

Debt Dilemma: Effects of College Student Loans on Higher Education and Labor Market Outcomes *

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Abstract

We examine the impact of college student loans on education and labor market outcomes using data from the National Survey of College Graduates (NSCG). Eligibility for federal loans is restricted to U.S. citizens and permanent residents, while non-permanent residents can only access commercial loans. By leveraging the interaction between the interest rate differential between commercial and federal loans and federal loan eligibility as an instrumental variable for college student loans, our analysis reveals that college graduates who borrow more due to changes in federal interest rates are more inclined to pursue graduate degrees and opt for higher-paying majors. However, despite the increase in educational attainment, this does not translate into enhancements in their labor market outcomes, such as hourly wages and annual earnings, as they encounter challenges in securing occupations aligned with their most recent post-secondary degree.

Keywords: student loan, interest rates, graduate education, labor market outcomes

JEL: I23, J24, H81

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1. Introduction

The increasing reliance on student loans to finance higher education has become a defining characteristic of the modern U.S. education system. While student loans have expanded access to college for many, they also pose significant financial risks and long-term consequences for borrowers. These risks are complex, extending beyond mere repayment challenges and affecting educational and career decisions. This paper explores how college student loans impact graduates' choices regarding further education and their subsequent labor market outcomes.

One challenge in studying this research question is that the amount of student loan debt is influenced by students' abilities and family backgrounds, which directly impact students' educational and labor market outcomes.¹ To address this challenge, we utilize the rule that only U.S. citizens and permanent residents are eligible for federal student loans, whereas non-permanent residents can only access commercial loans. Therefore, if the interest rate differential between commercial and federal loans increases, we would expect the amount of student debt to increase more for eligible students compared to non-eligible students. Using data from the National Survey of College Graduates (NSCG), we demonstrate that this relationship exists: when the interest rate of commercial loans is 1 percentage point higher than that of federal loans, eligible college students borrow an average of \$2,529 more than non-eligible students during their college years. Additionally, the likelihood of taking out a loan increases by 4.8 percentage points.

Next, we use the interest rate differential between commercial and federal loans, interacting with the eligibility status for federal loans, as an instrument to measure the impact of the amount of college student loans on various educational and labor market outcomes. Our analysis reveals that an increase in college loans does not significantly raise the likelihood of pursuing a high-paying college major or a double major. However, a \$1,000 increase in college loans leads to a 2.1 percentage point increase in the likelihood of obtaining a graduate degree and a 1.6 percentage point increase in the likelihood of choosing a high-paying graduate major. This effect may be driven by the incentive to achieve higher lifetime earnings through graduate education to facilitate debt repayment, and/or the reduced cost of graduate school due to

¹Students abilities and family backgrounds can also affect college tuitions and financial aids, which will also influence student loan debt.

the deferment of debt repayment during graduate studies.

We also find that students who borrow more for college tend to borrow more for graduate school as well. Specifically, a \$1,000 increase in college loans results in a 1.6 percentage point increase in the likelihood of taking out graduate loans and a \$1,101 increase in the amount of graduate school loans.² This suggests that high school graduates who face low federal interest rates not only accumulate more college loans but also more graduate loans, leading to higher overall debt levels upon entering the labor market.

Despite achieving higher educational attainment, we find no evidence that increased borrowing leads to better labor market outcomes. There are no significant improvements in hourly wages, annual earnings, employment rates, or the likelihood of full-time employment. Although a higher level of college debt encourages graduates to pursue high-paying graduate majors, their chances of working in high-paying occupations do not increase. Furthermore, a \$1,000 increase in college loans results in a 1.3 percentage point decline in the likelihood of individuals working in occupations related to their major. These findings suggest that marginal students, whose borrowing behaviors are influenced by interest rates, fail to translate higher educational attainment into better labor market outcomes. This may be due to the intense competition, which prevents them from securing jobs that match their graduate majors.

We also use the American Community Survey (ACS) to examine whether the interest rate differential affects college enrollment and completion decisions. We find that a 1 percentage point increase in the interest rate difference between commercial and federal loans can increase the likelihood of attending college by 0.2 percentage points. However, it does not increase the chance of obtaining a college degree, as marginal students are more likely to drop out. This finding also reassures that our previous analysis using college graduates from the NSCG is not subject to sample selection bias. Using the ACS data, we also find no evidence that the interest rate differential improves labor market outcomes, confirming the findings from the NSCG data.³ We also employ different measures of federal and commercial loan interest rates and

²These effects persist even when we restrict the sample to those who attend graduate school.

³One limitation to note is that the ACS data cannot distinguish between permanent residents and non-permanent residents among non-citizens. In our ACS analysis, we treat permanent residents as the control group (not eligible), which introduces measurement error. Therefore, the results using ACS should be interpreted with caution.

show that the results remain robust.

Previous studies have consistently found that borrowing constraints have negligible effects on college enrollment and completion (Keane and Wolpin, 2001; Cameron and Taber, 2004; Stinebrickner and Stinebrickner, 2008; Ionescu, 2009; Johnson, 2013).⁴ However, the literature presents mixed views on the impact of student loans on graduate studies. Some studies find that student loans lead to a decrease in graduate school enrollment (Malcom and Dowd, 2012; Folch and Mazzone, 2022; Chakrabarti et al., 2023), while others show a positive effect (Kim and Eyermann, 2006; Witteveen, 2023).⁵

Previous studies have also shown that student loans can affect a broad range of labor outcomes. For instance, Rothstein and Rouse (2011) and Sieg and Wang (2018) find that student debt leads college graduates to choose higher-paying jobs or jobs in the private sector. Velez et al. (2019) also finds that indebted students tend to have higher earnings, but Daniels Jr and Smythe (2019) shows that this is due to increased work hours rather than higher wage rates. However, Folch and Mazzone (2022) finds that student debt causes a persistent decrease in earnings growth, which is associated with a decline in graduate school enrollment.⁶

Compared with previous studies, we offer a new identification strategy to estimate the causal effect of student loans on various outcomes. Instead of using variations in tuition or grant aid as instruments for student loans, we utilize the institutional feature that only U.S. citizens and permanent residents are eligible for federal loans. We then use the interest rate differential between commercial loans and federal loans, interacting with eligibility status, as an instrument.

Using this new identification strategy, we are able to draw conclusions

⁴Marx and Turner (2019) finds that receiving a nonzero loan offer increased GPA and completed credits at a community college. Similarly, Barr et al. (2021) discovers that students who reduced their loan borrowing due to a loan campaign had worse academic performance.

⁵English and Umbach (2016) and Rothstein and Rouse (2011) find no significant association between undergraduate debt and graduate school attendance. Zhang (2013) finds that for public college graduates, college debt has a negative effect on the pursuit of doctoral, MBA, and first professional (FP) degrees, while for private college students, college debt has a positive effect on the choice of an MBA or FP program.

⁶In addition to education and labor market outcomes, the literature has consistently found that student loans delay marriage and fertility (Bozick and Estacion, 2014; Gicheva, 2016; Sieg and Wang, 2018; Velez et al., 2019).

from a broader sample. Unlike studies that rely on natural experiments or policy changes in specific colleges or states, we use nationally representative data to provide a more comprehensive picture of the impact of student loans on the general population. This approach allows us to analyze the effects on a variety of outcomes, including college major choice, pursuit of graduate degrees and graduate majors, graduate school loans, employment, occupation, and earnings.

The rest of the paper is organized as follows: Section 2 discusses the institutional background of U.S. federal student loans. Section 3 introduces the datasets used in the analysis. Section 4 details our empirical approach and identification strategy. Section 5 presents the empirical results on various educational and labor market outcomes. Section 6 conducts the robustness checks, and Section 7 concludes.

2. Background

Since its establishment in 1958 under the National Defense Education Act, the federal student loan program has played a critical role in financing American higher education. In 1993, the Direct Loan Program was introduced and under this program, the federal government lends money directly to students through their schools, eliminating the need for private lenders. As of 2023, the total student loan debt in the United States has climbed to approximately \$1.73 trillion.⁷ Of this amount, \$1.60 trillion represents the outstanding federal loan balance, accounting for 92.5% of all student loan debt.⁸ Currently, about 43.4 million Americans hold federal student loan debt, with the average student holding a federal debt of approximately \$36,900.⁹

The federal student loan program offers various types of loans to students. In 1994, William D. Ford Federal Direct Loan Program was created to simplify and streamline federal student loan borrowing. It encompasses Direct Subsidized Loans, Direct Unsubsidized Loans, and Direct PLUS loans. Direct Subsidized Loans are accessible to students with demonstrated financial need, with the federal government covering the interest during specific periods. Direct Unsubsidized Loans are available to all students, irrespective of financial

⁷Source: <https://www.federalreserve.gov/releases/g19/20231207/>.

⁸Source: <https://studentaid.gov/data-center/student/portfolio>.

⁹Source: <https://fsapartners.ed.gov/knowledge-center/library/electronic-announcements/2023-08-30/federal-student-aid-posts-new-quarterly-reports-fsa-data-ce>

need, with borrowers responsible for all interest accrued. Direct PLUS Loans are available to graduate or professional students and parents of dependent undergraduate students who pass a credit check, assisting in covering educational costs not met by other financial aid. Subsidized and unsubsidized loans generally feature lower interest rates compared to PLUS loans and private loans. In the period between 2010 and 2011, subsidized and unsubsidized loans collectively accounted for 75% of all student loans issued, as shown in Appendix Figure B.3. Given their substantial share, our analysis primarily focuses on changes in the interest rates of these two loan types.¹⁰

Appendix Table B.4 presents the interest rates for Subsidized and Unsubsidized Direct Loans for undergraduate and graduate students during the repayment period, from 1994 to 2015.¹¹ Subsidized loans do not accrue interest while the student is enrolled at least half-time, during the six-month grace period following graduation, or during deferment periods. In contrast, unsubsidized loans begin accruing interest immediately upon disbursement. Prior to 2006, federal student loans had variable interest rates that responded to market fluctuations, with rates set to be a fixed premium to the treasury rates. For loans issued from 2006 onwards, interest rates are fixed for the loan's duration. Throughout the entire period, unsubsidized loans consistently have interest rates that are either equal to or higher than those of subsidized loans. Notably, subsidized loans have been unavailable to graduate students since 2012. Appendix Table B.5 also shows the interest rates during the in-school, grace, and deferment periods. Prior to 2006, the interest rates during these periods were slightly lower than those during the repayment periods. However, this difference no longer exists after 2006.¹²

Federal student loans (Direct Loans) are exclusively available to U.S. citizens and permanent residents, while non-permanent residents can only apply for commercial loans, which have higher interest rates. Therefore, the

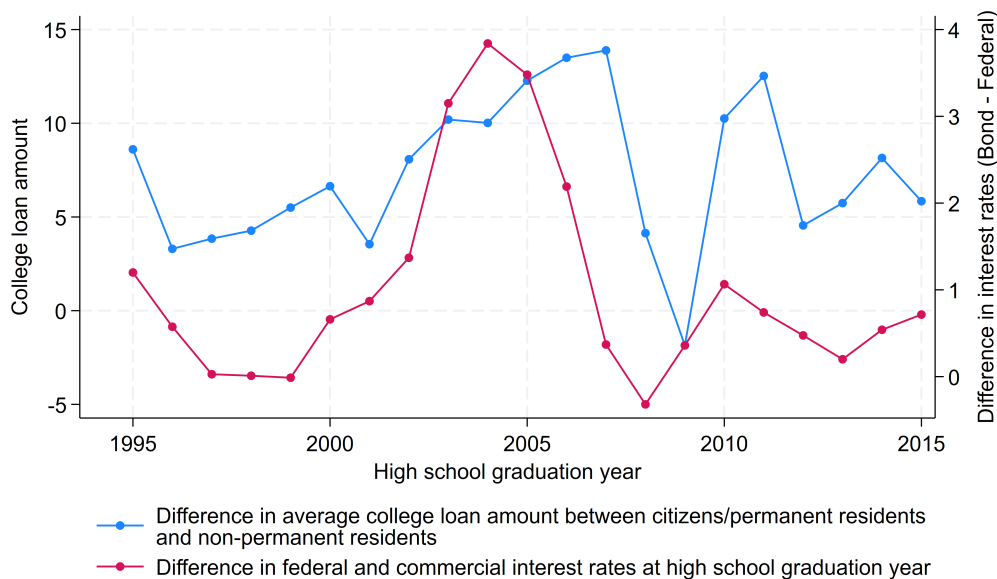
¹⁰It is also worth mentioning that non-federal loans, which encompass private loans and loans obtained from non-government entities, constituted only around 10% of the total student loans issued from 2010 to 2015. For a more comprehensive understanding of other loan types beyond subsidized and unsubsidized federal loans, please refer to the detailed information provided in Appendix Appendix B.2.

¹¹We stop in 2015 because our NSCG sample covers college graduates who entered college on or before 2015.

¹²These two loan types also differ in their interest rates and borrowing limits. Please refer to Appendix Appendix B.1 for more details.

difference in interest rates between commercial and federal loans indicates the benefits that citizens and permanent residents receive compared to non-permanent residents. Figure 1 presents how this difference has varied over time, with the Moody Baa Corporate Bond Yield serving as a proxy for commercial loan interest rates. We also plot the disparity in the amount of college loans borrowed by citizens and permanent residents versus non-permanent residents on the same graph. From 2000 to 2005, both the interest rate difference and loan difference increased. After 2005, the interest rate difference decreased, and so did the loan difference.

Figure 1: The Trends in the Differences in Interest Rates and College Loans



3. Data

We use the public version of the NSCG data from 2010 to 2019, which includes the 2010, 2013, 2015, 2017, and 2019 waves. The NSCG is a subset of the Scientists and Engineers Statistical Data System (SESTAT) sponsored by the National Center for Science and Engineering Statistics within the

National Science Foundation (NSF).¹³ Each wave is a stratified nationally representative sample of people with at least a Bachelor’s degree, living in the U.S., and between 23 and 76 years old. We use the NSCG data as multiple-year cross-sectional data and construct weights to make the pooled sample representative of the U.S. population of college graduates over the years of our sample. We apply weights throughout the analysis.

The NSCG is a rich dataset that contains detailed information on student loans, college and graduate school outcomes, and labor market outcomes. It includes data on the total amount of loans individuals have borrowed in the survey year to finance undergraduate and graduate degrees, as well as information on the type and major (including second major) of each degree individuals have at the bachelor’s level or higher. The NSCG also provides comprehensive information on labor market outcomes, such as employment status, working hours, annual salary, and occupation. Additionally, the NSCG gathers data on US citizenship and permanent resident status, as well as the time of obtaining permanent residency. This is crucial for our analysis, as both US citizens and permanent residents are eligible for federal student loans. Appendix Tables C.7 and C.8 present the summary statistics of the variables used in our analysis. We focus on a sample of college graduates who completed their high school on or after 1994 (the starting year of William D.Ford Federal Direct Loan Program), which contains 140,837 observations. Among them, 60% of college graduates have taken loans for college, and the average college loan amount is 20,003 USD.

However, the NSCG only covers individuals with at least a Bachelor’s degree, and there is a concern that the federal loan interest rate may affect individuals’ decisions to enroll and complete college. To address this concern, we also use the 2010-2019 waves of the American Community Survey (ACS). The ACS is an annual demographics survey program conducted by the U.S. Census Bureau that collects information on US citizenship status, educational attainment, income, and employment. The ACS includes both individuals with and without college degrees, allowing us to study the effects of federal loan interest rates on selection into college. However, the ACS does not

¹³Since 2010, the NSCG has used a rolling panel sampling structure. The 2010 NSCG sample is a representative subset of people in the 2010 American Community Survey (ACS) with a Bachelor’s degree. Starting from 2013, three-quarters of the sample were returning respondents from the previous survey, and a quarter of the sample was new respondents from the current-year ACS sample with a Bachelor’s degree.

distinguish between permanent and non-permanent residents among non-citizens, and it also does not contain information on student loans. Therefore, we only use it as supplementary data to examine selection into college. The summary statistics for the ACS data are presented in Appendix Tables D.12 and D.13. These tables show that the NSCG data are similar to the ACS data in many respects, such as the proportion of college students who obtain a graduate degree, as well as the average earnings, wage rates, and employment rate for college graduates. This provides us with confidence that the NSCG is nationally representative after reweighting.

4. Empirical Approach

To study the impact of college student loans on education and labor market outcomes, we need to address the challenge that the amount of student loans borrowed by college students is often correlated with family background and student ability, which can affect the outcome variables. To overcome this endogeneity issue, we employ the instrumental variable approach. Specifically, we utilize the fact that only US citizens and permanent residents are eligible for federal loans, whereas non-permanent residents can only apply for commercial loans. As there is a discrepancy in interest rates between federal and commercial loans that varies over time, this discrepancy can influence the amount of student loans borrowed by citizens and permanent residents as compared to non-permanent residents. In years when the interest rates for federal loans are significantly lower than those for commercial loans, we anticipate that citizens and permanent residents will borrow more student loans relative to non-permanent residents. Thus, we conduct a first-stage regression to examine this relationship:

$$\text{ColLoan}_{it} = \beta_0 + \beta_1 1_{\text{eligible}_i} + \beta_2 (\text{IR}_{\text{hs}}^{\text{bond}} - \text{IR}_{\text{hs}}^{\text{fed}}) \times 1_{\text{eligible}_i} + \delta_{hs} + X_{it}B + \epsilon_i \quad (1)$$

where i represents the individual, t represents the year of observation, and hs represents the year of high school graduation. The variable ColLoan quantifies the amount of student loan borrowed by college students, while 1_{eligible_i} indicates an individual's eligibility to apply for federal student loans at the time of college entry. Eligible individuals comprise native U.S. citizens (both native-born and naturalized) and non-U.S. citizens who hold permanent residency status at the time of college application. $\text{IR}_{\text{hs}}^{\text{bond}} - \text{IR}_{\text{hs}}^{\text{fed}}$ is the

difference between the interest rates of commercial loans and federal student loans. The interest rate of federal student loans is calculated as the average interest rate of subsidized and unsubsidized loans.¹⁴ While the interest rate of commercial loans varies considerably based on individual characteristics, we use Moody’s Seasoned Baa Corporate Bond Yield as a proxy. In the robustness check, we also use the average finance rate of personal loans at commercial banks (24-month loan) and find that the results remain robust.¹⁵ The interaction between the difference in interest rate between commercial loans and federal loans and individual eligibility status is the instrument, and β_2 is the coefficient of interest.

To account for variations in education and labor market conditions, such as college tuition and economic recessions, faced by different cohorts, we include high-school graduation year fixed effects in our analysis. Additionally, we control for individual characteristics (denoted as X_{it}) such as gender and race/Hispanic indicators, a quadratic function of age, and parental education indicators.

In the second stage, we estimate the following regression:

$$Y_{it} = \gamma_0 + \gamma_1 \widehat{ColLoan}_{it} + \gamma_2 1_{eligible_i} + \zeta_{hs} + X_{it}\Gamma + v_i \quad (2)$$

The dependent variables Y_{it} include various outcomes related to college study, further education, and labor market performance. College outcomes include whether an individual attended at least one year of college, obtained a college degree, studied a high-paying major, or had a double major. Outcomes related to graduate studies cover whether an individual obtained a graduate degree, chose a high-paying graduate major, took a loan for graduate school, the amount of graduate school loan, and the amount owed to graduate school loan. Labor market outcomes include annual earnings, hourly wage rate, employment, whether an individual worked full time, worked in a high-paying occupation, or worked in an occupation related to their major.¹⁶

¹⁴For the period between 1994 and 2006, the interest rates differ between the repayment period and the in-school period; we take the average of these two rates. We have conducted a robustness check using the interest rate during the repayment period and have found consistent results.

¹⁵Source: Baa Corporate Bond Yield: <https://fred.stlouisfed.org/series/DBAA>; Finance rate on personal loans at commercial banks: <https://fred.stlouisfed.org/series/TERMCBPER24NS>.

¹⁶Appendix Appendix A provides detailed definitions of these dependent variables.

We use $\widehat{ColLoan}_{it}$, the predicted college loan from Equation 1 in the first stage, as a key independent variable. Same as the first stage regression, we control for eligibility status, high-school graduation fixed effects, and individual characteristics. For regressions on labor market outcomes, we additionally control for calendar year fixed effects and employer location fixed effects in both stages. Finally, we report standard errors that are robust to heteroskedasticity.

In addition to our main two-stage least squares (2SLS) analysis, we also conduct a reduced-form analysis by examining the direct effect of the interaction between the interest-rate gap and eligibility on various education and labor market outcomes:

$$Y_{it} = \alpha_0 + \alpha_1 1_{\text{eligible}_i} + \alpha_2 (\text{IR}_{\text{hs}}^{\text{bond}} - \text{IR}_{\text{hs}}^{\text{fed}}) \times 1_{\text{eligible}_i} + \xi_{hs} + X_{it}A + e_i \quad (3)$$

The specification for this analysis is similar to the first-stage regression but with a change in the dependent variable from student loan to education or labor market outcomes. The focus of interest in this analysis is the coefficient α_2 , which captures the direct effect of the benefit of low federal loan interest rates on education and labor market outcomes.

Our main analysis is based on the NSCG data, which provides detailed information on student loans and allows us to estimate both 2SLS and reduced-form regressions. However, the NSCG only surveys college graduates, so we cannot observe the impact of federal loan interest rates on college enrollment and completion. To address this limitation, we also use the ACS data as a supplement to examine the impact of federal loan interest rates on these outcomes, as well as other education and labor market outcomes. However, student loan information is not available in the ACS data, so we only estimate reduced-form regressions when using this dataset.¹⁷ In the ACS analysis, eligible individuals include people born in the U.S. and people born abroad of American parents. Ineligible individuals are people who are not U.S. citizens when surveyed by the ACS. It's important to note that permanent residents who are not U.S. citizens may still be eligible for federal

¹⁷To exclude individuals who are still in school, we restrict the regression sample in the ACS to people at least 25 years old. Additionally, we do not control for parental education in the ACS analysis as it is difficult to link individuals to their parents if they no longer live together.

loans, but they cannot be identified in the ACS data. This limitation may lead to misspecification issues when conducting the analysis using ACS data.

5. Empirical Results

5.1. Impact on College Loans

We first examine the effect of federal interest rates on student loans borrowed by college students, following Equation (1). In Column (1) of Table 1, we observe that when the interest rate of commercial loans is 1 percentage point higher than that of federal loans, eligible college students (including citizens and permanent residents) borrow an average of 2,529 USD more than non-eligible students throughout their college. Additionally, the likelihood of taking out a loan increases by 4.8 percentage points. These findings provide strong evidence that the difference in interest rates between commercial and federal loans can significantly impact college students' borrowing behaviors, thus supporting our first stage.

Table 1: Effect of Interest Rate on Opting into Student Loan

	College loan amount	Take loan for college
$(\text{IR}_{\text{hs}}^{\text{bond}} - \text{IR}_{\text{hs}}^{\text{fed}}) \times 1_{\text{eligible}}$	2.529** (1.087)	0.048** (0.020)
Observations	140,837	140,837
R-squared	0.079	0.120

Notes: The table reports estimates of the effects of interest rate changes on students' decision to opt into student loans. The data includes NSCG 2010-2019. Sample weights and robust standard errors are used. The regression is equation (3). The regression controls for interactions between race/Hispanic and gender, high school graduation year fixed effects, age quadratic function, and parental education. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5.2. Impact on Education Choices

Our next step is to investigate the impact of college student loans on educational choices. We first examine the effect on choices in college, including whether students opt for high-paying majors or double majors. In the upper panel of Appendix Table C.9, we present the reduced-form results of Equation

(3), which directly assesses the effect of federal loan interest rates on major selection. The lower panel displays the second stage of the instrumental variable model, using $(\text{IR}_{\text{hs}}^{\text{bond}} - \text{IR}_{\text{hs}}^{\text{fed}}) \times 1_{\text{eligible}_i}$ as the instrument for college loans. Our results show no significant evidence that college student loans have a significant effect on the choice of high-paying majors or double majors.

We also examine the impact of college loans on decisions related to graduate school. As shown in the first two columns of Table 2, our 2SLS specification reveals that a 1000 USD increase in college loans results in a 2.1 percentage point increase in the likelihood of obtaining a graduate degree. This effect could be driven by two factors. First, attending graduate school can lead to higher lifetime earnings and facilitate debt repayment. Going to graduate school becomes an attractive option for those who carry a large amount of student loans because they can pay back the debts more quickly with a graduate degree. Second, pursuing further education can delay debt repayment. If individuals choose to pursue further education at the postgraduate level, repayment of the principal is deferred until the completion of their graduate studies.¹⁸ This repayment policy indirectly lowers the cost of going to graduate school for college loan takers.

Meanwhile, providing more college loans may also encourage college graduates to pursue high-paying graduate majors, such as Law, MD, MBA, or a Master’s degree in business-related fields. We find that a \$1000 increase in college loans can lead to a 1.6 percentage point increase in the likelihood of choosing a high-paying graduate major. This is consistent with our previous finding that college loan takers are motivated to increase their future earnings through education.

Furthermore, we find that a 1000 USD increase in college loans leads to a 1.6 percentage point increase in the likelihood of taking out graduate loans and a 1,101 USD increase in the amount of graduate school loans, as shown in the last two columns of Table 2. This effect is partly driven by a higher likelihood of attending graduate school. In addition, among those who attend graduate school, a 1000 USD increase in college loans leads to an increasing likelihood of choosing high-paying graduate major by 1.8 ppt, a higher chance of taking out graduate loans by 1.9 ppt and an increase in the amount of graduate school loans by 1,416 USD. Our results indicate that individuals who experience lower federal interest rates at the time of

¹⁸Please refer to Appendix Appendix B.1 for more details on the repayment schemes.

high school graduation not only borrow more college loans, but also more graduate loans, leading to higher levels of debt when they enter the labor market.

Moreover, our reduced form estimates reveal that a rise in the interest rate differential between commercial loans and federal loans lead to an increased probability of pursuing a graduate degree, selecting a high-paying graduate major, and borrowing loans for graduate school, as well as the amount of graduate school loans among individuals eligible for federal loans compared to those who are ineligible. These findings align with the results from our 2SLS estimates, underscoring the robustness and consistency of our results.

Table 2: Effect of Undergrad Loans on Graduate School Choices

	Obtain grad degree	High-paying grad major	Take loan for grad school	Grad school loan amount
Panel A: Reduced Form				
$(IR_{hs}^{bond} - IR_{hs}^{fed})$	0.052***	0.041**	0.040***	2.798**
$\times 1_{eligible}$	(0.019)	(0.017)	(0.015)	(1.197)
R-squared	0.070	0.039	0.041	0.044
Panel B: 2SLS				
College loan	0.021**	0.016**	0.016*	1.101*
	(0.010)	(0.007)	(0.009)	(0.571)
Cragg-Donald Wald F stat	35.66	35.66	35.66	35.98
Observations	140,837	140,837	140,837	140,837

Notes: The table reports estimates of undergraduate loans on graduate school choices. The regression specifications are the same as Table C.9. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.3. Impact on Labor Market Outcomes

Next, we investigate whether attending a graduate degree, especially a high-paying graduate major, can lead to better labor market outcomes for debt holders. Surprisingly, our analysis, as shown in Table 3, reveals no evidence that increased college loans result in higher earnings, wage rates, employment rates, or a greater likelihood of full-time employment.

We also find that individuals who borrow more college loans are less likely to work in occupations related to their major, and there is no evidence that

they work in high-paying occupations, even though they are more likely to obtain a high-paying graduate degree. This is based on a direct question in the NSCG data that asks whether the respondent’s principal job is closely or somewhat related to the field of study of their most recent post-secondary degree. Specifically, we find that a \$1000 increase in college loans leads to a 1.3 percentage point decline in the likelihood that individuals work in occupations related to their major.

Taken together, our findings suggest that marginal students whose borrowing behavior for college loans is affected by federal interest rates are more likely to borrow more money and attend graduate school to pursue a high-paying degree. However, these marginal students may have relatively low ability and may struggle to find a job related to their major after graduating. Consequently, we find no effect on their earnings, wage rates, or labor supply. While loans may encourage students to achieve a higher level of education, this advantage may disappear due to competition in the labor market. As a result, students who experience low federal interest rates may initially benefit from being able to borrow more college loans, but they may ultimately suffer by accruing a significant amount of debt through increased college and graduate school loans without any improvement in labor market outcomes.

Table 3: Effect of undergrad loan on labor market outcomes

	Occ relates to major	High-paying occ	ln(earnings)	ln(hourly wage rate)	Employment	Fulltime
Panel A: Reduced Form						
$(IR_{hs}^{bond} - IR_{hs}^{fed})$	-0.028**	-0.008	-0.037	-0.010	0.003	0.030
$\times 1_{eligible}$	(0.011)	(0.034)	(0.033)	(0.021)	(0.016)	(0.023)
R-squared	0.015	0.055	0.122	0.116	0.024	0.049
Panel B: 2SLS						
College loan	-0.013*	-0.0036	-0.023	-0.006	0.001	0.012
	(0.008)	(0.015)	(0.024)	(0.013)	(0.006)	(0.011)
Cragg-Donald Wald F stat	22.88	22.88	12.56	12.17	35.98	35.98
Observations	127,837	127,837	128,936	126,993	140,837	140,837

Notes: The table reports estimates of undergraduate loans on labor market outcomes. The regression specifications are the same as Table C.9. All regressions reported in this table also control for calendar year fixed effects and employer location at the region level. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

6. Robustness Checks

6.1. Selection into College Graduates

In this section, we perform several robustness checks to ensure the validity of our results. First, we address the selection problem, where changes in the interest rate difference between federal loans and college loans may affect individuals' decisions to attend and complete college, thereby influencing the composition of students observed in the NSCG (which only includes college graduates).

To investigate this issue, we use the ACS data to examine how interest rates affect college enrollment and completion decisions. As shown in the first two columns of Appendix Table D.11, the interest rate difference affects college enrollment but not college completion. Specifically, an increase in the interest rate difference between commercial loans and federal loans by 1 percentage point can increase the likelihood of attending college by 0.2 percentage points. However, it does not increase the chances of obtaining a college degree, as marginal students are more likely to drop out from college. This finding is consistent with the literature where they find borrowing constraint has little effect on college completion (Keane and Wolpin, 2001; Cameron and Taber, 2004; Stinebrickner and Stinebrickner, 2008; Ionescu, 2009; Johnson, 2013). Therefore, we can be confident that the sample of college graduates in the NSCG is not impacted by changes in interest rates.

6.2. Alternative Measures of Interest Rates

We proceed to examine two alternative measures of interest rates as robustness checks. The first approach uses the average finance rate of personal loans at commercial banks as the commercial interest rate, instead of the Moody's Baa Corporate Bond Yield. We present the results for the first stage in Appendix Table E.14 and the results for the reduced-form analysis and the second stage of the 2SLS model in Appendix Table E.15. The findings are consistent with those in the baseline model. We also use the interest rate of federal loans (rather than the difference in the interest rate between commercial and federal loans) interacting with the eligibility of federal loan as an instrument. Our findings continue to exhibit robustness, and detailed results are available upon request.

For the second robustness check, we use the interest rate during the repayment period, rather than the average interest rate between the repayment period and the in-school period, as the interest rate of the federal loan.

Appendix Tables E.16 and E.17 present the robust results for the first stage, reduced-form, and second stage estimation.

6.3. ACS Results

Lastly, we utilize the ACS data to perform a reduced-form analysis to examine the impact of interest rates on education and labor market outcomes.¹⁹ As shown in Appendix Table D.11, we find no evidence that the interest rate difference between commercial and federal loans affects the likelihood of selecting a high-paying college major, pursuing a double major, working in a high-paying occupation, earning higher incomes, receiving higher hourly wage rates, having higher employment rates, or working full-time.²⁰ However, we find suggestive evidence that the interest rate difference has a positive effect on obtaining an advanced degree, although only marginally significant. These findings are consistent with the results from the NSCG data, indicating that college loans may only improve educational attainment and not labor market outcomes. One limitation to note is that the ACS data lack the capability to differentiate between permanent residents and non-permanent residents among non-citizens. Consequently, permanent residents are treated as the control group (not eligible) in the ACS analysis, potentially introducing a mismeasurement issue that could impact the accuracy of our results.

7. Conclusion

When the interest rate for commercial loans is higher compared to federal loans, eligible students (U.S. citizens and permanent residents) tend to borrow more than non-eligible students. By using the interest rate differential interacting with the eligibility for federal loans as an instrument, we analyze the impact of college student loans on educational and labor market outcomes using data from the National Survey of College Graduates (NSCG).

We find that college graduates who borrow more due to favorable changes in federal loan interest rates are more likely to pursue graduate degrees and select higher-paying graduate majors. Despite achieving higher educational attainment, increased borrowing does not lead to better labor market outcomes.

¹⁹Since we do not observe student loans in the ACS data, we cannot conduct the 2SLS estimation.

²⁰Note that the ACS data only includes information on college majors, not graduate degree majors.

Specifically, there is no significant improvement in hourly wages, annual earnings, or full-time employment. Graduates with higher debt levels face challenges in securing jobs related to their most recent post-secondary degrees, and there is no evidence that they work in higher-paying occupations.

Additionally, students who borrow more for their undergraduate education also tend to take out loans for graduate school, leading to higher overall debt levels upon entering the labor market. While federal student loans facilitate higher educational attainment, they do not necessarily translate into improved labor market outcomes, raising concerns about the long-term financial burden on graduates. This also provides more rooms for discussion about whether the higher education can pay off, especially for marginal students.

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Appendix A. Definition of Dependent Variables in NSCG

Indicator for college loans ($\mathbb{1}_{college\ loan>0}$) is a dummy variable that equals 1 if the individual borrowed college loans that need to be repaid. We take advantage of the panel data and record that the person borrowed college loans if s/he ever chose “yes” to the question in any wave.

College loan is the numerical value for college loan amount. The questionnaire asks respondents to choose one from a list of intervals: did not borrow, 1-10k, 10-20k, 20-30k, 30-40k, 40-50k, 50-60k, 60-70k, 70-80k, 80-90k, 90k and above. We convert the categorical variable to a continuous value by assigning the mid-point value. For the “90k and above” category, we assign 95k. For people who didn’t get a degree or did not borrow, we assign the value of 0.

High-paying college major is a dummy variable for majoring in Economics, Engineering, Computer and Mathematical Sciences, Nursing, and Marketing. These majors are high-paying majors identified by an earnings regression with dummies for college majors, controlling for quadratic age, race, gender, and parental education on full-time workers.

Double major is a dummy variable for having a second major or minor in the person’s first BA degree.

High-paying graduate major is a dummy variable for having an advanced degree in Law, MD, MBA, or a Master’s degree in business-related fields.

Take loans for graduate school is a dummy variable that equals 1 if the individual borrowed loans for graduate school. Like the dummy for college loans, we assign the variable with 1 if the person ever chose “yes” to the question on graduate school loans in any wave.

Graduate school loan amount is the numerical value for graduate school loan amount, defined in the same way as the college loan variable.

$\ln(\textit{earnings})$ is the natural log of annual base earnings of the principal job.

$\ln(\textit{hourly\ wage\ rate})$ is the natural log of the hourly wage rate calculated as follows:

$$\text{hourly wage rate} = \frac{\text{earnings}}{\text{hours worked per week} \times \text{weeks worked per year}}.$$

Employment is a dummy variable that equals 1 if the person is employed, and 0 if the person is unemployed or out of the labor force.

Fulltime is a dummy variable that equals 1 if the person works for at least 35 hours per week and at least 41 weeks per year, and 0 otherwise.

Occupation relates to major is a dummy variable that equals 1 if the person states that his/her principal job is closely or somewhat related to the field of study of their most recent post-secondary degree, and 0 if the principal job is not related.

High-paying occupation is a dummy variable that equals 1 if the person's occupation in the principal job is Lawyer/Judge, Doctor, Top-level Managers, Managers of medicine and health occupations, and other Managers and Administrators.

Appendix B. More Background Information about Student Loans

Appendix B.1. Subsidized and Unsubsidized Federal Loans

Interest Rates. Table B.4 displays the interest rates of subsidized and unsubsidized federal loans for undergraduate and postgraduate students during the repayment period from 1994 to 2015. Meanwhile, Table B.5 shows the interest rates for the in-school, grace, and deferment periods.

Table B.4: Interest Rates of Different Types of Federal Loans (Repayment Period)

Period	Subsidized UG	Unsubsidized UG	Subsidized PG	Unsubsidized PG
7/1/2015–6/30/2016	4.29%	4.29%	NA	5.84%
7/1/2014–6/30/2015	4.66%	4.66%	NA	6.21%
7/1/2013–6/30/2014	3.86%	3.86%	NA	5.41%
7/1/2012–6/30/2013	3.40%	6.80%	NA	6.80%
7/1/2011–6/30/2012	3.40%	6.80%	6.80%	6.80%
7/1/2010–6/30/2011	4.50%	6.80%	6.80%	6.80%
7/1/2009–6/30/2010	5.60%	6.80%	6.80%	6.80%
7/1/2008–6/30/2009	6.00%	6.80%	6.80%	6.80%
7/1/2007–6/30/2008	6.80%	6.80%	6.80%	6.80%
7/1/2006–6/30/2007	6.80%	6.80%	6.80%	6.80%
7/1/2005–6/30/2006	5.30%	5.30%	5.30%	5.30%
7/1/2004–6/30/2005	3.37%	3.37%	3.37%	3.37%
7/1/2003–6/30/2004	3.42%	3.42%	3.42%	3.42%
7/1/2002–6/30/2003	4.06%	4.06%	4.06%	4.06%
7/1/2001–6/30/2002	5.99%	5.99%	8.19%	8.19%
7/1/2000–6/30/2001	8.19%	8.19%	8.19%	8.19%
7/1/1999–6/30/2000	6.92%	6.92%	6.92%	6.92%
7/1/1998–6/30/1999	7.46%	7.46%	7.46%	7.46%
7/1/1997–6/30/1998	8.25%	8.25%	8.25%	8.25%
7/1/1996–6/30/1997	8.25%	8.25%	8.25%	8.25%
7/1/1995–6/30/1996	8.25%	8.25%	8.25%	8.25%
7/1/1994–6/30/1995	7.43%	7.43%	7.43%	7.43%

Notes: The four columns present the interest rates of subsidized and unsubsidized federal loans for undergraduate and postgraduate students, respectively. Source:

<https://www.savingforcollege.com/article/historical-federal-student-interest-rates-and-fees>.

Borrowing Limit. Students borrowing federal loans are subject to an annual borrowing limit, as well as an aggregate loan limit for their entire study. Table B.6 illustrates the changes in aggregate borrowing limits for both undergraduate and graduate students since 1994. While borrowing limits for unsubsidized loans are not always specified, acts do provide details for the combined totals of Direct Loans. For instance, dependent students who

Table B.5: Interest Rates of Different Types of Federal Loans (In-school, Grace, and Deferment Periods)

Period	Subsidized UG	Unsubsidized UG	Subsidized PG	Unsubsidized PG
7/1/2015–6/30/2016	0	4.29%	NA	5.84%
7/1/2014–6/30/2015	0	4.66%	NA	6.21%
7/1/2013–6/30/2014	0	3.86%	NA	5.41%
7/1/2012–6/30/2013	0	6.80%	NA	6.80%
7/1/2011–6/30/2012	0	6.80%	0	6.80%
7/1/2010–6/30/2011	0	6.80%	0	6.80%
7/1/2009–6/30/2010	0	6.80%	0	6.80%
7/1/2008–6/30/2009	0	6.80%	0	6.80%
7/1/2007–6/30/2008	0	6.80%	0	6.80%
7/1/2006–6/30/2007	0	6.80%	0	6.80%
7/1/2005–6/30/2006	0	4.70%	0	4.70%
7/1/2004–6/30/2005	0	2.77%	0	2.77%
7/1/2003–6/30/2004	0	2.82%	0	2.82%
7/1/2002–6/30/2003	0	3.46%	0	3.46%
7/1/2001–6/30/2002	0	5.39%	0	5.39%
7/1/2000–6/30/2001	0	7.59%	0	7.59%
7/1/1999–6/30/2000	0	6.32%	0	6.32%
7/1/1998–6/30/1999	0	6.86%	0	6.86%
7/1/1997–6/30/1998	0	7.66%	0	7.66%
7/1/1996–6/30/1997	0	7.66%	0	7.66%
7/1/1995–6/30/1996	0	8.25%	0	8.25%
7/1/1994–6/30/1995	0	7.43%	0	7.43%

Notes: The four columns present the interest rates of subsidized and unsubsidized federal loans for undergraduate and postgraduate students, respectively. Subsidized loans do not need to pay interest during in-school, grace, and deferment periods. After 2006, unsubsidized loans no longer distinguish interest rates between the repayment period and in-school, grace, and deferment periods. Source: <https://www.savingforcollege.com/article/historical-federal-student-interest-rates-and-fees>.

Table B.6: Different Types Of Direct Loans And Corresponding Borrowing Limits

Period	Subsidized UG	Total UG		Subsidized UG + PG	Total UG + PG
		Dependent	Independent		
7/1/2008 to 7/1/2025	\$23,000	\$31,000	\$57,500	\$65,500	\$138,500
4/18/2008 to 6/30/2008	\$23,000	\$23,000	\$46,000	\$65,500	\$138,500
7/1/1996 to 4/17/2008	\$23,000	\$23,000	\$46,000	\$65,500	\$138,500
7/1/1994 to 6/30/1996	\$23,000	\$23,000	\$46,000	\$65,500	\$138,500

Notes: Total loan limit is the sum of limits for subsidized and unsubsidized loans. All PG loan borrowers are treated as independent students. Source: <https://www.savingforcollege.com/article/historical-federal-student-loan-limits>.

receive financial support from their families can borrow a total of up to \$31,000 in Direct Loans for their undergraduate study since July 2008, with no more than \$23,000 in subsidized loans. Conversely, independent students who do not receive financial support from their parents or guardians are subject to different borrowing limits. Graduate or professional students, for example, can borrow up to \$138,500 during their undergraduate and graduate studies since 2018, with no more than \$65,600 in subsidized loans.

Repayment Plans. While enrolled in school, students are only required to repay the interest on their loans. For subsidized loans, the government covers this interest. Generally, undergraduates begin repaying the principal amount six months after graduation, during a grace period. If they choose to pursue further education at the postgraduate level, repayment of the principal is deferred until the completion of their graduate studies. Students have several repayment options available, including Fixed Payment Repayment Plans such as Standard, Graduated, and Extended Repayment Plans. Alternatively, they can opt for an Income-Driven Repayment (IDR) Plan. Figure B.2 provides information on the different repayment plans available to students.²¹

When borrowers enter repayment, they are automatically enrolled in the Standard Repayment Plan. Under this plan, monthly payments are fixed and calculated based on the initial interest rate set at loan origination, following a ten-year repayment schedule. Graduated Repayment Plans have lower initial payments that increase typically every two years over the ten-year period, similar to the Standard Repayment Plan. In contrast, Extended Repayment Plans are available to borrowers with over \$30,000 in federal loan debt and extend the repayment term to 25 years. These three plans encompass all

²¹Source: <https://studentaid.gov/manage-loans/repayment/plans>.

Figure B.2: Repayment Plans

	Plans	Eligible Loans	Monthly Payment Amount
Fixed Payment Repayment Plans	Standard Repayment Plans	1.Direct Subsidized and Unsubsidized Loans 2.Subsidized and Unsubsidized Federal Stafford Loans	Payments are a fixed amount that ensures your loans are paid off within 10 years(within 10 to 30 years for Consolidation Loans).
	Graduated Repayment Plans	3.All PLUS loans (Direct or FFEL) 4.All Consolidation Loans (Direct or FFEL)	Payments are lower at first and then increase, usually every two years. Payment amounts are designed to ensure your loans are paid off within 10 years (within 10 to 30 years for Consolidation Loans).
	Extended Repayment Plans	To qualify for this plan, you must have more than \$30,000 in outstanding Direct Loans or more than \$30,000 in outstanding FFEL Program loans. 1.Direct Subsidized and Unsubsidized Loans 2.Subsidized and Unsubsidized Federal Stafford Loans 3.All PLUS loans (Direct or FFEL) 4.All Consolidation Loans (Direct or FFEL)	Payments can be fixed or graduated and will ensure that your loans are paid off within 25 years.
Income-Driven Repayment (IDR) Plan	Saving on a Valuable Education Plan(SAVE)		10% of discretionary income
	Pay As You Earn (PAYE)	1.Direct Subsidized and Unsubsidized Loans 2.Direct PLUS Loans made to students 3.Direct Consolidation Loans that do not include PLUS loans (Direct or FFEL) made to parents	10% of discretionary income but never more than what you would pay under the 10-year Standard Repayment Plan
	Income-Contingent Repayment (ICR) Plan	For PAYE, students must borrow on or after Oct. 1, 2007, and must have received a disbursement of a Direct Loan on or after Oct. 1, 2011.	Either 10% or 15% of your discretionary income (depending on when you received your first loans) but never more than what you would pay under the 10-year Standard Repayment Plan
	Income-Based Repayment (IBR) Plan	1.Direct Subsidized and Unsubsidized Loans 2.Subsidized and Unsubsidized Federal Stafford Loans 3.Direct and FFEL PLUS Loans made to students 4.Direct or FFEL Consolidation Loans that do not include PLUS loans (Direct or FFEL) made to parents	The lesser of (1)20% of your discretionary income, or (2)the amount you would pay on a repayment plan with a fixed payment over 12 years, adjusted according to your income

Source: <https://studentaid.gov/manage-loans/repayment/plans>.

types of federal loans.

Introduced in 1992, IDR plans include the Saving on a Valuable Education (SAVE) Plan, Pay As You Earn (PAYE) Repayment Plan, Income-Based Repayment (IBR) Plan, and Income-Contingent Repayment (ICR) Plan. These plans link the repayment amount to the borrower's income and extend the repayment period to either 20 or 25 years. Due to their flexibility and affordability, IDR plans have become increasingly popular over the past decade. In 2017, IDR plans accounted for 45% of balances in repayment, according to Karamcheva et al. (2020).

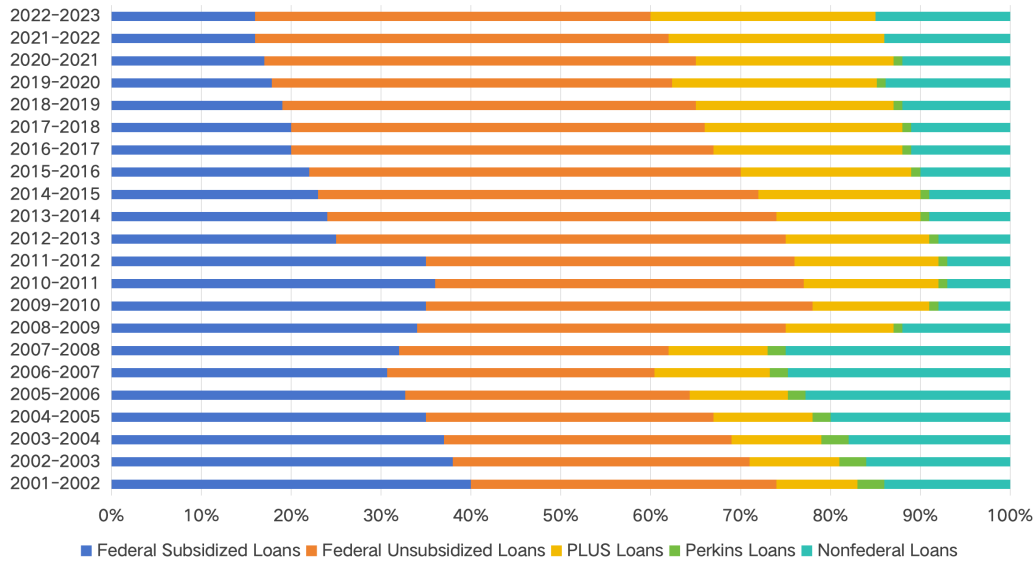
As payments under IDR plans are based on the borrower's income and family size, borrowers must provide updated income and family size information annually to their loan servicer. This information is used to recalculate the payment amount. Under the SAVE Plan, the monthly payment is 10% of discretionary income, defined as any income above one-and-a-half times the federal poverty guideline. Monthly payments for other plans vary between 10% to 20% of discretionary income, with the requirement that the payment amount must not exceed the amount calculated under the Standard Repayment Plan.

Appendix B.2. Other Types of Federal Loans besides Subsidized and Unsubsidized Loans

Direct subsidized and unsubsidized loans are the two most significant types of federal student loans, comprising more than half of the student loan market, as shown in Figure B.3. The primary differences between these two loans are threefold: (1) For subsidized loans, the government pays the interest while the student is in school, during the grace period, and during deferment periods. In contrast, students who borrow unsubsidized loans are responsible for all interest that accrues from the time the loan is disbursed. (2) The eligibility criteria for subsidized loans are more stringent, requiring students to demonstrate financial need. In contrast, unsubsidized loans do not require proof of financial need. (3) Since July 2012, subsidized loans have been available only to undergraduate students.

PLUS Loans are another popular option among college students and their parents. These loans are available to graduate students and parents of dependent undergraduate students. PLUS Loans require a credit check and typically have higher interest rates than subsidized and unsubsidized loans. Since July 1993, there have been no borrowing limits for PLUS Loans, which can cover any educational expenses not funded by other financial aid.

Figure B.3: Different Types of Loans Market Share



Source: Statisa <https://www.statista.com/statistics/235354/share-of-student-loans-provided-in-the-us-by-source/>.

Borrowers may also combine multiple federal student loans into a single Consolidation Loan. This consolidation can simplify repayment and extend the repayment period, but it may also result in paying more interest over time.

Two other types of loans, now discontinued, are Perkins Loans and loans under the Federal Family Education Loan (FFEL) Program. Perkins Loans were designed to assist students with exceptional financial needs, offering low-interest rates and provided by participating schools; this program was discontinued in 2017. The FFEL Program, funded by private lenders but guaranteed by the federal government, ended in 2010, and no new loans have been issued under this program since.

Appendix C. Supplementary Results

Table C.7: Summary statistics of continuous variables from the NSCG data

Variable	Mean	SD	Minimum	Maximum	Count
Moody Baa Corporate Bond Yield	7.326	0.874	4.85	8.63	140,837
Finance rate of personal loans at commercial banks	12.741	1.003	9.75	13.94	140,837
Federal loan interest rate (avg of repayment and in-school periods)	6.048	1.736	3.07	8.25	140,837
Federal loan interest rate (repayment period)	6.254	1.712	3.37	8.25	140,837
High school graduation year	2001.775	4.805	1994	2015	140,837
Take loan for college	0.601	0.490	0	1	140,837
College loan amount	20.003	24.873	0	95	140,837
High-paying college major	0.144	0.351	0	1	140,837
Double major	0.155	0.362	0	1	140,837
Obtain grad degree	0.294	0.456	0	1	140,837
High-paying grad major	0.077	0.266	0	1	140,837
Take loan for grad school	0.170	0.376	0	1	140,837
Grad school loan amount	8.026	22.153	0	95	140,837
Occupation relates to major	0.859	0.348	0	1	127,837
High-paying occupation	0.094	0.292	0	1	127,837
ln(earnings)	10.722	0.838	0.066	14.000	128,936
ln(hourly wage rate)	3.220	0.645	0.002	9.565	126,993
Employment	0.928	0.259	0	1	140,837
Fulltime	0.731	0.444	0	1	140,837

Notes: The table reports the minimum, maximum, weighted mean and standard deviation, and total cell count of outcome variables used in the regressions. The statistics are calculated using the regression sample from the NSCG data.

Table C.8: Summary statistics of discrete variables from the NSCG data

Variable	Value	Percentage	Count
Eligible for federal loans	Yes	98.877	138,045
	No	1.123	2,792
Race	White	82.105	103,082
	Black	7.599	12,164
	Asian	5.685	16,268
	Native	0.811	1,659
	Other	3.800	7,664
Gender	Male	42.376	67,701
	Female	57.624	73,136
Father's education	Less than high school	5.334	7,962
	High school	22.671	28,181
	Some college, vocational, trade school, 2-year college	21.833	29,101
	College	26.125	37,237
	Masters degree	14.645	22,505
	Professional degree	4.864	8,264
	Doctorate	4.528	7,587
Mother's education	Less than high school	4.674	7,081
	High school	22.465	28,696
	Some college, vocational, trade school, 2-year college	26.521	35,139
	College	27.230	39,921
	Masters degree	15.268	23,417
	Professional degree	1.898	3,450
	Doctorate	1.716	2,931
	Missing	0.228	202
Total			140,837

Note: The table reports the weighted percentage and unweighted cell counts of the distribution of the discrete variables used in the regressions. The statistics are calculated using the regression sample.

Table C.9: Effect of Undergrad Loan on College Major Choice

	High-paying college major	Double major
Panel A: Reduced Form		
$(\text{IR}_{\text{hs}}^{\text{bond}} - \text{IR}_{\text{hs}}^{\text{fed}}) \times 1_{\text{eligible}}$	0.005 (0.011)	0.013 (0.013)
R-squared	0.021	0.009
Panel B: 2SLS		
College loan	0.002 (0.005)	0.005 (0.006)
Cragg-Donald Wald F stat	35.66	35.66
Observations	140,837	140,837

Notes: The table reports estimates of the effects of undergraduate loans on college major choices. The data includes NSCG 2010-2019. Sample weights and robust standard errors are used. The reduced form regression is equation (3). The 2SLS regressions are equations (1) and (2). The 2SLS regressions are estimated on the same sample as the reduced form to ensure consistency. The regression controls for interactions between race/Hispanic and gender, high school graduation year fixed effects, age quadratic function, and parental education. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table C.10: Effect of Undergrad Loans on Graduate School Choices Among Grad Degree Owners

	High-paying grad major	Take loan for grad school	Grad school loan amount
Panel A: Reduced Form			
$(\text{IR}_{\text{hs}}^{\text{bond}} - \text{IR}_{\text{hs}}^{\text{fed}})$	0.083**	0.090***	6.626***
$\times \mathbb{1}_{\text{eligible}}$	(0.033)	(0.029)	(2.375)
R-squared	0.059	0.056	0.066
Panel B: 2SLS			
College loan	0.018**	0.019*	1.416**
	(0.007)	(0.011)	(0.702)
Cragg-Donald Wald F stat	66.35	66.35	65.56
Observations	60,930	60,930	60,930

Notes: The table reports estimates of undergraduate loans on graduate school choices. The regression specifications are the same as Table C.9. The sample is restricted to people who have an advanced degree by the last time they are observed in the sample. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Appendix D. ACS analysis

Appendix D.1. Definition of Dependent Variables in ACS

College enrollment is a dummy variable for having been enrolled in some college. It equals 1 if the individual's education attainment is at least 1 year of college, and 0 otherwise.

College completion is a dummy variable for having a college degree. It equals 1 if the educational attainment is a Bachelor's, Master's, Professional, or Doctoral degree, and 0 otherwise.

High-paying college major is a dummy variable for college majors in Computer and Information Sciences, Engineering, Law, Mathematics and Statistics, and Business.

Double major in college is a dummy variable for having a second major.

Advanced degree is a dummy variable for having an advanced degree. It equals 1 if the educational attainment is a Master's, Professional, or Doctoral degree, and 0 otherwise.

High-paying occupation is a dummy variable for Chief executives and legislators/public administrators, Lawyers and judges, magistrates, and other judicial workers, Physicians and Surgeons, Veterinarians, Optometrists, Dentists, and Podiatrists occupations.

$\ln(\text{earnings})$ is the natural log of annual wage income.

$\ln(\text{hourly wage})$ is the natural log of hourly wage rate calculated by dividing annual income by annual total hours. The total hours are calculated by multiplying weeks worked per year and hours worked per week. For weeks worked per year, the ACS data reports intervals and we impute numbers based on the intervals. Specifically, we impute 10 weeks for 1-13 weeks, 20 weeks for 14-26 weeks, 35 weeks for 27-39 weeks, 45 weeks for 40-47 weeks, 48 weeks for 48-49 weeks, and 52 weeks for 50-52 weeks.

Employment is a dummy variable for being in the labor force.

Working fulltime is a dummy for working fulltime, defined by working at least 41 weeks per year and 35 hours per week.

Appendix D.2. Supplementary Results using ACS

Table D.11: Effect of Federal Loan Interest Rates on Education and Labor Market Outcomes using the ACS data

Dependent variable	College enrollment	College completion	High-paying college major	Double major in college	Advanced degree
$(IR_{hs}^{bond} - IR_{hs}^{fed})$	0.002**	0.000	0.004	0.000	0.003
$\times 1_{eligible}$	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)
R-squared	0.070	0.062	0.054	0.005	0.029
Observations	3,808,847	3,808,847	1,133,034	1,330,062	1,330,062
Dependent variable	High-paying occupation	ln(earnings)	ln(hourly wage)	Employment	Working fulltime
$(IR_{hs}^{bond} - IR_{hs}^{fed})$	0.001	-0.002	-0.004	-0.000	0.002
$\times 1_{eligible}$	(0.001)	(0.005)	(0.004)	(0.002)	(0.002)
R-squared	0.011	0.107	0.143	0.019	0.034
Observations	1,294,422	1,200,018	1,172,963	1,330,062	1,330,062

Notes: The table reports estimates of the effects of undergraduate loans on college attendance, college completion, college majors, graduate school, and labor market outcomes. The data includes ACS 2010-2018. Sample weights and robust standard errors are used. The reduced form regression is equation (3). The controls include a set of race/Hispanic and gender dummies, a quadratic function of age, and fixed effects for high school graduation year. Regressions on labor market outcome (the lower panel) additionally control for fixed effects for calendar year and residential location at the region level. The college attendance and college completion regressions are estimated on the sample of people with a high school degree or above and were at least 25 years old when observed. The other regressions are estimated on people who completed college and were at least 25 years old when observed. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table D.12: Summary statistics of continuous variables from the ACS data

Variable	Mean	SD	Minimum	Maximum	Count
High school graduation year	2001.564	4.189	1995	2011	3,808,847
College Enrollment	0.594	0.491	0	1	3,808,847
College Completion	0.329	0.470	0	1	3,808,847
High-paying College Major	0.299	0.458	0	1	1,133,034
Double Major in College	0.098	0.298	0	1	1,330,062
Advanced degree	0.303	0.460	0	1	1,330,062
High-paying occupation	0.043	0.203	0	1	1,294,422
ln(earnings)	10.639	0.928	1.386	13.509	1,200,018
ln(hourly wage rate)	3.146	0.597	1.609	9.839	1,172,963
Employment	0.916	0.278	0	1	1,330,062
Fulltime	0.808	0.394	0	1	1,330,062

Notes: The table reports the minimum, maximum, weighted mean and standard deviation, and total cell count of outcome variables used in the regressions. The statistics are calculated using their corresponding regression sample. In particular, the first three variables use the full sample and the later variables use the sample of college graduates.

Table D.13: Summary statistics of discrete variables from the ACS data

Variable	Value	Percentage	Count
Eligible for federal loans	Yes	93.578	3,614,331
	No	6.422	194,516
Race	White	74.229	2,954,021
	Black	13.986	430,138
	Asian	0.755	29,347
	Native	3.105	127,002
	Other	7.925	268,339
Gender	Male	50.607	1,921,904
	Female	49.393	1,886,943
Total			3,808,847

Notes: The table reports the weighted percentage and unweighted cell counts of the distribution of the discrete variables used in the ACS regressions. The statistics are calculated using the regression sample of college enrollment (full sample of ACS).

Appendix E. Alternative Measures of Interest Rates

Appendix E.1. Using Alternative Commercial Interest Rates

Table E.14: Effect of Interest Rate on Opting into Student Loan Using Alternative Commercial Interest Rates

	College loan amount	Take loan for college
$(\text{IR}_{\text{hs}}^{\text{bond}} - \text{IR}_{\text{hs}}^{\text{fed}}) \times 1_{\text{eligible}}$	2.223** (1.007)	0.035 (0.022)
Observations	140,837	140,837
R-squared	0.079	0.120

Notes: The table reports estimates of the effects of interest rate changes on students' decision to opt into student loans. The data includes NSCG 2010-2019. Sample weights and robust standard errors are used. The regression is equation (3). We use the average finance rate of personal loans at commercial banks as the commercial interest rate, instead of the Moody's Baa Corporate Bond Yield. The regression controls for interactions between race/Hispanic and gender, high school graduation year fixed effects, age quadratic function, and parental education. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table E.15: Effect of Undergrad Loans on Education and Labor Market Outcomes Using Alternative Commercial Interest Rates

	High-paying college major	Double major	Obtain grad degree	High-paying grad major	Take loan for grad school	Grad school loan amount
Panel A: Reduced Form						
$(IR_{hs}^{bond} - IR_{hs}^{fed})$	0.005	0.016	0.050**	0.027*	0.040**	2.593**
$\times I_{eligible}$	(0.012)	(0.017)	(0.023)	(0.014)	(0.019)	(1.007)
R-squared	0.021	0.009	0.070	0.039	0.041	0.044
Panel B: 2SLS						
College loan	0.002	0.007	0.022*	0.012*	0.018	1.161*
	(0.005)	(0.009)	(0.014)	(0.006)	(0.013)	(0.596)
Cragg-Donald Wald F stat	24.85	24.85	24.85	24.85	24.85	25.10
Observations	140,837	140,837	140,837	140,837	140,837	140,837
	Occ relates to major	High-paying occ	ln(earnings)	ln(hourly wage rate)	Employment	Fulltime
Panel A: Reduced Form						
$(IR_{hs}^{bond} - IR_{hs}^{fed})$	-0.025**	-0.017	-0.037	-0.020	0.009	0.035
$\times I_{eligible}$	(0.012)	(0.036)	(0.031)	(0.022)	(0.015)	(0.024)
R-squared	0.015	0.055	0.122	0.116	0.024	0.049
Panel B: 2SLS						
College loan	-0.011*	-0.007	-0.025	-0.015	0.004	0.016
	(0.006)	(0.014)	(0.026)	(0.019)	(0.008)	(0.014)
Cragg-Donald Wald F stat	22.25	22.25	8.857	8.095	25.10	25.10
Observations	127,837	127,837	128,936	126,993	140,837	140,837

Notes: The table reports estimates of undergraduate loans on labor market outcomes. The regression specifications are the same as Table C.9. We use the average finance rate of personal loans at commercial banks as the commercial interest rate, instead of the Moody's Baa Corporate Bond Yield. All regressions reported in this table also control for calendar year fixed effects and employer location at the region level. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix E.2. Using Alternative Federal Loan Interest Rates

Table E.16: Effect of Interest Rate on Opting into Student Loan Using Alternative Federal Loan Interest Rates

	College loan amount	Take loan for college
$(\text{IR}_{\text{hs}}^{\text{bond}} - \text{IR}_{\text{hs}}^{\text{fed}}) \times 1_{\text{eligible}}$	2.591** (1.115)	0.051** (0.021)
Observations	140,837	140,837
R-squared	0.079	0.120

Notes: The table reports estimates of the effects of interest rate changes on students' decision to opt into student loans. The data includes NSCG 2010-2019. Sample weights and robust standard errors are used. The regression is equation (3). We use the interest rate during the repayment period, rather than the average interest rate between the repayment period and the in-school period, as the interest rate of the federal loan. The regression controls for interactions between race/Hispanic and gender, high school graduation year fixed effects, age quadratic function, and parental education. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table E.17: Effect of Undergrad Loans on Education and Labor Market Outcomes Using Alternative Federal Loan Interest Rates

	High-paying college major	Double major	Obtain grad degree	High-paying grad major	Take loan for grad school	Grad school loan amount
Panel A: Reduced Form						
$(IR_{hs}^{bond} - IR_{hs}^{fed})$	0.008	0.015	0.051**	0.041**	0.039***	2.795**
$\times I_{eligible}$	(0.012)	(0.013)	(0.021)	(0.017)	(0.015)	(1.205)
R-squared	0.021	0.009	0.070	0.039	0.041	0.044
Panel B: 2SLS						
College loan	0.003	0.006	0.020**	0.016**	0.015*	1.074*
	(0.005)	(0.006)	(0.010)	(0.007)	(0.009)	(0.555)
Cragg-Donald Wald F stat	33.27	33.27	33.27	33.27	33.27	33.53
Observations	140,837	140,837	140,837	140,837	140,837	140,837
	Occ relates to major	High-paying occ	ln(earnings)	ln(hourly wage rate)	Employment	Fulltime
Panel A: Reduced Form						
$(IR_{hs}^{bond} - IR_{hs}^{fed})$	-0.031**	-0.012	-0.040	-0.008	0.003	0.033
$\times I_{eligible}$	(0.012)	(0.035)	(0.035)	(0.022)	(0.016)	(0.024)
R-squared	0.015	0.055	0.122	0.116	0.024	0.049
Panel B: 2SLS						
College loan	-0.014*	-0.005	-0.023	-0.005	0.001	0.013
	(0.008)	(0.015)	(0.025)	(0.013)	(0.006)	(0.012)
Cragg-Donald Wald F stat	21.00	21.00	12.12	11.87	33.53	33.53
Observations	127,837	127,837	128,936	126,993	140,837	140,837

Notes: The table reports estimates of undergraduate loans on labor market outcomes. The regression specifications are the same as Table C.9. We use the interest rate during the repayment period, rather than the average interest rate between the repayment period and the in-school period, as the interest rate of the federal loan. All regressions reported in this table also control for calendar year fixed effects and employer location at the region level. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1