

Student Loans and Labor Market Outcomes: Analyzing the Role of Federal Loan Interest Rates *

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Abstract

We analyze the impact of federal loan interest rates on college financing, education, and labor market outcomes using data from the National Survey of College Graduates. Students from regions with fewer public universities tend to pay higher tuition fees and are more sensitive to fluctuations in federal loan interest rates. Employing a continuous difference-in-difference approach that exploits variation in federal loan interest rates over time and the regional share of college students attending private universities, we find that an increase in interest rates reduces the amount of college loans borrowed, prompting students to rely more on family assistance instead. Higher interest rates also lead college students to choose majors with higher earnings growth and subsequently pursue occupations with higher earning potential. Additionally, increased financing costs make individuals less likely to be unemployed, self-employed, or employed at small firms. These individuals tend to have higher earnings, longer working hours, and are more likely to work in occupations that align closely with their majors. However, they also report lower job satisfaction. Our findings suggest that an increase in federal loan interest rates raises college financing costs, which could have long-term implications across various aspects of the labor market.

Keywords: federal student loans, interest rates, education outcomes, labor market outcomes, college financing costs

JEL: I23, J24, H81

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1. Introduction

The increasing reliance on student loans to finance higher education has become a prominent feature of the contemporary U.S. education system. As of 2023, total student loan debt in the United States is approximately 1.60 trillion is outstanding federal loan debt, representing 92.5% of the total. Currently, about 43.4 million Americans hold federal student loan debt, with the average borrower owing around \$36,900. While many studies have examined the consequences of holding federal student loans, little is known about how the costs of financing these loans influence educational and labor market choices.

Specifically, the costs of financing federal loans are affected by their interest rates. When interest rates are higher, college becomes more expensive because students are required to pay more interest on the same amount of borrowed funds. Consequently, this may lead to a reduction in the amount of federal student loans borrowed, and hence, students and their parents need to pay more out of pocket. A decrease in cash at college entry can create financial pressure, potentially leading to tradeoffs between earnings and non-pecuniary utility. Such tradeoffs could influence students' choices of majors and occupations, employment decisions, and overall job satisfaction.

This paper investigates how interest rates on federal student loans influence various outcomes, including college financing, educational choices, and labor market performance. In particular, we leverage the variation in federal loan interest rates over time and their differential effects across regions with different tuition levels. Specifically, a decrease in federal loan interest rates is expected to lead to a larger increase in student loan amounts in regions with higher tuition costs, as indicated by the share of students attending private universities. To analyze this, we adopt a continuous difference-in-differences approach, utilizing variations in federal loan interest rates over time and regional differences in the share of students enrolled in private universities.

Using data from the National Survey of College Graduates (NSCG) from 2003 to 2019, we first confirm this relationship: a 1-percentage-point decrease in federal loan interest rates is associated with an increase of approximately \$2,075 in the amount borrowed for college student loans, as well as a 2.3 percentage point rise in the likelihood of students taking out a loan among those from regions with the highest shares of students attending private universities, compared to regions with the lowest shares.¹ However, this change does not affect the interest payments, suggesting that the reduction in loan amounts offsets the impact of higher interest rates. We further show that an increase in interest rates raises the likelihood of parents substituting family loans with financial assistance and makes students

¹In our sample, the share of students attending private universities ranges from 0.19 to 0.64.

more likely to pay tuition using their own savings. These adjustments imply that higher rates raise the net cost of college attendance, reducing upfront liquidity and increasing the reliance on out-of-pocket payments.

This study examines the impact of federal student loan interest rates on educational outcomes. The analysis indicates that higher interest rates at the point of college entry correlate with a higher propensity for students to select majors characterized by greater earnings growth. Aligned with this major selection, students are subsequently more likely to enter occupations with higher earnings potential after graduation.

We further demonstrate that federal loan interest rates affect various labor market outcomes beyond occupational choice. Specifically, higher interest rates are associated with an increased labor supply, evidenced by lower unemployment rates and longer work hours. Affected individuals are also more likely to secure high-paying jobs. For instance, they are less likely to be self-employed or work in small firms and more likely to work in occupations directly related to their final major. Consequently, higher interest rates at college entry exert a long-run positive effect on annual earnings. A one-percentage-point increase in the interest rate raises annual earnings by 2.81% for graduates from the highest private university share division relative to those from the lowest division.

Lastly, the NSCG data includes information on job satisfaction, enabling us to examine the tradeoff between salary and job amenities. We find that college graduates who faced higher interest rates at college entry are more likely to prioritize salary as an important job characteristic. However, these individuals are less likely to be satisfied with aspects such as job dependency and responsibility. This suggests that increased college financing costs may have an unintended consequence: while individuals work harder and earn more, these higher earnings are associated with lower job amenities and job satisfaction.

We conduct a series of robustness checks to rule out potential alternative channels. First, we find no evidence that universities adjust tuition, total costs, or financial aid in response to interest rate changes using Integrated Postsecondary Education Data System (IPEDS) from 1992 to 2020. Furthermore, interest rates do not appear to influence college enrollment, completion rates, or the composition of the student body. This finding supports our use of NSCG data, which is limited to college graduates, as it suggests that analyzing this sample is not subject to selection bias. Additionally, interest rates have no significant effect on the likelihood of attending a public university, pursuing a double major, changing majors, or obtaining a graduate degree. Finally, we show that controlling for labor market conditions at the time of college graduation — measured by the unemployment rate — does not alter our baseline results.

This study contributes to the extensive literature on student loans. Earlier research pri-

marily identified loan effects through indirect variations in tuition or grant aid (Field, 2009; Bettinger et al., 2019; Chakrabarti et al., 2023; Witteveen, 2023) or by incorporating borrowing constraints into structural models (Keane and Wolpin, 2001; Cameron and Taber, 2004; Ionescu, 2009; Johnson, 2013; Sieg and Wang, 2018; Folch and Mazzone, 2022). More recent work has used natural or quasi-natural experiments to directly estimate the impact of student loans, though such studies are typically limited to specific colleges or states (Stinebrickner and Stinebrickner, 2008; Rothstein and Rouse, 2011; Marx and Turner, 2019; Barr et al., 2021).

In this paper, we introduce a novel identification strategy that establishes a causal effect of federal loan interest rates on borrowing amounts. Specifically, we leverage the interaction between time-varying federal interest rates and regional variation in the share of students attending private universities. This approach allows us to draw causal inferences from a broader, nationally representative sample. Consequently, our analysis provides a more generalizable understanding of how federal loan interest rates influence student borrowing and subsequent life outcomes.

Our work is also closely related to a small literature examining specific features of federal student loans. Goodman et al. (2021), Black et al. (2023) and Black et al. (2025) analyze the effects of loan limits across various federal programs. In contrast, we offer a comprehensive analysis of how federal loan interest rates influence a wide range of educational and labor market outcomes. To our knowledge, this is among the first studies to isolate the cost of financing college by exploiting variation in interest rates, distinct from loan amounts.

Previous studies have shown that student loans can influence a wide range of labor outcomes, but the findings remain inconclusive. Some research suggests that student debt increases the likelihood of working in jobs with higher initial wages or in the private sector (Minicozzi, 2005; Field, 2009; Rothstein and Rouse, 2011; Sieg and Wang, 2018; Velez et al., 2019; Daniels and Smythe, 2019; Gervais and Ziebarth, 2019).² Conversely, other studies suggest that student debt causes a persistent slowdown in earnings growth (Minicozzi, 2005), possibly due to reduced graduate school enrollment (Folch and Mazzone, 2022) or changes in major selection (Hampole, 2022).

Our study offers a new insight into the impact of student debt by highlighting the critical role of why borrowing increases. We propose that when higher loan take-up is driven by lower interest rates, it generates a positive liquidity effect. Although students incur more debt,

²For instance, Rothstein and Rouse (2011) and Sieg and Wang (2018) find that student debt leads college graduates to choose higher-paying jobs or roles in the private sector. Velez et al. (2019) also find that indebted students tend to have higher earnings, but Daniels and Smythe (2019) show this is driven by increased work hours rather than higher wages.

they receive greater upfront resources. This relaxes immediate financial constraints, allowing them to make educational and career choices that are less dictated by short-term earnings needs and more aligned with their long-term preferences.

The rest of the paper is organized as follows: Section 2 discusses the institutional background of US federal student loans. Section 3 introduces the datasets used in the analysis. Section 4 details our empirical approach and identification strategy. Section 5 presents empirical results on various educational and labor market outcomes. Section 6 conducts the robustness checks. Lastly, Section 8 concludes.

2. Background

Established in 1958 under the National Defense Education Act, the federal student loan program has played a critical role in financing American higher education. The Direct Loan Program was introduced in 1993 to allow the federal government to lend money directly to students through their schools, replacing private lenders. As of 2023, total student loan debt in the United States stands at approximately \$1.73 trillion.³ Of this amount, \$1.60 trillion is outstanding federal loan debt, accounting for 92.5% of the total.⁴ Currently, about 43.4 million Americans hold federal student loan debt, with the average student holding a federal debt of approximately \$36,900.⁵

The federal student loan program offers several types of loans to students. Established in 1994, the William D. Ford Federal Direct Loan Program, including Direct Subsidized Loans, Direct Unsubsidized Loans, and Direct PLUS loans, aimed to simplify and streamline federal student loan borrowing. Direct Subsidized Loans are available to students with demonstrated financial need, with the federal government covering the interest during specific periods. Direct Unsubsidized Loans are available to all students, regardless of financial need, with borrowers responsible for all accrued interest. Direct PLUS Loans are available to graduate or professional students and parents of dependent undergraduate students who pass a credit check, helping cover educational costs not met by other financial aid. Subsidized and unsubsidized loans generally feature lower interest rates compared to PLUS loans and private loans. Between 2010 and 2023, subsidized and unsubsidized loans collectively accounted for about 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

³Source: <https://www.federalreserve.gov/releases/g19/20231207/>.

⁴Source: <https://studentaid.gov/data-center/student/portfolio>.

⁵Source: <https://fsapartners.ed.gov/knowledge-center/library/electronic-announcements/2023-08-30/federal-student-aid-posts-new-quarterly-reports-fsa-data-center>.

loan types.⁶

We summarize the interest rates for Subsidized and Unsubsidized Direct Loans for undergraduate and graduate students during the repayment period from 1994 to 2015 in Appendix Table B.1.⁷ Subsidized loans do not accrue interest while students are enrolled at least half-time, during the six-month grace period after graduation, or during deferment. In contrast, unsubsidized loans accrue interest immediately upon disbursement. Prior to 2006, federal student loans had variable interest rates tied to market fluctuations, with rates set to be a fixed premium to the treasury rates. Since 2006, interest rates have been fixed for the loans' duration. Unsubsidized loans consistently have interest rates equal to or higher than those of subsidized loans.⁸

In this study, we examine the impact of federal loan interest rates on undergraduates, using the average interest rates of subsidized and unsubsidized loans as the primary independent variable. Lower federal interest rates can reduce borrowing costs, potentially encouraging students to take on more federal loans. Figure 1 illustrates fluctuations in federal interest rates over time. The interest rate is calculated as the average of subsidized and unsubsidized loan interest rates.⁹ The average federal loan interest rate during our sample period (1992–2014) is 6.1%, with a standard deviation of 1.7%. We hypothesize that the impact of federal interest rates on student borrowing varies across regions with different tuition fee structures. Specifically, in regions with a higher share of students enrolled in private universities — where tuition tends to be more expensive — student loans are more responsive to changes in interest rates. Figure 1 also plots the difference in average college loan amounts between regions with high and low shares of students in private universities. We find that this difference is negatively correlated with federal interest rates, supporting our hypothesis.

⁶It is also worth mentioning that non-federal loans, including private loans and loans from non-government entities, constituted only about 10% of total student loans issued from 2010 to 2015. For details on other loan types, see Appendix B.2.

⁷The table only shows interest rates up to 2016 because our NSCG sample covers college graduates who entered college on or before 2016.

⁸Appendix Table B.2 also provides the interest rates during in-school, grace, and deferment periods. Prior to 2006, the interest rates during these periods were slightly lower than those during the repayment periods. This difference disappeared after 2006. Another thing to note is that subsidized loans have been unavailable to graduate students since 2012.

⁹From 1994 to 2006, the interest rates differed between the repayment and in-school periods; we use the average of these rates.

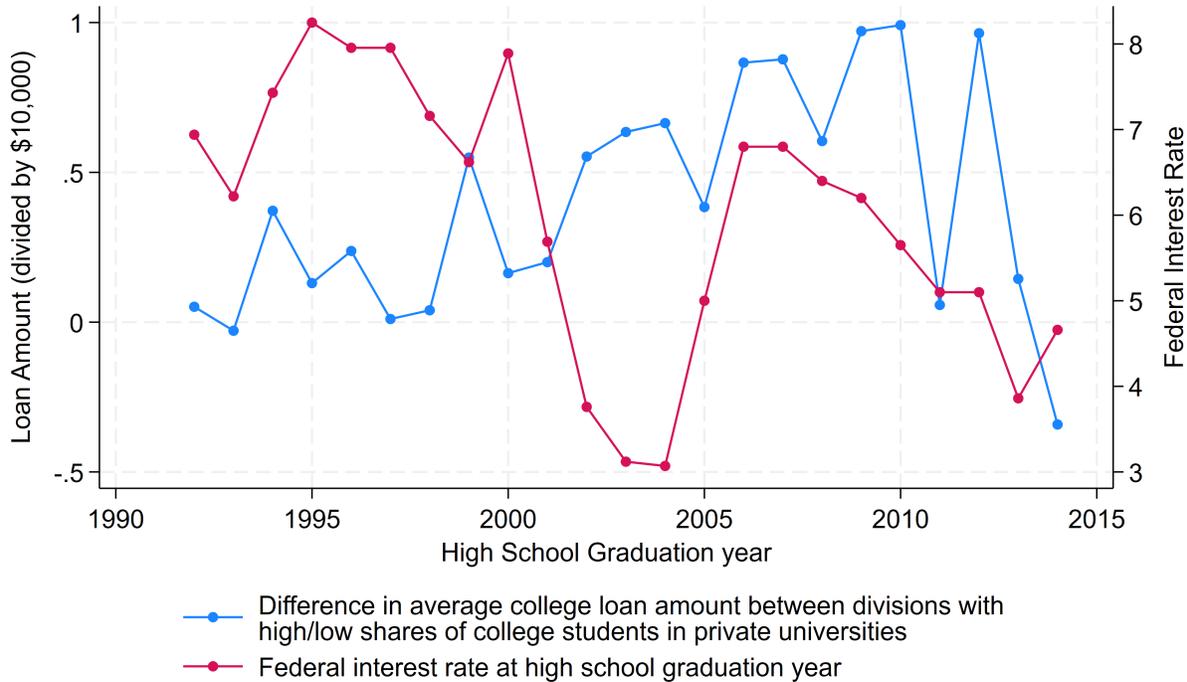


Figure 1: Trends in Federal Loan Interest Rates and the College Loan Gaps

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).¹⁰ Each wave is a stratified, nationally representative sample of U.S. residents aged 23 to 76 with at least a bachelor’s degree. We treat 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. Weights are applied throughout the analysis. This dataset provides rich information on student loans, college and graduate school outcomes, and labor market results such as employment status, working hours, annual salary, and occupation. It includes measures on the total amount borrowed in the survey year to finance undergraduate and graduate degrees, as well as the year and location (at the division level) of high school graduation — an essential factor in our analysis, since federal loan interest rates at the time

¹⁰Since 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 in 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.

of high school graduation and local college expenses are key determinants of loan-taking decisions.¹¹ Additionally, the NSCG offers information on the type and major of each degree obtained at the bachelor’s level or higher.

In our empirical analysis, we restrict the sample to individuals who graduated from high school in or after 1992, the year when federal student loans were formalized. The latest cohort in our sample comprises those who completed high school in 2015. Additionally, we limit the sample to individuals who hold only one bachelor’s degree and obtained their college degree in the United States.¹² We also restrict the sample to U.S. citizens and permanent residents, as non-permanent residents are not eligible for federal student loans. This leaves us with a final sample of 129,692 individual-year observations.

Table C.1 presents summary statistics for the variables used in our analysis. The individuals in our sample graduated from college between 1993 and 2014. On average, 60.5% of college graduates have taken out college loans, with an average loan amount of \$19,130 (including individuals with zero loans). Among those who borrowed, the average loan amount is \$31,620.

On average, 3% of college graduates are unemployed, 5% are self-employed in non-corporate businesses, and 10% work in small firms with ten or fewer employees. For full-time workers (defined as those working more than 35 hours per week and 41 weeks per year, following Altonji and Zhong (2021)), the average log earnings is 10.9, with a log hourly wage rate of 3.20. Additionally, 54% of these workers are employed in occupations related to their last college major.

We also use the Integrated Postsecondary Education Data System (IPEDS) from 1992 to 2020 to calculate the share of first-year college students enrolled in private universities at the division and year levels.¹³ The sample is restricted to four-year private and public institutions and excludes online institutions. This information is merged with the NSCG data to characterize the share of private university students in each residential division at the high school graduation year for each individual. Moreover, the IPEDS also provides information on tuition, total costs, and financial aid, enabling us to analyze the impact of federal loan interest rates on schools’ responses. Appendix Table C.2 report the summary statistics of the IPEDS data.

¹¹There are nine divisions in the US: New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific regions. In the publicly available NSCG data, information about respondents’ high school residential states is not provided.

¹²Some individuals report multiple Bachelor’s degrees awarded in the same year, each with a different major. We treat them as one Bachelor’s degree with multiple majors, and treat the primary major reported in the first BA degree as the first major.

¹³Appendix A details the construction of the measure.

4. Empirical Approach

To study the impact of federal loan interest rates on college financing, education, and labor market outcomes, we leverage the variation in federal loan interest rates across years, which means that high school graduates from different cohorts face different financing costs. Moreover, the impact of federal interest rates varies across regions. Regions with a higher share of students attending private universities tend to have higher tuition costs, as public universities typically charge lower in-state tuition. In these regions, interest rates play a more significant role in loan-taking decisions, since students are more likely to rely on loans to finance their college education. We expect that in years of low federal loan interest rates, students living in regions with a high private share will borrow more than those living in regions with a low private share. Thus, we adopt a continuous difference-in-differences approach, utilizing variations in federal loan interest rates over time and regional differences in the share of students enrolled in private universities:

$$Y_{id_0t_0t} = \beta_0 + \beta_1 PS_{d_0t_0} + \beta_2 IR_{t_0} \times PS_{d_0t_0} + \delta_{t_0} + \delta_{d_0} (+ \delta_t) + X_{it}B + \epsilon_{id_0t_0t} \quad (1)$$

where i represents the individual, d_0 the location of high school graduation (measured by division), t_0 the year of high school graduation, and t the year of observation. IR_{t_0} captures the federal loan interest rate at the national level during the high school graduation year t_0 . $PS_{d_0t_0}$ represents the share of first-year students enrolled in private universities within division d_0 and year t_0 at the time of high school graduation. Since the publicly available NSCG data do not include respondents' high school residential states, we use their high school residential divisions instead. There are nine divisions in the US: New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific regions. The coefficient β_2 , which measures the interaction between the federal loan interest rate and the private share, is the parameter of interest.

We include high-school graduation year fixed effects in our analysis to account for cohort-specific variations in education and labor market conditions, such as college tuition, commercial loan interest rates, and economic recessions. We also control for high-school graduation division fixed effects to account for geographical variation. Additionally, we control for individual characteristics (denoted as X_{it}), including the interaction of gender and race/ethnicity, a quadratic function of age, and parental education. When we analyze the impact on time-varying outcomes, we also control for survey year fixed effects (δ_t). For all specifications, standard errors are clustered at the high school graduation year and division level. Sample weights provided by NSCG are used to ensure the representativeness of the results.

We conduct a comprehensive analysis of the impact of federal loan interest rates on various short- and long-term outcomes. The dependent variables (Y_{idotot}) are categorized into five groups: (1) Student loans: including whether students borrow loans, the amount borrowed, and total interest payments; (2) College financing: whether college costs are financed through government loans, family loans, parental assistance, or personal savings; (3) Educational outcomes: such as college major choice; (4) Labor market outcomes: including unemployment, self-employment, firm size, annual earnings, working hours, hourly wages, and occupation choice; (5) Job satisfaction: whether individuals are satisfied with various aspects of their current job.¹⁴

5. Empirical Results

5.1. Impact on Student Loans

We begin by examining the effect of federal loan interest rates on college student financing, specifically focusing on the amount of loans borrowed and the amount of interest that needs to be repaid. We find that, when interest rates vary over time, these two variables do not necessarily move in the same direction.

We first analyze the impact of interest rates on student loans using the specification outlined in Equation (1). Column (1) of Table D.5 shows that a 1 percentage point increase in federal loan interest rates is associated with a reduction of the probability of students taking out a loan by 5.06 percentage points among students in regions where 100% attend private universities, compared to regions with no private university presence. Given that the average share of students in private universities ranges from 19% to 64% across our sample periods, this implies that, on average, a 1 percentage point increase in interest rates reduces the probability of borrowing college loans by 2.28 percentage points for students in regions with the highest private university share compared to those with the lowest.¹⁵

Additionally, as shown in Column (2), a 1 percentage point increase in interest rates is associated with an average decline of \$2,075 in the amount of student loans among students in regions with the highest private university share, compared to those in regions with the lowest share.¹⁶ These results indicate that federal loan interest rates significantly influence students' borrowing behavior. When the costs of financing college through federal loans rise, students tend to reduce the amount they borrow.

¹⁴Appendix A provides detailed definitions of these dependent variables.

¹⁵The division with the highest private university share is New England, that with the lowest share is West South Central.

¹⁶Calculation: $4,610 \times (0.64 - 0.19) = 2,075$.

Table 1: Effects of Federal Loan Interest Rates on Student Loans

	(1)	(2)	(3)
	Take loan for college	Loan borrow amount (in 10k)	Interest payment (in 10k)
$IR_{t_0} \times PS_{d_0t_0}$	-0.0506*** (0.017)	-0.461*** (0.084)	-0.00744 (0.031)
R-squared	0.205	0.127	0.143
Observations	129692	129692	124715

Notes: The table reports estimates of the effect of federal loan interest rates on student loans. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** p<0.01, ** p<0.05, * p<0.1.

The amount of loans borrowed only reflects the principal, excluding interest payments. While higher interest rates increase interest payments, the reduction in the borrowed amount offsets this effect. Therefore, the overall effect on interest payments is ambiguous. We impute the interest payments using the following formula

$$TotalPayment = 0.7Loan \frac{\frac{ir_s}{12}}{1 - (1 + \frac{ir_s}{12})^{-120}} + 0.3Loan \frac{\frac{ir_p}{12}}{1 - (1 + \frac{ir_p}{12})^{-120}} \quad (2)$$

$$InterestPayment = TotalPayment - Loan \quad (3)$$

where $Loan$ represents the amount of loans borrowed, ir_s denotes the monthly average interest rates for subsidized and unsubsidized loans, and ir_p refers to the monthly interest rate for PLUS loans. We assume a repayment period of 10 years, which is common for Fixed Payment Repayment Plans.¹⁷ According to Figure B.3, approximately 70% of the student loans are federal subsidized and unsubsidized loans. The remaining portion primarily consists of PLUS loans, which are also federal loans. Based on this, we assume that 70% of the loans accrue the average interest rates of subsidized and unsubsidized loans (note that these two types of loans generally have the same interest rates during most of our sample period), while the remaining 30% accrue the interest rates of PLUS loans.¹⁸ After calculating the total

¹⁷The Income-Driven Repayment Plan only gained popularity after the late 2000s, and thus has limited overlap with our studied sample. It is important to note that the total amount of loans may include federal loans, state government loans, commercial loans from banks, and loans from parents.

¹⁸This calculation is subject to measurement error because part of the remaining 30% could originate from commercial loans with higher interest rates than PLUS loans or from family loans with zero interest rates. However, non-federal loans only account for approximately 10% of the total loans.

payment, we determine the interest payment by subtracting the amount of loans borrowed from the total payment.

Next, we analyze the effect of federal loan interest rates on interest payments. As shown in Column (3), there is no significant impact on interest payments. This indicates that when interest rates are higher at college entry, students tend to borrow less, resulting in total interest payments remaining relatively unchanged.

Discussion. In summary, lower interest rates lead students to borrow more, resulting in larger loan balances upon graduation. While this increases the total debt burden, it does not necessarily make students worse off. The key is that interest payments remain similar, and the additional borrowing provides greater upfront liquidity, allowing students to better smooth consumption during college.

The traditional literature often treats loan amounts as a primary constraint, implicitly holding financing costs constant. Our analysis reveals that when interest rates vary, larger loans can reflect an endogenous, optimizing response to lower financing costs. This reframes the interpretation: if higher borrowing is driven by declining rates, it signals a positive liquidity effect. Students take on more debt precisely because the cost of borrowing has fallen, which relaxes their financial constraints and improves welfare despite the higher principal. In particular, with greater upfront resources, students can make more optimal educational and career choices — following their preferences rather than being forced by short-run financial pressure into fields with the highest immediate earnings.

5.2. College Financing

We further analyze how federal loan interest rates affect how students finance their college. First, we decompose student loans into two categories: loans from the government and banks, and loans from parents. Columns (1) and (2) of Table D.6 show that an increase in interest rates reduces the likelihood that students obtain loans from government or banks, as well as loans from parents. Moreover, Column (3) suggests that parents substitute family loans with financial assistance. When interest rates are high, the cost of financing college increases for students, leading parents to provide financial support through direct assistance rather than loans, since the latter require repayment while the former does not. This indicates that family responses can partially offset the negative effects of rising interest rates. Additionally, Column (4) shows that college students are more likely to use their own savings to finance college.

5.3. Impact on Education Choices

Next, we assess whether federal loan interest rates influence major choices of college students. We calculate the initial earnings (γ_{0k}) and earnings growth (γ_{1k}) for each major k

Table 2: Effects of Federal Loan Interest Rates on College Financing

	(1) Loans from government or banks	(2) Loans from parents	(3) Financial support from parents	(4) Own Savings
$IR_{t_0} \times PS_{dot_0}$	-0.0697*** (0.022)	-0.0304*** (0.009)	0.0449** (0.020)	0.0433** (0.021)
R-squared	0.146	0.022	0.182	0.056
Observations	120133	120133	120133	90618

Notes: The table reports estimates of the effects of federal loan interest rates on students' college financing, including whether they borrow from the government or banks, whether they receive assistance or loans from parents, and whether use their own savings. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

using the NSCG data with the following regression:

$$w_{it} = \gamma_{0k} + \gamma_{1k}exp_{it} + \gamma_2exp_{it}^2 + \gamma_3edu_i \quad (4)$$

where the constant term and the coefficient for potential experience are allowed to vary by major. These estimated parameters are then used as dependent variables in Equation (1).

Columns (1) and (2) of Table D.7 indicate that students facing higher federal interest rates at college entry are more likely to select majors with higher earnings growth. Although interest rates have no effect on major-specific initial earnings, a one percentage point increase in interest rates is associated with an increase in γ_{1k} of 0.0153 percentage points for students from regions with the lowest private university share, compared to those from regions with the highest share.¹⁹ This result suggests that students facing greater financial pressure at college entry are more likely to choose majors with higher long-term earnings potential.

5.4. Impact on Labor Market Outcomes

This section examines whether federal loan interest rates at the time of college entry influence long-term labor market outcomes. Table D.8 presents the estimated effects on employment status. We find that a one-percentage-point increase in interest rates is associated with a 0.54 percentage point decline in the unemployment rate for students from regions with the lowest private university share, relative to those from regions with the highest share.²⁰ This result aligns with the intuition that higher interest rates place greater financial pressure on students, making them less able to remain unemployed while searching for better

¹⁹Calculation: $0.034 \times (0.64 - 0.19) = 0.0153$.

²⁰ $1.21 * (0.64 - 0.19) = 0.54$.

Table 3: Effect of Federal Loan Interest Rates on College Major Choice

	(1)	(2)
	Major-specific initial earnings	Major-specific earnings growth
$IR_{t_0} \times PS_{dot_0}$	-0.00185 (0.009)	0.000336* (0.000)
R-squared	0.456	0.401
Observations	134045	134045

Notes: The dependent variables are the major-specific initial earnings and earnings growth. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

job opportunities.

Table 4: Effects of Federal Loan Interest Rates on Labor Market Outcomes (Full Sample)

	(1)	(2)	(3)
	Unemployed	Self employment	Work in a small firm
$IR_h^{\text{fed}} \times \text{Private}_{h,j}$	-0.0121** (0.006)	-0.0213* (0.012)	-0.0200* (0.012)
R-squared	0.015	0.011	0.008
Observations	134045	134045	123023

Notes: The table reports the effects of federal loan interest rates at high-school graduation year on labor market outcomes, using the full sample. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, survey year fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the division and high-school graduation year level and reported in parentheses. Sample weights are used. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Additionally, we find that higher interest rates —and the consequent reduction in student loan amounts — are associated with employment in higher-paying jobs. As shown in the last two columns of Table D.8, this is reflected in a decreased likelihood of both self-employment in non-incorporated businesses and employment at small firms. Our measure of self-employment specifically excludes owners of incorporated businesses, thereby capturing more informal or casual employment. This pattern suggests that the higher financing costs associated with college compel individuals to seek jobs with higher earnings.

Next, we concentrate on the full-time sample to examine the effects of student loans on earnings, work hours, hourly wage rates, and occupation. Full-time workers are defined as

working more than 35 hours per week and 41 weeks per year. The preferences and abilities of individuals may differ between those working part-time and those working full-time (Altonji and Zhong, 2021). Since our analysis indicates that federal loan interest rates do not affect full-time employment, we focus on the full-time sample, where measures of earnings and occupation are more relevant.²¹

As shown in Column (1) of Panel A, Table D.9, a one-percentage-point increase in federal loan interest rates at college entry raises annual earnings by 2.81% for graduates from the highest private university share division relative to those from the lowest division.²² We further decompose the change in annual earnings into its two components: annual hours worked and hourly wage rates. The results indicate that the positive effect on earnings stems from increases in both components, although the impact on hourly wage rates is only marginally significant.

Table 5: Effects of Undergraduate Loans on Labor Market Outcomes (Full-time Working Sample)

	(1)	(2)	(3)	(4)	(5)	(6)
	ln(annual earnings)	ln(annual hours)	ln(hourly wage)	Occ initial earnings	Occ earnings growth	Occ relevant
$IR_{t_0} \times PS_{d_0t_0}$	0.0624** (0.030)	0.0144* (0.008)	0.0296 (0.024)	0.00837 (0.012)	0.000489*** (0.000)	0.0416* (0.023)
R-squared	0.171	0.049	0.184	0.435	0.576	0.020
Observations	103850	104107	103413	104107	104107	102955

Notes: The table reports the effects of undergraduate loans and federal loan interest rates at high-school graduation year on labor market outcomes, using the full-time working sample. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, survey year fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In addition, we find that the choice of occupation significantly contributes to explaining the observed changes in earnings. Using Equation (4), we calculate the average initial earnings and earnings growth by age for each occupation.²³ Our results indicate that individuals facing higher interest rates are more likely to work in occupations characterized by higher earnings growth and roles relevant to their last majors. Specifically, a one percentage point increase in interest rate is associated with a 0.022 percentage point increase in occupation-specific earnings growth and a 1.87 percentage point increase in the probability of working in an occupation related to their last major.²⁴

²¹We find that federal loan interest rates have no significant effect on full-time employment. The results are available upon request.

²² $6.24\% * (0.64 - 0.19) = 2.81\%$.

²³In this context, k indicates occupation rather than major.

²⁴Calculations: For occupation-specific earnings growth, $0.0489 * (0.64 - 0.19) = 0.022$; for relevant occu-

Lastly, we analyze the impact on job amenities. Workers often face a tradeoff between salary and job amenities, and the results are shown in Table D.10. Specifically, college graduates with higher federal loan interest rates are more likely to consider salary as an important factor in job characteristics. Conversely, they are less likely to be satisfied with aspects such as independence and responsibility in their current roles. This indicates that higher salaries may come at the expense of lower job satisfaction, suggesting that the higher college financing costs prompt individuals to prioritize salary over other job amenities in their employment choices.

Table 6: Impact on Job Factor and Job Satisfaction

	(1) Salary as an important factor	(2) Satisfied with independence	(3) Satisfied with responsibility
$IR_{t_0} \times PS_{d_0t_0}$	-0.0137** (0.006)	-0.0167*** (0.006)	0.00329** (0.001)
R-squared	0.006	0.011	0.005
Observations	123023	123023	133731

Notes: The table reports estimates of the effects of federal loan interest rates on treating salary as an important factor when choosing a job, and being satisfied with independence and responsibility. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, survey year fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6. Robustness Checks

6.1. Other Potential Channels

Impact on College Prices. We first analyze the impact on college pricing at the regional level. We construct division-by-year aggregates for our key outcomes — tuition, total cost of attendance (including tuition, books, supplies, room and board, and other expenses), and financial aid — using IPEDS data. These aggregates are weighted by the number of first-year students in each institution. The regression specification follows Equation (1) but excludes individual-level controls.

$$Y_{d_0t_0} = \alpha_0 + \alpha_1 PS_{d_0t_0} + \alpha_2 IR_{t_0} \times PS_{d_0t_0} + \xi_{d_0} + \xi_{t_0} + e_{id_0t_0} \quad (5)$$

pation, $4.16 * (0.64 - 0.19) = 1.87$.

Table D.2 shows that interest rates do not have a significant effect on tuition, total costs, or financial aid. This contrasts with findings by Black et al. (2025), who demonstrate that the creation of Grad PLUS led to significantly higher program prices. Since interest rates tend to adjust frequently, colleges may not be able to respond promptly to changes in interest rates.

Impact on College Attendance and Completion. Next, we investigate the impact of federal loan interest rates on college attendance and completion. In particular, reduced federal loan interest rates may plausibly increase college enrollment or completion rates, thereby raising the number of college graduates. This could alter the student composition in the NSCG dataset, which only contains college graduates.

To address this issue, we utilize IPEDS data to analyze the impact of federal loan interest rates on college enrollment. IPEDS provides information on the number of first-year college students at the institution-year level. Additionally, we estimate the effect on college completion using the NSCG dataset. Specifically, the inverse of the sampling weight in the NSCG represents the number of students each respondent stands for. We aggregate the counts of freshmen and college graduates to the division-year level. Following the specification in Equation (5), we replace the dependent variable with either the number of first-year college students or the number of college graduates. Columns (1) and (2) of Table D.1 indicate that the interaction between federal loan interest rates and the share of students in private universities has no significant effect on college enrollment or completion. This finding aligns with existing literature suggesting that borrowing constraints exert minimal influence on college completion (Keane and Wolpin, 2001; Cameron and Taber, 2004; Stinebrickner and Stinebrickner, 2008; Ionescu, 2009; Johnson, 2013).

We also investigate whether interest rates influence the composition of students who complete college. Specifically, we analyze the impact on fathers' and mothers' education levels among NSCG respondents, following Equation (1). Our findings indicate that federal loan interest rates are not significantly associated with parental educational attainment, as shown in the last two columns of Table D.1. These results collectively support the conclusion that our analysis using the NSCG data is unlikely to be affected by selection issues.

6.2. Controlling for Labor Market Conditions at College Entry

Another potential concern is that federal loan interest rates may be correlated with labor market conditions at college entry, which are known to have large and persistent effects on career outcomes (Kahn, 2010; Oreopoulos et al., 2012). To address this, we control for the local unemployment rate at the time of college graduation. Specifically, we use the

unemployment rate in the student’s college graduation year for the census division of their reported high school location, sourced from the U.S. Bureau of Labor Statistics.²⁵

As shown in Appendix Appendix D.2, our baseline results remain robust after including this control. Consistent with prior literature, we also find that higher local unemployment rates at graduation are associated with a higher probability of unemployment, lower hourly wages, and lower annual earnings.

7. Conclusion

Students from regions with fewer public universities typically face higher tuition costs, making their college financing decisions more sensitive to changes in federal loan interest rates. We leverage this heterogeneity by implementing a continuous difference-in-differences design that exploits variation in federal interest rates over time and cross-sectional variation in the regional share of students attending private universities. This strategy allows us to estimate the causal impact of interest rates on college financing, educational choices, and subsequent labor market outcomes using data from the NSCG.

We find that an increase in federal loan interest rates reduces the total amount of student loans borrowed but does not lead to higher interest payments. In response to higher rates, students shift their financing mix: they rely more on family assistance and personal savings and less on government and private loans. This shift indicates that higher interest rates increase the immediate, out-of-pocket cost of college. Students receive less liquidity upfront at college entry and must cover a larger share of expenses from current resources.

We further demonstrate that federal loan interest rates influence major and occupation choices by shifting individuals toward fields with higher earning potential. Higher rates are also associated with a lower likelihood of unemployment, self-employment, and employment at small firms. Consequently, affected individuals tend to have higher earnings, longer work hours, and jobs more closely related to their major. They are also more likely to report salary as an important job characteristic. This shift toward higher pay, however, comes at the cost of job amenities: these workers report lower satisfaction with their job responsibilities and level of independence. This pattern suggests that increased financial pressure leads students to prioritize salary over personal preference when making career decisions.

This study reveals that the federal student loan interest rate prevailing at college entry exerts a persistent influence on labor market outcomes. By raising the cost of borrowing,

²⁵As we do not observe the division of the college attended, we use the high school division as a proxy. Given that most students attend college in their home state, this measure, while imperfect, provides a reasonable control for local economic conditions at graduation. The unemployment rate data comes from the U.S. Bureau of Labor Statistics, Regional and State Unemployment, 1993–2024.

higher rates lead graduates to prioritize salary over job amenities—a trade-off with lasting implications for career satisfaction and economic welfare. Consequently, policymakers should evaluate interest rates not merely as a tool for financing education, but as a significant determinant of graduates' long-term professional and well-being.

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Appendix A. Definition of Dependent Variables

Appendix A.1. Variables from NSCG

Indicator for college loans ($\mathbb{1}_{college\ loan>0}$) is a dummy variable that equals 1 if the individual borrowed college loans that require repayment. Using the panel data, we assign this variable a value of 1 if the respondent ever answered “yes” to the loan question in any wave.

College loan is the numerical value for the college loan amount, including federal loans and private loans. Respondents select from 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 midpoint of each range. For the “90k and above” category, we assign 95k, and for respondents who did not borrow or complete a degree, we assign 0.

Total payment is the imputed total amount to be repaid on undergraduate loans, including both principal and interest, assuming a 10-year repayment plan with fixed monthly installments. We assume that 70% of loans accrue the average subsidized/unsubsidized federal interest rate (i_f) and 30% accrue the PLUS loan interest rate (i_p), where both annual rates are converted to monthly rates by dividing by 12. The total repayment is computed as the sum of two components using the standard annuity formula:

$$\text{Total Payment} = (0.7L) \times \frac{i_f(1+i_f)^{120}}{(1+i_f)^{120}-1} + (0.3L) \times \frac{i_p(1+i_p)^{120}}{(1+i_p)^{120}-1},$$

where L is the undergraduate loan principal, i_f is the monthly federal interest rate, i_p is the monthly PLUS loan interest rate, and 120 is the number of monthly payments over a 10-year horizon.

Borrowed from school, banks, federal or state government is a dummy variable equal to 1 if the individual reports having borrowed student loans from their school, banks, or federal or state government, and 0 otherwise.

Loans from parents or other relatives, to be repaid is a dummy variable equal to 1 if the individual reports having borrowed money from parents or other relatives that requires repayment, and 0 otherwise.

Financial assistance from parents, spouse, other relatives, not to be repaid is a dummy variable equal to 1 if the individual reports having received financial assistance from parents, spouse, or other relatives that does not require repayment, and 0 otherwise.

High initial wage major and *High wage growth major* are two continuous variables constructed from the following regression using the NSCG data. We estimate the following earnings regression that includes college major dummies and their interaction with age on the full-time working sample. We normalize age to 25 years old. The outcome variable Y_{it} is the natural logarithm of annual earnings. The controls, X_{it} , include all the control variables in the main regression, in addition to the public/private status of the BA degree institution, calendar year, employers' location, and a dummy for having a graduate degree when observed. The coefficient on each major dummy (λ_1^{major}) would reflect the initial labor market return of the major, and the coefficient on its interaction term with age (λ_2^{major}) would reflect its growth as age (serving as a proxy for years of professional experience) increases. In the main text, we call λ_1^{major} the “*Major Initial Earnings*”, and λ_2^{major} the “*Major Earnings Growth*”.

$$Y_{it} = \lambda_1^{major} + \lambda_2^{major} (Age - 25) + \lambda_3 (Age - 25)^2 + X_{it}\Lambda + \epsilon_i$$

Double major is a dummy variable equal to 1 if the individual has a second major or minor in their first BA degree.

Obtain grad degree is a dummy variable equal to 1 if the individual has a graduate degree by the last time we observe this individual in the panel data. We add the age restriction because a substantial share of U.S. college graduates delay graduate school enrollment until their late 20s or early 30s.

Participation is a dummy variable equal to 1 if the individual is participating in the labor market, including employed and unemployed. It is 0 if the individual is not in the labor force.

Unemployment is a dummy variable equal to 1 if the individual is participating in the labor market and unemployed. It is 0 if the individual is employed or not in the labor force.

Employment is a dummy variable equal to 1 if the individual is employed and 0 if they are unemployed or out of the labor force.

Fulltime is a dummy variable equal to 1 if the individual works at least 35 hours per week and at least 41 weeks per year, and 0 otherwise.

Self-employment is a dummy variable equal to 1 if the individual is self-employed in a non-

incorporated business, professional practice, or farm. It is 0 if the individual is a business owner (i.e. self-employed in an incorporated business, professional practice, or farm) or employed by any private sector or public sector corporation. It is also 0 if the individual is unemployed or out of the labor force.

Work in a small firm is a dummy variable equal to 1 if the individual works for a firm with ten or fewer employees. It is 0 if the individual works for a firm with more than 10 employees, is unemployed, or is not in the labor force.

$\ln(\text{earnings})$ is the natural logarithm of annual base earnings from the principal job.

$\ln(\text{annual hours})$ is the natural logarithm of the hourly wage rate, calculated as:

$$\text{annual hours} = \text{hours worked per week} \times \text{weeks worked per year}.$$

$\ln(\text{hourly wage rate})$ is the natural logarithm of the hourly wage rate, calculated as:

$$\text{hourly wage rate} = \frac{\text{earnings}}{\text{annual hours}}.$$

Occ initial earnings and *Occ earnings growth* are two continuous variables constructed in a similar manner as *Major initial earnings* and *Major earnings growth*, except that the coefficients are occupation-specific instead of major-specific. *Occ initial earnings* reflects the initial labor market return of the occupation, and *Occ earnings growth* reflects its rate of return to years of professional experience.

$$Y_{it} = \lambda_1^{occ} + \lambda_2^{occ} (\text{Age} - 25) + \lambda_3 (\text{Age} - 25)^2 + X_{it}\Lambda + \epsilon_i$$

Occupation relates to major is a dummy variable equal to 1 if the individual reports that their principal job is closely or somewhat related to the field of study of their most recent post-secondary degree, and 0 if it is not related.

Salary is important is a dummy variable equal to 1 if the individual reports that they consider salary as an important factor when thinking about a job, and 0 otherwise. We categorize “very important”, “somewhat important”, and “somewhat unimportant” as 1, and “not important at all” as 0.

Degree of independence is important is a dummy variable equal to 1 if the individual reports that they consider the degree of independence as an important factor when thinking about a job, and 0 otherwise. We categorize “very important”, “somewhat important”, and “somewhat unimportant” as 1, and “not important at all” as 0.

Level of responsibility is important is a dummy variable equal to 1 if the individual reports that they consider the level of responsibility as an important factor when thinking about a job, and 0 otherwise. We categorize “very important”, “somewhat important”, and “somewhat unimportant” as 1, and “not important at all” as 0.

Appendix A.2. Variable from IPEDS

Total number of college freshmen (thousands) represents the total count of full-time, first-time, degree- or certificate-seeking undergraduates (in thousands) within a specific division and year.

Fraction of college freshmen enrolled in private school refers to the proportion of first-year students attending private (versus public) institutions within a specific division and year. It is calculated by dividing the number of first-year students in private institutions by the total number of first-year students enrolled in that division and year.

Because IPEDS is school-by-year level data and our analysis requires division-by-year aggregates, we apply a consistent adjustment to all monetary variables. Specifically, all amounts are converted to 2013 USD using the CPI-U, and we correct for missing values by computing school-type-specific averages (public and private) and then aggregating to the division level using enrollment weights. Formally, for each school type $s \in \{\text{public, private}\}$ we compute

$$\bar{X}_s = \frac{\sum_{i \in s} X_i}{N_s},$$

where X_i is the reported amount for institution i and N_s is the number of reporting institutions in sector s . We then aggregate to the division level as

$$\bar{X} = \frac{\sum_s E_s \cdot \bar{X}_s}{\sum_s E_s},$$

where E_s denotes the number of enrolled students in sector s . This procedure preserves both the relative size of the public and private sectors and the scale of reported amounts. This adjustment applies to all four variables below. For each monetary variable, we also construct

its natural logarithm.

Tuition fee refers to the adjusted average of published tuition and fees per student for a given division and year. At the school level, tuition is defined as the mean of in-state and in-district tuition rates.

Total cost of college refers to the adjusted average annual cost of attendance per student for a given division and year. It is calculated as the sum of tuition and fees, books and supplies, room and board, and other expenses. Observations are included only if tuition data is available; other components are incorporated when reported.

Average amount of financial aids refers to the adjusted division–year average of grant aid per first-year student. It is calculated by dividing the total federal, state, local, and institutional grant aid by the number of full-time, first-time undergraduates at the institution.

Appendix B. More Background Information about Student Loans

Appendix B.1. Subsidized and Unsubsidized Federal Loans

Interest Rates. Table B.1 reports the interest rates of subsidized and unsubsidized federal loans for undergraduate and graduate students during the repayment period from 1994 to 2015. Meanwhile, Table B.2 shows the interest rates for the in-school, grace, and deferment periods.

Table B.1: 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%
7/1/1993–6/30/1994	6.22%	6.22%	6.22%	6.22%
7/1/1992–6/30/1993	6.94%	6.94%	6.94%	6.94%

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 both annual and aggregate borrowing limits for their entire course of study. Table B.3 outlines changes in aggregate borrowing limits for undergraduate and graduate students since 1994. While borrowing limits for unsubsidized loans are not always specified, legislation provides details for the combined totals of Direct Loans. For example, dependent students receiving financial support from

Table B.2: 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%
7/1/1993–6/30/1994	0	6.22%	0	6.22%
7/1/1992–6/30/1993	0	6.94%	0	6.94%

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.3: 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>.

families have been able to borrow up to \$31,000 in Direct Loans for undergraduate study since July 2008, with no more than \$23,000 in subsidized loans. In contrast, independent students without financial support from parents or guardians face different borrowing limits. For example, graduate or professional students have been able to borrow up to \$138,500 for undergraduate and graduate studies since 2018, with no more than \$65,600 in subsidized loans.

Repayment Plans. While enrolled in school, students are required to repay only the interest on their loans. For subsidized loans, the government pays the interest. Undergraduates typically begin repaying the principal six months after graduation, during a grace period. If students pursue further education at the graduate level, principal repayment is deferred until they complete graduate studies. Students can choose from several repayment options, including Fixed Payment Repayment Plans such as Standard, Graduated, and Extended Repayment Plans. Alternatively, they may opt for an Income-Driven Repayment (IDR) Plan. Figure B.2 details the various repayment plans available to students.²⁶

Borrowers are automatically enrolled in the Standard Repayment Plan when they enter repayment. In this plan, monthly payments are fixed and calculated using the initial interest rate set at loan origination, with a ten-year repayment schedule. Graduated Repayment Plans feature lower initial payments that typically increase every two years over the ten-year period, similar to the Standard Repayment Plan. In contrast, Extended Repayment Plans are available to borrowers with federal loan debt exceeding \$30,000 and extend the repayment term to 25 years. All three plans apply to all 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 tie the repayment amount to the borrower's income and extend the repayment term to either 20 or 25 years. Due to

²⁶Source: <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 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.	10% of discretionary income but never more than what you would pay under the 10-year Standard Repayment Plan
	Income-Contingent Repayment (ICR) Plan		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: Federal Student Loan Repayment Plans, Federal Student Aid.

their flexibility and affordability, IDR plans have become increasingly popular over the past decade. As of 2017, IDR plans accounted for 45% of balances in repayment, according to Karamcheva et al. (2020).

Because payments under IDR plans are based on income and family size, borrowers must annually update this information with their loan servicer, who recalculates payment amounts accordingly. Under the SAVE Plan, monthly payments are 10% of discretionary income, defined as income above one-and-a-half times the federal poverty guideline. For other plans, monthly payments range from 10% to 20% of discretionary income and must not exceed the amount calculated under the Standard Repayment Plan.

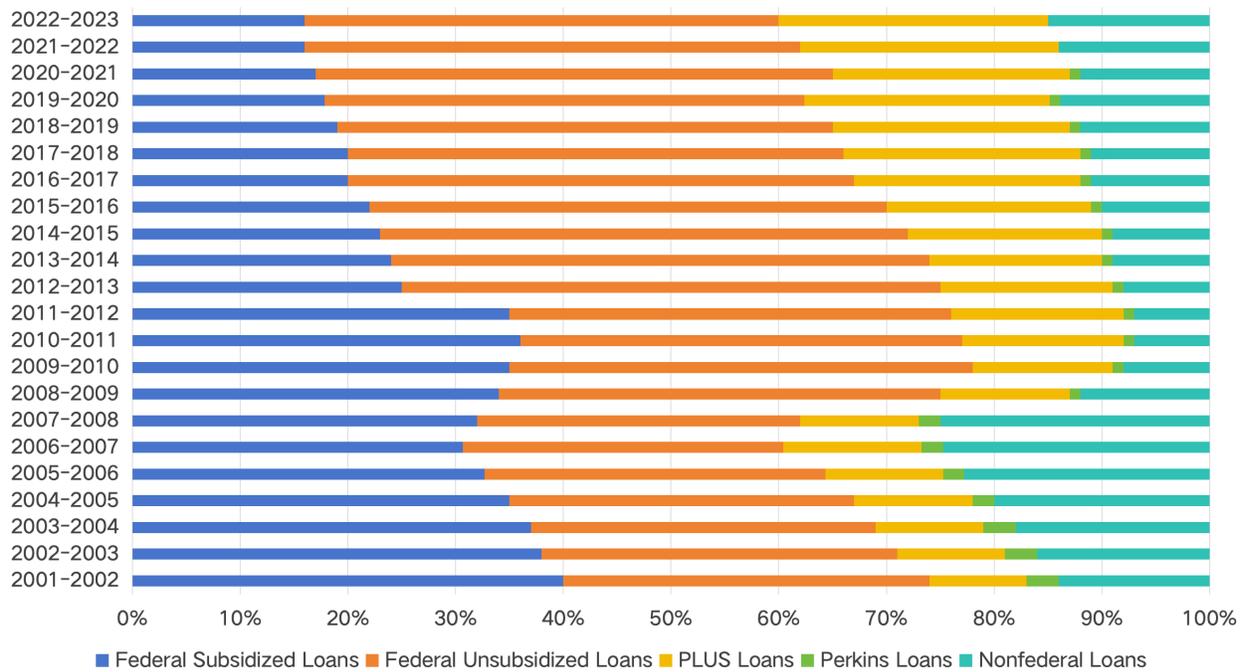
Appendix B.2. Other Types of Federal Loans besides Subsidized and Unsubsidized Loans

Direct subsidized and unsubsidized loans are the two most prominent 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. In contrast, students who borrow unsubsidized loans are responsible for all interest that accrues from the time of disbursement. (2) Subsidized loans have more stringent eligibility criteria, requiring students to demonstrate financial need, whereas unsubsidized loans do not require proof of financial need. (3) Since July 2012, subsidized loans have been restricted to undergraduate students.

PLUS Loans are another widely used option among college students and their parents. These loans are available to graduate students and the parents of dependent undergraduate students. PLUS Loans require a credit check and generally have higher interest rates than subsidized and unsubsidized loans. Since July 1993, PLUS Loans have had no borrowing limits and can cover any educational expenses not funded by other financial aid. Borrowers can combine multiple federal student loans into a single Consolidation Loan. Consolidation can simplify repayment and extend the repayment period, but it may also lead to higher interest costs over time.

Two discontinued loan programs are the Perkins Loans and the Federal Family Education Loan (FFEL) Program. Perkins Loans, designed to assist students with exceptional financial needs, offered low-interest rates and were provided by participating schools. This program was discontinued in 2017. The FFEL Program, funded by private lenders and guaranteed by the federal government, ended in 2010, with no new loans issued under the program since. Figure B.3 presents the market share of different types of loans. Federal subsidized and unsubsidized loans account for more than 70% of the market share during the period of 2001 to 2023.

Figure B.3: Different Types of Loans Market Share



Source: Share of total student loans provided in the United States, by source from 2001/02 to 2022/23, Statista.

Appendix C. Supplementary Results

Table C.1: Summary Statistics

Variable	Mean	SD
Full sample		
High school graduation year	2001	5.360
Take loan for college	0.605	0.489
College loan amount (in 10k)	1.913	2.362
Total payment (in 10k)	0.687	0.881
Proportion of students who borrowed student loans from the school, banks, federal or state government	0.086	0.281
Loans from parents or other relatives, to be repaid	0.086	0.281
Financial assistance from parents, spouse, other relatives, not to be repaid	0.637	0.481
Major initial earnings	11.006	0.243
Major earnings growth	0.035	0.021
Double major in college	0.157	0.364
Obtain grad degree	0.308	0.462
Labor force participation	0.926	0.263
Unemployment	0.030	0.172
Employment	0.895	0.306
Working full-time	0.726	0.446
Self-employment	0.050	0.219
Work in a small firm	0.101	0.301
Count = 129,692		
Full-time worker sample		
ln(earnings)	10.933	0.636
ln(annual hours)	7.738	0.166
ln(hourly wage rate)	3.218	0.547
Occupation initial earnings (log)	11.085	0.276
Occupation earnings growth	0.023	0.023
Occupation related to major	0.540	0.498
Salary is important	0.998	0.041
Degree of independence is satisfied	0.971	0.167
Level of responsibility is satisfied	0.969	0.172
Count = 100,889		

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

Table C.2: Summary Statistics of School Statistics from IPEDS

Variable	Mean	SD
Total number of college freshmen (thousands)	148.262	68.510
Fraction of college freshmen enrolled in private school	0.368	0.125
Tuition fee	12651.01	5047.921
ln(tuition fee)	9.126	0.408
Total cost of college	25012.97	6103.287
ln(total cost of college)	10.031	0.232
Average amount of financial aids	6195.296	2078.321
ln(average amount of financial aids)	8.455	0.353
Total cell count		135

Notes: The table reports the weighted mean and standard deviation, and total cell count of school characteristic variables we calculated from IPEDS. The table reports average annual tuition, annual total cost, financial aid, and student loan amounts per enrolled student. Because some institutions do not report tuition, financial aid, or student loan information, we construct averages in a way that corrects for missing data. Specifically, for each school type $s \in \{\text{public, private}\}$, we compute

$$\bar{X}_s = \frac{\sum_{i \in s} X_i}{N_s},$$

where X_i is the reported amount for institution i and N_s is the number of reporting institutions in sector s . We then aggregate to the state level as

$$\bar{X} = \frac{\sum_s E_s \cdot \bar{X}_s}{\sum_s E_s},$$

where E_s denotes the number of enrolled students in sector s . The resulting statistics preserve both the relative size of the public and private sectors and the scale of reported amounts, providing corrected measures of the average annual tuition, financial aid, and student loans per enrolled student.

Appendix D. Robustness Checks

Appendix D.1. Alternative Potential Channels

Table D.1: Effect of Federal Loan Interest Rates on Selection into College Graduates

	(1)	(2)	(3)	(4)
	# freshmen	# college graduates	Father's education	Mother's education
$IR_{t_0} \times PS_{d_0t_0}$	30.64 (40.47)	5.689 (7.421)	-0.126 (0.112)	-0.056 (0.111)
Observations	198	198	129,692	129,508
R-squared	0.855	0.942	0.063	0.065

Notes: The dependent variables in the first two columns are the logarithm of numbers of first-year college students and college graduates at the division-year level from the IPEDS data and NSCG data, respectively. The dependent variables in the last two columns are fathers' and mothers' years of schooling from the NSCG data. The regression controls for high school graduation year fixed effects and division fixed effects. The last two columns additionally control for interactions between ethnicity and gender and age quadratic function. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table D.2: Effects of Interest Rate on College Tuition and Financial Aid

	(1)	(2)	(3)
	ln(tuition)	ln(total costs)	ln(financial aid)
$IR_{t_0} \times PS_{d_0t_0}$	0.019 (0.027)	0.006 (0.009)	0.006 (0.009)
Observations	135	135	135
R-squared	0.982	0.994	0.958

Notes: The dependent variables include the logarithm of the amount of tuition, total costs of colleges, and financial aid at the division-year level from the IPEDS data. The regression controls for high school graduation year fixed effects and division fixed effects. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix D.2. Controlling for the Unemployment Rate at College Graduation

Table D.3: Effects of Federal Interest Rates on College and Graduate School Outcomes

	(1) Attend public universities	(2) Double major	(3) Change major	(4) Obtain grad degree
$IR_{t_0} \times PS_{d_0t_0}$	0.0277 (0.020)	0.0227 (0.017)	0.0155 (0.026)	0.00756 (0.020)
R-squared	0.059	0.012	0.033	0.065
Observations	134045	134045	55488	134045

Notes: The table reports the effects of federal loan interest rates on college and graduate school outcomes. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table D.4: Effects of Federal Interest Rates on Major and Occupation Choices (ACS Data)

	(1) Major-specific initial earnings	(2) Major-specific earnings growth	(3) Occ-specific initial earnings	(4) Occ-specific earnings growth
$IR_{t_0} \times PS_{d_0t_0}$	-0.00852 (0.008)	0.00110** (0.000)	0.00878 (0.011)	0.00146* (0.001)
R-squared	0.053	0.054	0.808	0.078
Observations	133516	133516	100809	100809

Notes: The table reports the effects of federal loan interest rates on major and occupation choices. The data includes NSCG 2003-2019, with the first two columns using the full sample and the last two columns using the full-time working sample. The regression controls for high school graduation year fixed effects, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. The last two columns additionally control for survey year fixed effects. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table D.5: Effects of Federal Loan Interest Rates on Student Loans

	(1)	(2)	(3)
	Take loan for college	Loan borrow amount (in 10k)	Interest payment (in 10k)
$IR_{t_0} \times PS_{d_0t_0}$	-0.0530*** (0.017)	-0.489*** (0.090)	-0.0159 (0.032)
Unemployment Rate	0.0157*** (0.004)	0.123*** (0.028)	0.0384*** (0.011)
R-squared	0.209	0.132	0.146
Observations	127412	127412	122547

Notes: The table reports estimates of the effect of federal loan interest rates on student loans. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** p<0.01, ** p<0.05, * p<0.1.

Table D.6: Effects of Federal Loan Interest Rates on College Financing

	(1)	(2)	(3)	(4)
	Loans from government or banks	Loans from parents	Financial support from parents	Own Savings
$IR_{t_0} \times PS_{d_0t_0}$	-0.0723*** (0.023) (0.022)	-0.0298*** (0.009) (0.009)	0.0530** (0.020) (0.020)	0.0438** (0.021) (0.021)
Unemployment Rate	0.0128*** (0.004)	-0.00219 (0.002)	-0.0262*** (0.005)	-0.00351 (0.004)
R-squared	0.147	0.022	0.188	0.057
Observations	118128	118128	118128	89240

Notes: The table reports estimates of the effects of federal loan interest rates on students' college financing, including whether they borrow from the government or banks, whether they receive assistance or loans from parents, and whether use their own savings. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** p<0.01, ** p<0.05, * p<0.1.

Table D.7: Effect of Federal Loan Interest Rates on College Major Choice

	(1)	(2)
	Major-specific initial earnings	Major-specific earnings growth
$IR_{t_0} \times PS_{d_0 t_0}$	-0.000404 (0.009)	0.000332* (0.000)
Unemployment Rate	-0.00317 (0.002)	-0.00000649 (0.000)
R-squared	0.457	0.401
Observations	131683	131683

Notes: The dependent variables are the major-specific initial earnings and earnings growth. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** p<0.01, ** p<0.05, * p<0.1.

Table D.8: Effects of Federal Loan Interest Rates on Labor Market Outcomes (Full Sample)

	(1)	(2)	(3)
	Unemployed	Self employment	Work in a small firm
$IR_h^{\text{fed}} \times \text{Private}_{h,j}$	-0.0131** (0.006)	-0.0220* (0.012)	-0.0204* (0.012)
Unemployment Rate	0.00308* (0.002)	-0.00235 (0.003)	0.00134 (0.002)
R-squared	0.015	0.011	0.008
Observations	131683	131683	120962

Notes: The table reports the effects of federal loan interest rates at high-school graduation year on labor market outcomes, using the full sample. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, survey year fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the division and high-school graduation year level and reported in parentheses. Sample weights are used. *** p<0.01, ** p<0.05, * p<0.1.

Table D.9: Effects of Undergraduate Loans on Labor Market Outcomes (Full-time Working Sample)

	(1)	(2)	(3)	(4)	(5)	(6)
	ln(annual earnings)	ln(annual hours)	ln(hourly wage)	Occ initial earnings	Occ earnings growth	Occ relevant
$IR_{t_0} \times PS_{d_0t_0}$	0.0699** (0.032)	0.0143* (0.008)	0.0369 (0.025)	0.00898 (0.012)	0.000490*** (0.000)	0.0462* (0.024)
Unemployment Rate	-0.0324*** (0.007)	-0.000366 (0.002)	-0.0276*** (0.006)	-0.00219 (0.003)	-0.0000433 (0.000)	-0.0147*** (0.005)
R-squared	0.160	0.048	0.176	0.434	0.576	0.022
Observations	102182	102437	101763	102437	102437	101319

Notes: The table reports the effects of undergraduate loans and federal loan interest rates at high-school graduation year on labor market outcomes, using the full-time working sample. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, survey year fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table D.10: Impact on Job Factor and Job Satisfaction

	(1)	(2)	(3)
	Salary as an important factor	Satisfied with independence	Satisfied with responsibility
$IR_{t_0} \times PS_{d_0t_0}$	-0.0130** (0.006)	-0.0159*** (0.006)	0.00301** (0.001)
Unemployment Rate	-0.00520*** (0.001)	-0.00507*** (0.002)	0.000711** (0.000)
R-squared	0.008	0.012	0.005
Observations	120962	120962	131393

Notes: The table reports estimates of the effects of federal loan interest rates on treating salary as an important factor when choosing a job, and being satisfied with independence and responsibility. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, division fixed effects, survey year fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors are clustered at the high-school graduation year and division level and reported in parentheses. Sample weights are used. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.