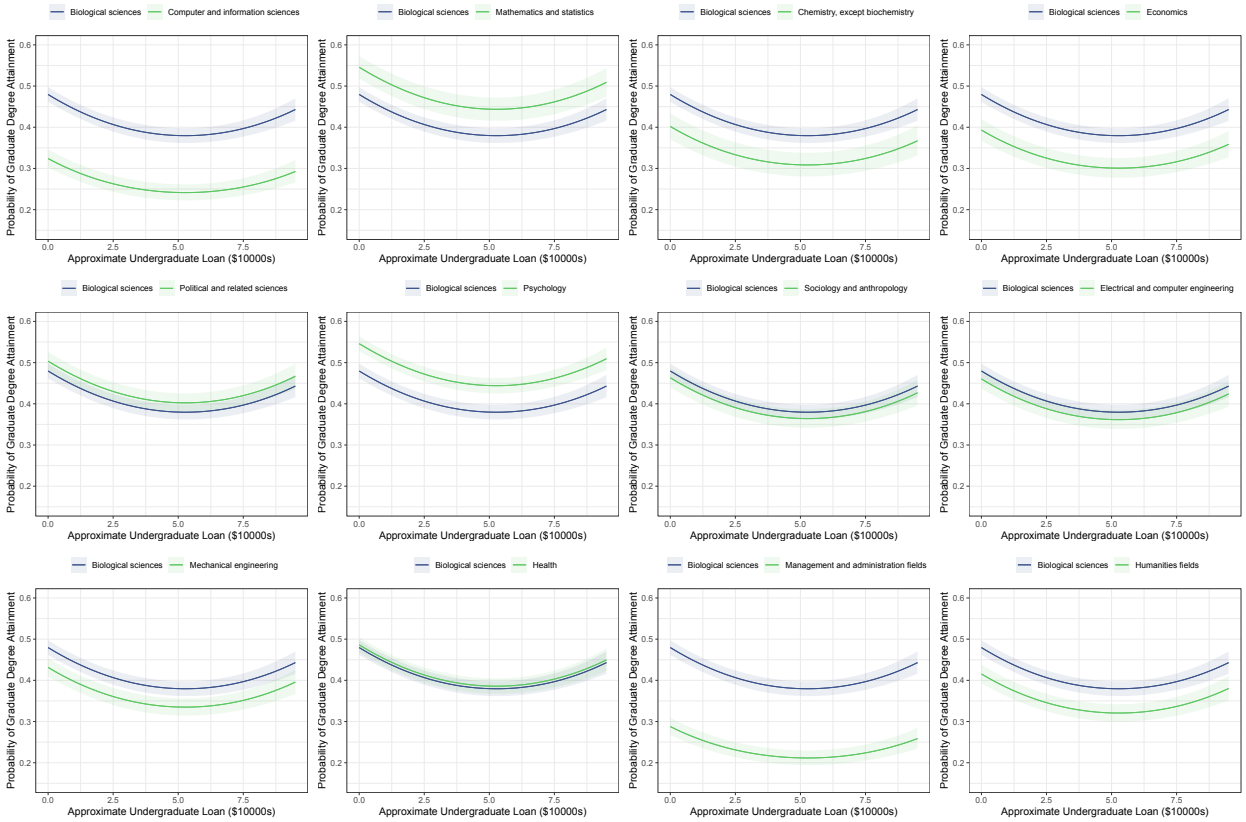


Notes: This figure depicts the estimated marginal effects on each loan category in Equation (5.4) for different fields of study. The dataset is divided along field of study; when estimating the model, the categorical variable for field of study is functionally excluded. Labels along the x-axis refer to the starting value for the respective loan category. The error bars represent the 95% confidence interval. Numerical estimates are presented in Table A.12 and Table A.13.

Differences across majors become prominent when considering the overall probability of graduate degree attainment. For example, a degree in computer and information sciences typically yields high immediate returns, and individuals who choose to major in this field are thus less likely to pursue further education in favor of entering the labor force. We see

some evidence that the presence of undergraduate loans further disincentives graduate degree attainment for this group. On the other hand, psychology degrees tend to yield lower returns until the holder obtains a post-baccalaureate degree. We see that the likelihood of graduate attainment is much higher for psychology compared to biological sciences, and subsequently most other majors represented in Figure 6.9. Put differently, the sensitivity toward the amount of loans does not vary across different groups of students, but an economics major who takes on no debt, for example, has the same probability of attaining a graduate degree as a biological sciences major who borrows approximately $25,000.

Figure 6.9: Predictions on the probability of graduate degree attainment as a function of undergraduate borrowing, conditioned on field of study.



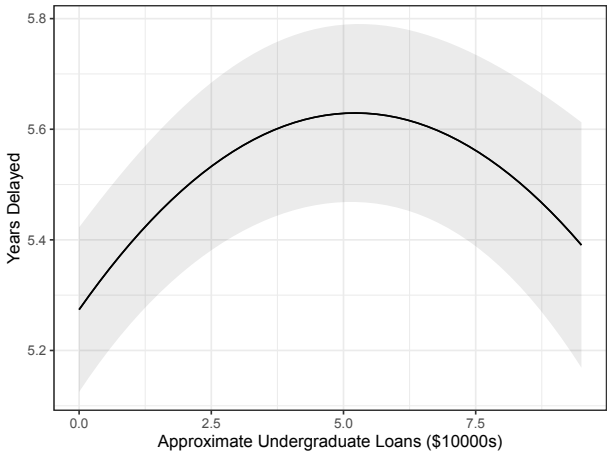
Notes: This figure depicts the predictions on the likelihood of graduate degree attainment. Values are generated using Equation (5.5) and the estimated coefficients, conditional on twelve selected fields of study. The loan amount is varied, and every other variable, aside from a specified value for field of study, is fixed at its mean or mode.

6.3 Probability of Graduate Degree Deferral

6.3.1 Estimation of Years Delayed

Estimation of Equation (5.6) provides evidence that higher levels of borrowing are correlated with an increase in the amount of time that graduate school is delayed. The coefficient $\hat{\beta}_1 = 0.136$ implies that the expected number of years between the completion of a graduate and undergraduate degree increases by 0.136 with every \$10,000 increase in the amount of undergraduate loans, offset very slightly by the non-linearity in the effect on loans; the coefficient on the squared term is $\hat{\beta}_2 = -0.013$. This relationship is depicted in Figure 6.10.

Figure 6.10: Predictions on the number of years delayed between degrees.

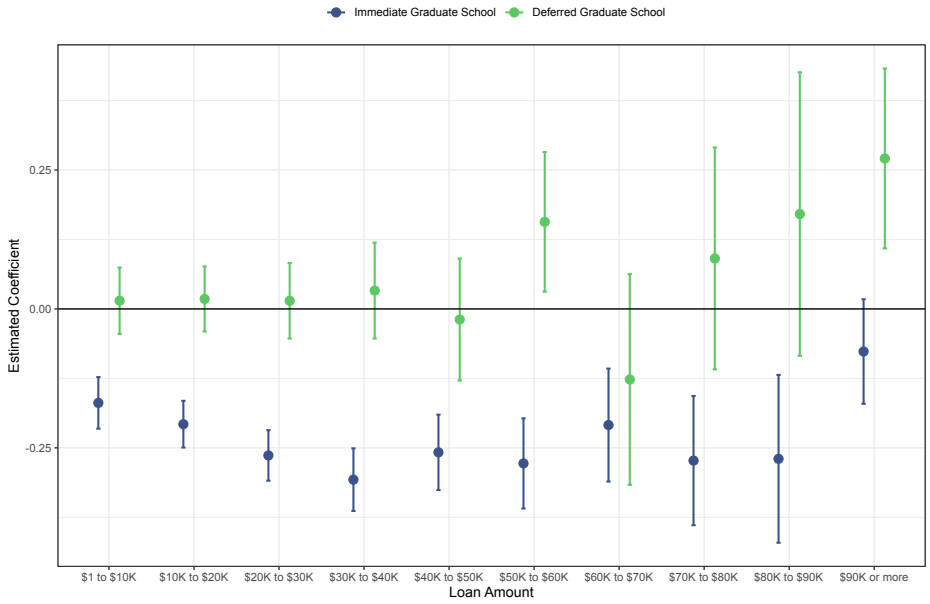


Notes: This figure depicts the predictions on the outcome variable "Years Delayed", which refers to the number of years between completion of a bachelor's degree and completion of a graduate degree. Predictions are generated using Equation (5.6) and the estimated coefficients which are presented in Table A.14. The loan amount is varied, and every other variable in the model is fixed at its mean or mode.

6.3.2 Effects on Loans for Deferral

Figure 6.11 depicts the estimated coefficients on each loan category for both choices of additional schooling. Upon separating individuals who choose to immediately obtain a graduate degree from those who defer their education, we see that there is enough evidence to reject the hypothesis that the effect of undergraduate loans is the same for both schooling decisions and conclude that borrowing affects the timing of graduate education.

Figure 6.11: Estimation of the coefficients in Equation (5.7).



Notes: This figure depicts the estimated coefficient for each loan category in Equation (5.7). The two sets of coefficients correspond to the schooling choices of immediate graduate degree attainment and deferred graduate degree attainment; the baseline category is no further education. The error bars represent the 95% confidence interval. Numerical estimates are presented in Table A.15.

This result implies that the effect of undergraduate loans loses its influence over time as individuals either begin to repay their outstanding debt or become less sensitive to holding debt. Under this interpretation, individuals defer graduate school until the incentive to continue in the labor force as a means for debt repayment tapers off. If we assume that individuals make an effort to repay their loans, a future decision to invest in graduate school relies on the amount of loans held at that time, which may be close to zero. However, I do not obtain any conclusive results on each of the loan categories which differentiate between the choices to defer graduate school or to forgo graduate school altogether.

To compute representative marginal effects on the multinomial logit model, I use the alternate specification where the loan categories are replaced with the continuous version of the variable and its corresponding squared value. For every $10,000 increase in the amount of undergraduate loans taken, the probability of no further investment increases by about

1.28%, the probability of immediate graduate school investment decreases by about 1.60%, and the probability of deferred graduate school increases by about 0.319%.

7 Discussion and Concluding Remarks

7.1 Broader Implications

Overall, the results presented in the previous section illustrate several influential factors in the decision of if and when to attend graduate school for different individuals. First, parental education, and by extension parental income, determines the financial endowment passed on to children. This endowment affects the degree of borrowing that an individual must adopt when financing a bachelor's degree. At the same time, the field of study that the individual chooses introduces an additional factor that will influence borrowing if the individual is forward-looking and anticipates that the returns to such a degree will recover any losses incurred by taking on debt.

Upon graduation, the individual faces a choice for further investment in education. Generally, we observe a decreasing trend in graduate degree attainment with increasing levels of undergraduate borrowing. Undergraduate debt can itself act as a disincentive for further borrowing and limit access to external sources of funding for additional investments in education at the graduate level. If borrowing is driven directly by parental endowment, then graduate school attainment becomes a function of parents' education, and upwards movement in educational attainment throughout familial generations becomes limited. When the margin between the returns of a graduate degree and the returns of a bachelor's degree is not sufficiently large, students are more likely to forgo a graduate program in favor of entering the labor force, especially if they are risk averse.

Finally, the individual has an additional option to defer a graduate degree. We observe an increase in the amount of years delayed for graduate school with increasing levels of

undergraduate borrowing. Assuming this time is spent in the labor force, the wages earned through delay lessens the constraint brought upon by debt, and the sensitivity toward such debt diminishes over time to a level where an individual feels comfortable enough to make an additional investment in schooling. No matter the level of education eventually achieved, this cycle repeats itself; individuals in the current generation pass on their wealth to a future generation which takes the endowment and re-invests it into education.

7.2 Limitations

The most notable limitation to the results presented in this paper is the measurement error on the loan amounts used in estimating the regressions throughout this paper. The National Survey of College Graduates only provides loan data in the form of categorical bins of $10,000. It is reasonable to hypothesize that the sensitivity to these loans vary even within the categories. In regressions which use a continuous variable adapted from these loan categories, the results are limited by the assumption that each bin has a largely uniform distribution.

Secondly, the results also rely on approximations for parental wealth through the use of education proxies. Although the general correlation between education and income is present, the approximation does not accurately account for outliers within each group, differing occupations, or any other financial obligations which may significantly impede the amount of wealth passed down.

Finally, the regressions in this paper do not include any regressors which estimate expected graduate loans or represent timely business cycles. Upon making investment decisions related to post-baccalaureate schooling, it is reasonable to assume that individuals are sufficiently forward-looking and account for potential debt or unemployment. If there is a perception of high debt accumulation, individuals may be deterred from graduate school, regardless of whether this expectation is actually realized. On the other hand, if the rate

of unemployment is high when an individual obtains a bachelor's degree, he might be more inclined to enroll in a graduate program if the uncertainty of finding a job and earning a wage is high.

7.3 Conclusion

This paper set out to evaluate the effects of undergraduate borrowing on an individual's decision to invest in further graduate education. Regressions estimating graduate degree attainment on the National Survey of College Graduates yield evidence of an inverse trend between the outcome and the level of undergraduate borrowing, though there is no evidence that the effects differ across groups split on parents' education and field of study within the younger subset of the data, despite general differing trends in the rate of post-baccalaureate education for these groups. Future work might address the limitations of the results outlined previously to obtain more accurate estimates for every parameter of interest discussed in this paper and to better understand the complexity behind the decisions for graduate education.

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A Appendix

Table A.1: Sample origin by survey iteration.

	Sample Origin	
Survey and Year	Returning Samples	New Samples
NSCG 2021	ACS 2013 ACS 2015 ACS 2017	ACS 2019
NSCG 2021	ACS 2011 ACS 2013 ACS 2015	ACS 2017
NSCG 2017	ACS 2009 ACS 2011 ACS 2013	ACS 2015
NSCG 2015	ACS 2009 NSRCG 2010 ACS 2011	ACS 2013
NSCG 2013	ACS 2009 NSRCG 2010	ACS 2011

Notes: This table outlines the sample origin of each iteration of the National Survey of College Graduates used in this paper. ACS refers to the American Community Survey, and NSRCG refers to the National Survey of Recent College Graduates. All samples from the NSCG 2013 are included in the dataset, and only new samples from the NSCG 2015 through 2021 are included in the dataset to prevent duplicate observations.

Table A.2: Selected samples and corresponding observations.

Survey Origin	Num. of Obs.	Share
ACS 2009	19,451	0.163
NSRCG 2010	6,935	0.058
ACS 2011	30,980	0.260
ACS 2013	12,684	0.107
ACS 2015	13,984	0.117
ACS 2017	17,619	0.148
ACS 2019	17,542	0.147
Total	119,195	1.000

Notes: This table refers to the number of samples and its share per survey origin (as specified in Table A.1) included in the dataset used for analysis.

Table A.3: Number of observations by category of loans and select demographic regressors.

Variable	Num. of. Obs	Share
Loan Category		
$0	50,939	42.736%
$1 to $10,001	13,540	11.360%
$10,001 to $20,000	16,606	13.932%
$20,001 to $30,000	13,732	11.521%
$30,001 to $40,000	8,332	6.990%
$40,001 to $50,000	5,301	4.447%
$50,001 to $60,000	3,635	3.050%
$60,001 to $70,000	2,118	1.777%
$70,001 to $80,000	1,639	1.375%
$80,001 to $90,000	948	0.795%
$90,001 or more	2,405	2.018%
Gender		
Female	58,713	49.258%
Male	60,482	50.742%
Race		
Asian only	13,165	11.045%
American Indian / Alaska Native only	861	0.722%
Black only	11,436	9.594%
White only	87,633	73.521%
Native Hawaiian / Other Pacific Islander only	595	0.499%
Multiple Race	5,505	4.618%
Hispanic		
No	104,518	87.687%
Yes	14,677	12.313%

Notes: This table presents the number of observations belonging to each group and its share of the total observations. When the loan category is converted to a continuous variable, the mean is $16,442.22, and the median is $5,000.

Table A.4: Number of observations by category of schooling outcome.

Variable	Num. of. Obs	Share
Graduate School		
No	71,190	59.726%
Yes	48,005	40.274%
Graduate Timing		
Never	71,190	59.726%
Immediate	34,485	28.932%
Deferred	13,520	11.342%

Notes: This table presents the number of observations belonging to each group and its share of the total observations. Under *Graduate Timing*, "Never" refers to observations with a bachelor's degree only, and "Immediate" refers to observations who complete a graduate degree within six years of finishing their bachelor's degree.

Table A.5: Mean and median estimates for the amount of undergraduate loans and the graduate degree rate, split by highest parental education.

Highest Parental Education	Num. of. Obs.	Median Loan	Mean Loan	Graduate Rate
Less than high school completed	6,245	5,000	16,098.48	33.611%
High school diploma or equivalent	19,377	15,000	18,470.61	34.107%
Some college, vocational, or trade school	25,015	15,000	19,852.29	36.490%
Bachelor's degree	31,017	5,000	16,245.29	38.366%
Master's degree	23,061	5,000	14,859.29	46.867%
Professional degree	6,794	0	10,047.10	53.371%
Doctorate	6,976	0	11,026.38	52.623%
Not applicable	710	5,000	18,387.32	23.099%

Notes: This table presents the estimates of the median and mean loan value which are calculated by assuming that each observation borrows the middle value of the loan category in which they belong. Highest parental education refers to the highest level of education attained by at least one parent. The graduate rate refers to the proportion of individuals within the parental education group who hold a master's or professional degree. The mean loan and graduate rate estimates match the ones depicted in Figure 4.1.

Table A.6: Mean and median estimates for the amount of undergraduate loans and the graduate degree rate, split by field of study.

Field of Study	Num. of. Obs	Median Loan	Mean Loan	Graduate Rate
Computer and mathematical sciences				
Computer and information sciences (11)	6,244	5,000	16,191.54	26.714%
Mathematics and statistics (12)	3,451	5,000	13,803.25	49.232%
Life and related sciences				
Agricultural and food sciences (21)	1,363	5,000	13,180.48	30.814%
Biological sciences (22)	10,898	5,000	17,062.76	45.082%
Environmental life sciences (23)	1,541	5,000	15,188.19	31.862%
Physical and related sciences				
Chemistry, except biochemistry (31)	2,752	5,000	15,187.14	36.337%
Earth, atmospheric and ocean sciences (32)	3,699	5,000	14,435.10	37.660%
Physics and astronomy (33)	1,174	5,000	16,209.54	51.874%
Other physical sciences (34)	132	15,000	18143.94	35.606%
Social and related sciences				
Economics (41)	4,029	5,000	13,684.54	40.258%
Political and related sciences (42)	5,943	5,000	16,463.91	52.16221%
Psychology (43)	10,300	15,000	18,888.83	50.631%
Sociology and anthropology (44)	4,720	15,000	18,175.85	43.263%
Other social sciences (45)	2,799	5,000	16,872.10	43.837%
Engineering				
Aerospace, aeronautical and astronautical engineering (51)	1,069	5,000	17,614.59	52.479%
Chemical engineering (52)	2,479	5,000	13,803.95	31.303%
Civil and architectural engineering (53)	3,699	5,000	15,029.74	34.901%
Electrical and computer engineering (54)	6,532	5,000	13,959.74	37.201%
Industrial engineering (55)	1,300	5,000	14,773.08	37.077%
Mechanical engineering (56)	6,446	5,000	16,021.56	35.014%
Other engineering (57)	2,620	5,000	16,437.02	40.344%
S&E-related fields				
Health (61)	8,853	15,000	19,624.42	43.420%
Science and mathematics teacher education (62)	1,162	5,000	14,845.09	44.578%
Technology and technical fields (63)	1,649	5,000	15,958.16	18.496%
Other S&E related fields (64)	1,283	15,000	18,472.33	36.399%
Non-S&E fields				
Management and administration fields (71)	7,732	5,000	14,801.47	27.664%
Education, except science and math teacher education (72)	3,094	5,000	16,194.25	46.283%
Social service and related fields (73)	1,485	15,000	18,501.68	52.525%
Sales and marketing fields (74)	1,137	5,000	14,349.16	22.339%
Art and humanities fields (75)	6,579	5,000	17,168.26	45.341%
Other non-S&E fields (76)	5,243	5,000	17,332.63	34.637%

Notes: This table presents estimates of the median and mean loan values which are calculated by assuming that each observation borrows the middle value of the loan category in which they belong. The graduate rate refers to the proportion of individuals within the field of study group who hold a master's or professional degree. The number in parentheses refers to the survey assigned code and matches the numerical labels in Figure 4.2.

Table A.7: Estimated coefficients on each category of parents' education for Equation (5.1), Equation (5.2), and Equation (5.3).

	Dependent Variable: Loan Amount		
	(1)	(2)	(3)
(Intercept)	16245.285***	17062.764***	17190.375***
	(126.492)	(215.531)	(240.502)
Highest Parental Education (Reference: Bachelor's degree)			
Less than high school	−146.806		−249.485
	(297.059)		(296.137)
High school diploma	2225.325***		2172.858***
	(204.330)		(204.217)
Some college, vocational, or trade school	3607.004***		3437.254***
	(193.430)		(193.431)
Master's degree	−1385.999***		−1423.189***
	(191.939)		(191.642)
Professional degree	−6198.184***		−6461.128***
	(270.209)		(271.547)
Doctorate	−5218.909***		−5296.953***
	(270.304)		(270.912)
Not applicable	2142.039*		2095.087*
	(910.683)		(908.518)
R^2	0.015	0.006	0.022
Adj. R^2	0.015	0.006	0.021
Num. obs.	119195	119195	119195

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: This table presents the estimated coefficients for each linear loan specification. Column (1) presents the estimated coefficients for the model containing only parental education; column (2) presents the estimated coefficients for the model containing only field of study; and column (3) presents estimates for the model containing both regressors. The estimates in this table match the ones displayed in Figure 6.1.

Table A.8: Estimated coefficients on each category of field of study for Equation (5.1), Equation (5.2), and Equation (5.3).

	Dependent Variable: Loan Amount		
	(1)	(2)	(3)
(Intercept)	16245.285***	17062.764***	17190.375***
	(126.492)	(215.531)	(240.502)
Field of Study (Reference: Biological sciences)			
Computer and information sciences		−871.220*	−1296.084***
		(353.657)	(351.836)
Mathematics and statistics		−3259.518***	−3289.033***
		(402.547)	(399.039)
Agricultural and food sciences		−3882.280***	−4523.176***
		(557.891)	(557.312)
Environmental life sciences		−1874.574**	−2190.945***
		(543.538)	(540.322)
Chemistry, except biochemistry		−1875.627***	−2235.567***
		(450.428)	(446.217)
Earth, atmospheric, and ocean sciences		−2627.660***	−2756.352***
		(546.498)	(539.614)
Economics		−3378.227***	−2946.272***
		(392.738)	(388.741)
Psychology		1826.071***	1445.355***
		(318.498)	(315.587)
Chemical engineering		−3258.811***	−3266.254***
		(477.005)	(472.497)
Civil and architectural engineering		−2033.026***	−2280.547***
		(403.108)	(400.069)
Electrical and computer engineering		−3103.027***	−3376.475***
		(336.033)	(333.847)
Industrial engineering		−2289.687***	−2628.837***
		(635.755)	(630.954)
Mechanical engineering		−1041.200**	−1225.735***
		(350.604)	(348.439)
Health		2561.657***	1774.102***
		(335.833)	(334.372)
Science and mathematics teacher education		−2217.669**	−2865.837***
		(611.597)	(609.578)
Technology and technical fields		−1104.607	−2043.444***
		(550.293)	(552.400)
Management and administration fields		−2261.289***	−2971.445***
		(320.953)	(319.957)
Education, except science and math		−868.517	−1676.844***
		(435.545)	(434.415)
Sales and marketing fields		−2713.599***	−3287.932***
		(646.092)	(643.417)
R^2	0.015	0.006	0.022
Adj. R^2	0.015	0.006	0.021
Num. obs.	119195	119195	119195

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: This table continues on from Table A.7. Column (1) presents the estimated coefficients for the model containing only parental education; column (2) presents the estimated coefficients for the model containing only field of study; and column (3) presents estimates for the model containing both regressors. Only fields of study which are significant at the level of $p < 0.001$ in (3) are included in the table for clarity. The estimates in this table match the ones displayed in Figure 6.2.

Table A.9: Estimated marginal effects for Equation (5.4).

	Marginal Effects: Loan Category			
	(1)	(2)	(3)	(4)
\$1 to \$10,000	−0.03010***	−0.03280***	−0.02519***	−0.02336***
	(0.00461)	(0.00459)	(0.00457)	(0.00452)
\$10,001 to \$20,000	−0.03784***	−0.04758***	−0.02034***	−0.03262***
	(0.00425)	(0.00418)	(0.00423)	(0.00415)
\$20,001 to \$30,000	−0.06162***	−0.07080***	−0.02950***	−0.04226***
	(0.00451)	(0.00444)	(0.00459)	(0.00449)
\$30,001 to \$40,000	−0.07938***	−0.08591***	−0.04196***	−0.04955***
	(0.00545)	(0.00536)	(0.00560)	(0.00550)
\$40,001 to \$50,000	−0.07801***	−0.08776***	−0.03957***	−0.04730***
	(0.00663)	(0.00648)	(0.00682)	(0.00669)
\$50,001 to \$60,000	−0.07173***	−0.08330***	−0.03387***	−0.04077***
	(0.00792)	(0.00772)	(0.00809)	(0.00795)
\$60,001 to \$70,000	−0.08014***	−0.08594***	−0.04018***	−0.04220***
	(0.01014)	(0.00989)	(0.01039)	(0.01019)
\$70,001 to \$80,000	−0.07645***	−0.07991***	−0.03953***	−0.04272***
	(0.01151)	(0.01130)	(0.01182)	(0.01165)
\$80,001 to \$90,000	−0.06591***	−0.06605***	−0.03593*	−0.03716*
	(0.01516)	(0.01491)	(0.01537)	(0.01513)
\$90,001 or more	−0.02714**	−0.02355*	−0.00323	−0.00051
	(0.00993)	(0.00978)	(0.00995)	(0.00984)
Demographic Controls		✓		✓
Education Controls			✓	✓
Log Likelihood	−80108.04704	−78580.19915	−76564.21254	−75050.17386
Num. obs.	119195	119195	119195	119195

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: This table presents the estimated marginal effects for each loan category in Equation (5.4) on the complete processed dataset. Demographic controls refer to age, age squared, gender, race, and ethnicity. Education controls include both parents' educational background, year of bachelor's attainment, public or private institution status, and field of study. The predicted marginal effect on the loan variable when taken as a continuous value in Equation (5.5) is -0.02165^{***} with standard error 0.001. The marginal effect on the loan value squared is 0.002^{***} with standard error 0.0002. Values in column (4) match the ones displayed in Figure 6.3.

Table A.10: Estimated marginal effects for Equation (5.4), split along age.

	Marginal Effects: Loan Category	
	(1) Older Group	(2) Younger Group
\$1 to \$10,000	−0.00759	−0.04070***
	(0.00586)	(0.00685)
\$10,001 to \$20,000	−0.01808**	−0.04991***
	(0.00583)	(0.00569)
\$20,001 to \$30,000	−0.01351*	−0.06963***
	(0.00689)	(0.00574)
\$30,001 to \$40,000	−0.01473	−0.07274***
	(0.00896)	(0.00673)
\$40,001 to \$50,000	−0.00355	−0.07908***
	(0.01128)	(0.00797)
\$50,001 to \$60,000	−0.00972	−0.06690***
	(0.01345)	(0.00945)
\$60,001 to \$70,000	−0.02292	−0.06418***
	(0.01890)	(0.01149)
\$70,001 to \$80,000	−0.00600	−0.06751***
	(0.02260)	(0.01291)
\$80,001 to \$90,000	−0.01136	−0.05926***
	(0.02956)	(0.01689)
\$90,001 or more	0.10502***	−0.04543***
	(0.01999)	(0.01081)
Log Likelihood	−37619.52505	−35477.32625
Num. obs.	59045	60150

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: This table presents the estimated marginal effects on each loan category in Equation (5.4) on two different groups. The younger group refers to the subset of observations 34 years or younger. When taken as a continuous variable, the marginal effect on the loan is -0.031^{***} with standard error 0.002. The marginal effect on the loan value squared is 0.003^{***} with standard error 0.0003. The estimates in this table match the ones displayed in Figure 6.5.

Table A.11: Estimated marginal effects for Equation (5.4), split by highest parental education.

	Marginal Effects: Loan Category						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
\$1 to \$10,000	−0.06516*	−0.07055***	−0.00595	−0.04764***	−0.02082	−0.11234**	−0.03487
	(0.02795)	(0.01767)	(0.01521)	(0.01271)	(0.01546)	(0.03480)	(0.03069)
\$10,001 to \$20,000	−0.03610	−0.02434	−0.05418***	−0.03129**	−0.07749***	−0.07161*	−0.03898
	(0.02641)	(0.01565)	(0.01223)	(0.01064)	(0.01236)	(0.02947)	(0.02631)
\$20,001 to \$30,000	−0.06916**	−0.06357***	−0.05668***	−0.06690***	−0.08247***	−0.06693*	−0.08893**
	(0.02520)	(0.01543)	(0.01233)	(0.01054)	(0.01281)	(0.02927)	(0.02831)
\$30,001 to \$40,000	−0.07339*	−0.04174*	−0.06871***	−0.08174***	−0.08482***	−0.05581	−0.06750*
	(0.03010)	(0.01757)	(0.01400)	(0.01207)	(0.01598)	(0.03666)	(0.03411)
\$40,001 to \$50,000	−0.05829	−0.05532**	−0.08406***	−0.09654***	−0.07712***	−0.04693	−0.03826
	(0.03692)	(0.02002)	(0.01594)	(0.01438)	(0.01951)	(0.04371)	(0.03935)
\$50,001 to \$60,000	−0.15486***	−0.04708*	−0.03778*	−0.07105***	−0.07651**	−0.10328*	−0.03070
	(0.03759)	(0.02321)	(0.01850)	(0.01734)	(0.02425)	(0.05194)	(0.04959)
\$60,001 to \$70,000	−0.05717	−0.00924	−0.06582**	−0.06329**	−0.09149***	−0.16375**	−0.04632
	(0.05797)	(0.02892)	(0.02172)	(0.02182)	(0.02683)	(0.06261)	(0.06353)
\$70,001 to \$80,000	0.00880	−0.03638	−0.03681	−0.09905***	−0.05980	−0.10467	−0.20508**
	(0.06378)	(0.03204)	(0.02543)	(0.02328)	(0.03141)	(0.06695)	(0.06647)
\$80,001 to \$90,000	0.01759	−0.07175	−0.02983	−0.02631	−0.11318**	−0.22489*	−0.13165
	(0.07778)	(0.03830)	(0.03288)	(0.03155)	(0.04084)	(0.08979)	(0.09142)
\$90,001 or more	0.01234	−0.01727	−0.02574	−0.04888*	−0.08160***	−0.04219	−0.04633
	(0.06151)	(0.02870)	(0.02275)	(0.02028)	(0.02368)	(0.04760)	(0.05209)
Log Likelihood	−1353.31469	−4181.17362	−7078.46141	−9872.19269	−8042.90123	−2222.73586	−2345.28724
Num. obs.	2462	7449	12208	16949	13180	3704	3878

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: This table presents estimated marginal effects on the loan categories when split by groups as follows: (1) Less than high school completed; (2) High school diploma or equivalent; (3) Some college, vocational, or trade school; (4) Bachelor's degree; (5) Master's degree; (6) Professional degree; and (7) Doctorate. The estimates in this table match the ones displayed in Figure 6.6.

Table A.12: Estimated marginal effects for Equation (5.4), split by field of study.

	Marginal Effects: Loan Category						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
\$1 to \$10,000	−0.04106	−0.03944	−0.06627**	−0.09983*	−0.01390	−0.03721	−0.04553*
	(0.04022)	(0.02693)	(0.02166)	(0.04740)	(0.03698)	(0.03180)	(0.02243)
\$10,001 to \$20,000	−0.10273**	−0.05940**	−0.06703***	−0.06890	−0.04476	−0.04270	−0.03225
	(0.03433)	(0.02136)	(0.01844)	(0.03641)	(0.03046)	(0.02627)	(0.01918)
\$20,001 to \$30,000	−0.08649*	−0.03667	−0.07773***	−0.11974***	−0.01420	−0.06600*	−0.06818***
	(0.03517)	(0.02366)	(0.01816)	(0.03289)	(0.03145)	(0.02653)	(0.02010)
\$30,001 to \$40,000	−0.04373	−0.11662***	−0.09915***	−0.13696**	0.00436	−0.07347*	−0.06331**
	(0.04221)	(0.02528)	(0.02152)	(0.04304)	(0.04221)	(0.03353)	(0.02200)
\$40,001 to \$50,000	−0.17185**	−0.12578***	−0.10384***	−0.14083**	−0.00673	−0.07685*	−0.03729
	(0.05291)	(0.02967)	(0.02504)	(0.04593)	(0.04435)	(0.03607)	(0.02630)
\$50,001 to \$60,000	−0.08485	−0.09375**	−0.09192**	−0.05586	0.01901	−0.06298	−0.04720
	(0.06010)	(0.03527)	(0.02933)	(0.06543)	(0.04894)	(0.04746)	(0.03033)
\$60,001 to \$70,000	−0.12671	−0.09769*	−0.07191*	−0.05691	−0.07033	−0.10736*	0.00551
	(0.08004)	(0.04302)	(0.03550)	(0.07527)	(0.06739)	(0.05254)	(0.03615)
\$70,001 to \$80,000	−0.28289***	−0.02954	−0.04581	−0.05748	−0.05609	−0.21795***	−0.02856
	(0.07312)	(0.04968)	(0.04256)	(0.08971)	(0.07875)	(0.05676)	(0.04070)
\$80,001 to \$90,000	−0.22330**	−0.15020**	−0.08098	0.09503	0.09753	−0.09984	−0.01242
	(0.08125)	(0.05471)	(0.05371)	(0.13033)	(0.09793)	(0.07283)	(0.05598)
\$90,001 or more	−0.11019	−0.05021	−0.00992	−0.08657	−0.03379	−0.07370	−0.00170
	(0.07410)	(0.04616)	(0.03407)	(0.06848)	(0.06260)	(0.04886)	(0.03476)
Log Likelihood	−1114.49309	−1514.79275	−3676.62349	−721.32172	−1149.59232	−1906.03530	−3568.72563
Num. obs.	1809	2985	6092	1278	2078	3116	5884

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: This table presents the estimated marginal effects on the loan categories when split by group as follows: (1) Mathematics and statistics; (2) Computer and information sciences; (3) Biological sciences; (4) Chemistry, except biochemistry; (5) Economics; (6) Political and related sciences; and (7) Psychology. The estimates in this table match the ones displayed in Figure 6.8.

Table A.13: Estimated marginal effects for Equation (5.4), split by field of study (continued).

	Marginal Effects: Loan Category					
	(1)	(2)	(3)	(4)	(5)	(6)
\$1 to \$10,000	−0.00158	−0.00240	−0.09526***	−0.02951	−0.05134	−0.00077
	(0.03285)	(0.02960)	(0.02628)	(0.02467)	(0.02825)	(0.03352)
\$10,001 to \$20,000	−0.03940	−0.04429	−0.08433***	−0.03134	−0.03418	−0.02636
	(0.02766)	(0.02473)	(0.02147)	(0.02091)	(0.02466)	(0.02722)
\$20,001 to \$30,000	−0.06315*	−0.05537*	−0.07936***	−0.10119***	−0.04724	−0.06892*
	(0.02836)	(0.02670)	(0.02042)	(0.02009)	(0.02576)	(0.02743)
\$30,001 to \$40,000	−0.02884	−0.13766***	−0.06848**	−0.07260**	−0.01694	−0.03413
	(0.03445)	(0.02954)	(0.02381)	(0.02256)	(0.03016)	(0.03228)
\$40,001 to \$50,000	−0.02173	−0.15943***	−0.12893***	−0.06594*	0.04442	−0.05046
	(0.03693)	(0.03636)	(0.02918)	(0.02645)	(0.03980)	(0.04044)
\$50,001 to \$60,000	0.01123	−0.13159**	−0.01701	−0.10131***	0.02996	−0.04887
	(0.04773)	(0.04692)	(0.03995)	(0.02871)	(0.04642)	(0.04315)
\$60,001 to \$70,000	0.01537	−0.06182	−0.08604	−0.06790	−0.11202*	−0.06037
	(0.05446)	(0.05416)	(0.04405)	(0.03906)	(0.04514)	(0.05419)
\$70,001 to \$80,000	0.03037	−0.06100	−0.12340**	−0.08798*	−0.02224	0.01785
	(0.06549)	(0.06570)	(0.04509)	(0.03797)	(0.06212)	(0.05817)
\$80,001 to \$90,000	0.08799	0.00360	−0.12690*	−0.07327	0.10195	−0.08518
	(0.09604)	(0.08242)	(0.05502)	(0.05100)	(0.07544)	(0.08156)
\$90,001 or more	0.00095	−0.08079	−0.13276***	−0.04703	0.01241	−0.00739
	(0.05579)	(0.04902)	(0.03598)	(0.03463)	(0.05870)	(0.04908)
Log Likelihood	−1584.62786	−1756.85984	−2027.06129	−2810.39867	−1449.98664	−1696.60077
Num. obs.	2644	2998	3685	4843	2709	2827

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: This table presents the estimated marginal effects on the loan categories when split by group as follows: (1) Sociology and anthropology; (2) Electrical and computer engineering; (3) Mechanical engineering; (4) Health; (5) Management and administration fields; and (6) Arts and humanities. The estimates in this table match the ones displayed in Figure 6.8.

Table A.14: Estimated coefficients for Equation (5.6).

	Dependent Variable: Years Delayed	
	(1) Categorical Loan	(2) Continuous Loan
(Intercept)	318.696***	321.937***
	(9.345)	(9.307)
Loan Category (Reference: $0)		
$1 to $10,000	0.344***	
	(0.076)	
$10,001 to $20,000	0.312***	
	(0.059)	
$20,001 to $30,000	0.306***	
	(0.060)	
$30,001 to $40,000	0.393***	
	(0.072)	
$40,001 to $50,000	0.286**	
	(0.085)	
$50,001 to $60,000	0.362**	
	(0.096)	
$60,001 to $70,000	0.156	
	(0.112)	
$70,001 to $80,000	0.193	
	(0.123)	
$80,001 to $90,000	0.316	
	(0.162)	
$90,001 or more	0.352**	
	(0.105)	
Loan Amount		0.136***
		(0.021)
Loan Amount^2		−0.013***
		(0.003)
R^2	0.242	0.241
Adj. R^2	0.241	0.240
Num. obs.	48005	48005

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: The table presents the estimated coefficients for two versions of the model specified by Equation (5.6). In column (1), the loan variable is given as the original categories observed in the survey; in column (2), the loan variable is given as the continuous approximation. These coefficients are used to compute the predictions in Figure 6.10.

Table A.15: Estimated coefficients for Equation (5.7).

	Dependent Variable: Schooling Choice	
	(1) Immediate Grad. Education	(2) Deferred Grad. Education
(Intercept)	89.336***	162.652***
	(3.277)	(4.590)
Loan Category (Reference: $0)		
$1 to $10,000	−0.169***	0.015
	(0.024)	(0.030)
$10,001 to $20,000	−0.207***	0.018
	(0.021)	(0.030)
$20,001 to $30,000	−0.264***	0.015
	(0.0232)	(0.035)
$30,001 to $40,000	−0.307***	0.033
	(0.035)	(0.044)
$40,001 to $50,000	−0.258***	−0.019
	(0.035)	(0.056)
$50,001 to $60,000	−0.278***	0.157*
	(0.041)	(0.064)
$60,001 to $70,000	−0.209***	−0.127
	(0.052)	(0.097)
$70,001 to $80,000	−0.273***	0.091
	(0.059)	(0.102)
$80,001 to $90,000	−0.270***	0.171
	(0.077)	(0.130)
$90,001 or more	−0.077	0.271**
	(0.048)	(0.083)
Log Likelihood	-98971.07	
Num. obs.	119195	

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

Notes: This table presents the estimated coefficients for the multinomial logit model defined by Equation (5.7). Columns in this table refer to different sets of coefficients within the same model. The baseline (reference) category for the multinomial logit model is "No graduate school". Values presented in this table match the ones displayed in Figure 6.11.