

# The Ripple Effects of Rising Loan Costs: Major and Occupation Choices, Earnings, and Job Satisfaction <sup>\*</sup>

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## Abstract

This paper analyzes the impact of federal loan interest rates on college financing, education, and labor market outcomes using micro-data from the National Survey of College Graduates. Students from regions with a higher share of private university enrollment face higher tuition costs and rely more heavily on student loans, making them more responsive to changes in federal loan interest rates. We employ a continuous difference-in-differences framework that exploits variation in federal loan interest rates over time and across regions by private university enrollment share. Higher interest rates shift college financing away from student borrowing and toward family resources. They also raise college financing costs, steering students' educational and career trajectories toward pecuniary returns at the expense of job satisfaction. Individuals exposed to higher interest rates increase their labor supply, reflected in lower unemployment and longer working hours. They also treat salary as a more important job attribute and sort into job types with higher monetary returns. In particular, they are less likely to be self-employed or to work in small firms, and more likely to hold positions closely aligned with their field of study. These shifts in education and career choices translate into higher earnings, at the cost of lower satisfaction with job independence.

*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 defining feature of the U.S. education system. As of 2023, total student loan debt in the United States stands at approximately \$1.60 trillion, with federal loans accounting for 92.5% of this amount. Around 43.4 million Americans hold federal student loan debt, and the average borrower owes roughly \$36,900. While a large literature examines the consequences of student loan debt, much less is known about how the cost of financing this debt shapes individuals' educational and labor market choices.

The cost of federal student loans is largely determined by their interest rates. Changes in interest rates affect not only the overall cost of borrowing, but also students' borrowing behavior and the composition of financing, including the relative use of loans, family support, and personal savings. When financing costs rise, students may borrow less and rely more heavily on out-of-pocket resources, reducing liquidity at the time of college entry. This tightening of financial constraints can generate pressure to prioritize earnings over non-pecuniary job attributes, influencing a sequence of educational and labor market decisions, including major choice, occupation selection, and labor supply, with downstream consequences for earnings and job satisfaction. Taken together, higher financing costs may shift individuals from preference-based choices toward more income-driven decisions.

This paper studies how federal student loan interest rates affect college financing, educational choices, and labor market outcomes. We exploit time-series variation in federal loan interest rates and cross-regional differences in exposure to these changes, proxied by the share of students enrolled in private universities. Students in regions with higher private enrollment face higher tuition costs and rely more on student loans, making them more responsive to changes in interest rates. Using a continuous difference-in-differences framework, we estimate how variation in financing costs at college entry shapes borrowing behavior and subsequent life outcomes.

Using data from the National Survey of College Graduates (NSCG) from 2003 to 2019, we first show that changes in federal loan interest rates have substantial effects on students' financing decisions. A one-percentage-point decrease in interest rates increases the amount borrowed by approximately \$2,075 and raises the likelihood of taking out a student loan by 2.3 percentage points among students from regions with the highest shares of private university enrollment relative to those from regions with the lowest shares.<sup>1</sup> At the same time, total interest payments remain largely unchanged, as lower borrowing at higher interest rates offsets the mechanical increase in financing costs. We also document that when interest

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

rates rise, students substitute away from loan financing toward family resources and personal savings. Taken together, these results indicate that higher interest rates reduce liquidity at college entry and increase reliance on out-of-pocket funding.

We then examine how these changes in financing conditions translate into educational and career choices. We find that higher interest rates shift students toward majors with higher expected earnings growth, and, consistent with this pattern, toward occupations with greater earnings potential after graduation. Consistent with this shift, students are also more likely to select into STEM fields. In particular, they move away from fields such as psychology and foreign languages toward fields such as biology, environmental science, and engineering. Quantitatively, a one-percentage-point increase in the interest rate raises major-specific earnings growth by 30.4 percent and occupation-specific earnings growth by 7.7 percent. These results suggest that tighter financial constraints at college entry lead individuals to place greater weight on future earnings when making human capital investment decisions.

Consistent with this shift in educational and occupational choices, higher financing costs also affect labor market behavior and preferences. Individuals exposed to higher interest rates supply more labor, as reflected in lower unemployment and longer working hours, and sort into job types with higher monetary returns. In particular, they are less likely to be self-employed or to work in small firms, and more likely to hold positions closely aligned with their field of study. At the same time, they are more likely to report salary as an important job attribute. These patterns suggest that tighter financial constraints lead individuals to place greater weight on earnings when making labor market decisions.

These behavioral adjustments translate into distinct labor market outcomes. Individuals facing higher financing costs earn more, with a one-percentage-point increase in interest rates raising annual earnings by 2.81 percent for those from regions with the highest private university share relative to those from the lowest. However, these gains come with a cost: individuals exposed to higher interest rates report lower satisfaction with job attributes such as independence and responsibility. This pattern highlights a central trade-off: higher financing costs are associated with greater earnings and labor supply, but also with reduced job amenities and lower job satisfaction.

We conduct a series of robustness checks to rule out alternative channels and support our identification. Using IPEDS data from 1992 to 2020, we find no evidence that universities adjust tuition, total costs, or financial aid in response to changes in federal loan interest rates, alleviating concerns that institutional responses confound our estimates. We also find no effects on college enrollment, completion, or student composition, suggesting that our results are not driven by selection into the NSCG sample of college graduates. Finally, interest rates

do not affect key educational margins, including attendance at public universities, double majoring, major switching, or graduate study, and our results are robust to controlling for local labor market conditions at graduation, indicating that our findings are not driven by alternative educational adjustments or macroeconomic factors.

This study contributes to the extensive literature on student loans by focusing on the cost of financing rather than the level of borrowing. Earlier research primarily identifies loan effects through variation in tuition or grant aid (Field, 2009; Bettinger et al., 2019; Chakrabarti et al., 2023; Witteveen, 2023) or through structural models that incorporate borrowing constraints (Keane and Wolpin, 2001; Cameron and Taber, 2004; Ionescu, 2009; Johnson, 2013; Sieg and Wang, 2018; Folch and Mazzone, 2022). More recent work exploits natural or quasi-natural experiments to estimate the impact of student loans, although such analyses are typically limited to specific institutions or states (Stinebrickner and Stinebrickner, 2008; Rothstein and Rouse, 2011; Marx and Turner, 2019; Barr et al., 2021). Our contribution is twofold: first, we exploit variation in federal loan interest rates together with regional differences in sensitivity to interest rate changes to identify the causal effects of interest rates on borrowing behavior and subsequent educational and labor market choices and outcomes. And second, this variation in the effective financing cost across regions allows us to conduct the analysis on a broad, nationally representative sample.

Our paper is also related to a smaller literature examining specific features of federal student loan programs. Goodman et al. (2021), Black et al. (2023), and Black et al. (2025) study the effects of loan limits across different programs. We complement their work by providing a comprehensive analysis of how interest rates shape a wide range of outcomes, thereby isolating the role of financing costs distinct from borrowing constraints or loan availability.

Finally, our findings speak to a broader literature on the relationship between student debt and labor market outcomes. Existing evidence is mixed: some studies find that student debt leads individuals to choose higher-paying jobs or private-sector employment (Minicozzi, 2005; Field, 2009; Rothstein and Rouse, 2011; Sieg and Wang, 2018; Velez et al., 2019; Daniels and Smythe, 2019; Gervais and Ziebarth, 2019), while others document negative effects on earnings growth, potentially through reduced graduate education or altered major choices (Minicozzi, 2005; Folch and Mazzone, 2022; Hampole, 2022). We contribute to this debate by showing that financing costs play a central role in shaping these outcomes. In particular, we highlight a mechanism whereby changes in interest rates alter liquidity at college entry, shifting individuals' choices toward higher-earning paths and generating a trade-off between monetary returns and job amenities.

The rest of the paper is organized as follows: Section 2 discusses the institutional back-

ground 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. Institutional 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.<sup>2</sup> Of this amount, \$1.60 trillion is outstanding federal loan debt, accounting for 92.5% of the total.<sup>3</sup> Currently, about 43.4 million Americans hold federal student loan debt, with the average student holding a federal debt of approximately \$36,900.<sup>4</sup>

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 loan types.<sup>5</sup>

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

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<sup>2</sup>Source: <https://www.federalreserve.gov/releases/g19/20231207/>.

<sup>3</sup>Source: <https://studentaid.gov/data-center/student/portfolio>.

<sup>4</sup>Source: <https://fsapartners.ed.gov/knowledge-center/library/electronic-announcements/2023-08-30/federal-student-aid-posts-new-quarterly-reports-fsa-data-center>.

<sup>5</sup>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.

Table B.1.<sup>6</sup> 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.<sup>7</sup>

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.<sup>8</sup> 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.

### 3. Data

We use the public version of the NSCG data from 2003 and 2010 to 2019, which includes the 2003, 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).<sup>9</sup> Each

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<sup>6</sup>The table only shows interest rates up to 2016 because our NSCG sample covers college graduates who entered college on or before 2016.

<sup>7</sup>Appendix 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.

<sup>8</sup>From 1994 to 2006, the interest rates differed between the repayment and in-school periods; we use the average of these rates.

<sup>9</sup>The 2003 sample is a representative subset of individuals in the 2000 Decennial Census long form with a bachelor's degree. Since 2010, the NSCG has employed a rolling panel sampling structure. The 2010 NSCG sample is a representative subset of individuals in the 2010 American Community Survey (ACS) with a

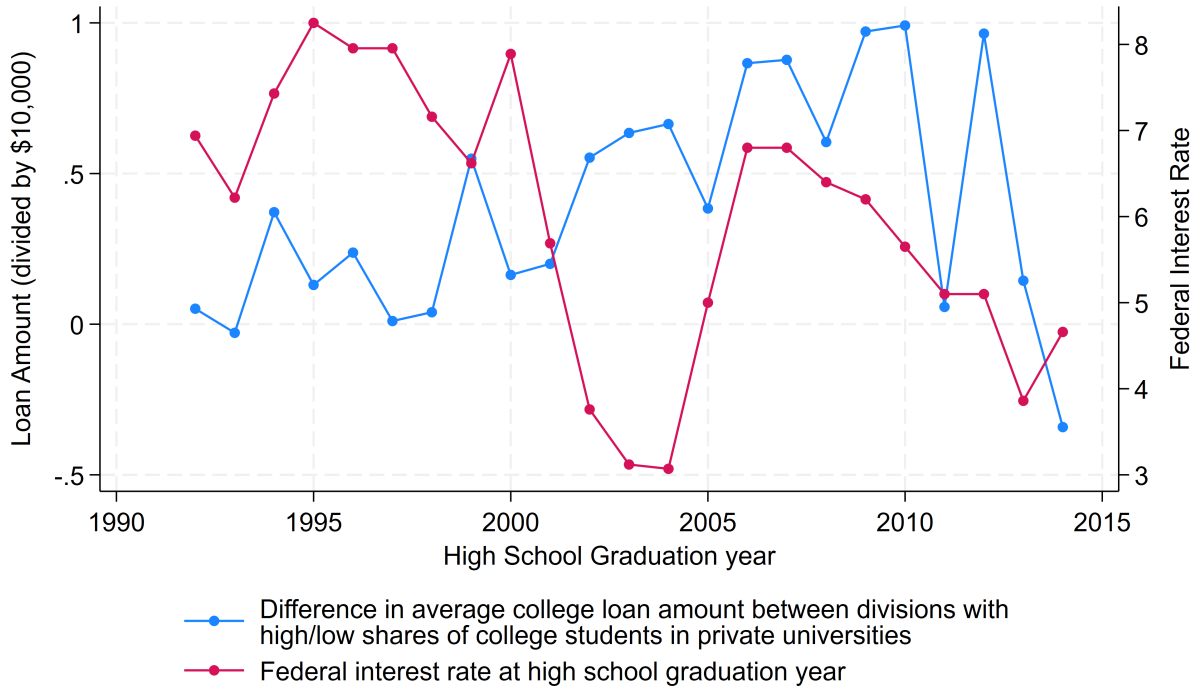


Figure 1: Trends in Federal Loan Interest Rates and the College Loan Gaps

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 repeated 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 these weights throughout the analysis.

This dataset provides rich information on student loans, educational outcomes, and labor market outcomes such as employment status, work hours, annual salary, occupation, and job satisfaction. It includes measures of 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 of high school graduation and local college expenses are key determinants of loan-taking decisions.

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

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bachelor’s degree. Beginning in 2013, three-quarters of the sample consisted of returning respondents from the previous survey, while the remaining quarter comprised new respondents drawn from the current-year ACS sample with a bachelor’s degree.

degree in the United States.<sup>10</sup> 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 134,045 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 1992 and 2015. On average, 60.5% of college graduates have taken out college loans, with an average loan amount of \$19,127 (including individuals with zero loans). Among those who borrowed, the average loan amount is \$31,601.

On average, 3% of college graduates are unemployed, 5% are self-employed in non-incorporated business, professional practice, or farm, 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 (\$55,826 in 2013 USD), with a log hourly wage rate of 3.20 (\$24.5 in 2013 USD). Additionally, 54% of these workers are employed in occupations related to their major in the highest degree.

We also use the Integrated Postsecondary Education Data System (IPEDS) from 1991 to 2020 to calculate the share of first-year college students enrolled in private universities at the division and year levels.<sup>11</sup> The sample is restricted to four-year private and public institutions and excludes online institutions. We have in total 65,031 institution-year observations. 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 at the university level, 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.

## 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

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<sup>10</sup>Some 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. On the other hand, if the person received multiple Bachelor's degrees in different years, regardless of the fields of studies being the same or different, we treat them as distinct BA degrees and exclude this person from the analysis sample.

<sup>11</sup>Appendix A details the construction of the measure.

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:

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

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.  $\text{IR}_{t_0}$  captures the federal loan interest rate at the national level during the high school graduation year  $t_0$ .  $\text{PS}_{d_0t_0}$  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  $\beta_2$ , 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 trends, commercial loan interest rates, and business cycles. 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 ( $\delta_t$ ). 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.

One key identification assumption is that, absent changes in federal loan interest rates, regions with high and low private shares would follow parallel trends<sup>12</sup>. To test this, Figure E.1 presents trends in demographic characteristics (age, gender, ethnicity, and parental ed-

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<sup>12</sup>By high private share, we mean the private share is above 45%.

ucation), college characteristics (incoming freshman enrollment and tuition), and economic conditions (GDP per capita and unemployment rate) across the two types of regions. For all dimensions considered, we find parallel trends, supporting the validity of our identification assumption. Figure E.2 reports the trends of private shares by division over time. Private shares vary substantially across divisions but remain relatively stable within divisions over time.

We conduct a comprehensive analysis of the impact of federal loan interest rates on various short- and long-term outcomes. The dependent variables ( $Y_{id0tot}$ ) are grouped into five categories: (1) Student loans: includes whether students borrow, 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: college major choice, attendance at a public university, and graduate degree attainment; (4) Labor market outcomes: unemployment, self-employment, firm size, annual earnings, work hours, hourly wages, and occupation choice; (5) Job satisfaction: satisfaction with various aspects of the current job.<sup>13</sup>

## 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 1 shows that a one-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 one-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.<sup>14</sup>

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<sup>13</sup>Appendix A provides detailed definitions of these dependent variables.

<sup>14</sup>The division with the highest private university share is New England, that with the lowest share is West South Central.

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, clustered at the high school graduation year and division level, are reported in parentheses. Sample weights are used. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Additionally, as shown in Column (2), a one-percentage-point increase in interest rates is associated with an average decline of \$2,075 in student loan principal among students in regions with the highest private university share, relative to those in regions with the lowest share.<sup>15</sup> These results indicate that federal loan interest rates significantly influence students' borrowing behavior: when the cost of financing college through federal loans rises, students reduce the amount they borrow.

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

$$Total\ Payment = \left[ (0.7Loan) \frac{ir_s(1 + ir_s)^{120}}{(1 + ir_s)^{120} - 1} + (0.3Loan) \frac{ir_p(1 + ir_p)^{120}}{(1 + ir_p)^{120} - 1} \right] \times 120 \quad (2)$$

$$Interest\ Payment = Total\ Payment - Loan \quad (3)$$

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.<sup>16</sup> According to Figure B.3, approximately 70% of the student loans are federal subsidized and unsubsidized loans. The remaining portion primarily consists

<sup>15</sup>Calculation:  $4,610 \times (0.64 - 0.19) = 2,075$ .

<sup>16</sup>The 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.

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.<sup>17</sup> After calculating the total 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 2 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

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<sup>17</sup>This 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.

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.

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
$IR_{t_0} \times PS_{d_0t_0}$	-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, clustered at the high school graduation year and division level, are reported in parentheses. Sample weights are used. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

### 5.3. Impact on Education Choices

Next, we assess whether federal loan interest rates influence college students' major choices. We estimate initial earnings ( $\gamma_{0k}$ ) and earnings growth ( $\gamma_{1k}$ ) for each major  $k$  using the NSCG data and the following specification:

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

where the constant term and the coefficient on potential experience vary by major.  $\gamma_{0k}$  captures major-specific initial earnings, and  $\gamma_{1k}$  captures major-specific earnings growth. These estimated parameters then serve as dependent variables in Equation (1).

Columns (1) and (2) of Table 3 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  $\gamma_{1k}$  of 0.0153 percentage points, representing a 30.4% increase, for students from regions with the lowest private university share, compared to those from regions with the highest share.<sup>18</sup> This result suggests that students facing

<sup>18</sup>Calculation:  $0.034 \times (0.64 - 0.19) = 0.0153$ .  $0.0153/0.0504 = 30.4\%$

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

	(1)	(2)	(3)
	Major-specific initial earnings	Major-specific earnings growth	Major in STEM
$IR_{t_0} \times PS_{dot_0}$	-0.00185 (0.009)	0.000336* (0.000)	0.0344** (0.016)
R-squared	0.456	0.401	0.038
Observations	134045	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, clustered at the high school graduation year and division level, are reported in parentheses. Sample weights are used. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

greater financial pressure at college entry are more likely to choose majors with higher long-term earnings potential. In Table E.1, we additionally present results based on the American Community Survey (ACS) to estimate major-specific initial earnings and earnings growth. The findings remain robust when using the ACS data.

We further examine the impact of financing costs on specific major choices. Column (3) of Table 3 shows that students with higher college financing costs are more likely to choose STEM majors, which generally yield higher earnings. Table 4 shows that these students tend to switch from psychology, foreign languages, and literature toward biology, microbiological sciences, immunology, pharmacy, environmental science, and engineering. As we discuss in Section 5.4, this switch to higher-earning majors in turn leads to a switch to higher-earning occupations.

#### 5.4. Impact on Labor Market Choices

This section examines whether federal loan interest rates at the time of college entry influence long-term labor market choices. We divide these choices into three categories: (1) labor supply, (2) job types, and (3) occupation choices.

*Impact on Labor Supply.* Table 5 presents the estimated effects on employment. Column (1) shows 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.<sup>19</sup> 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 job opportunities.

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<sup>19</sup> $1.21 * (0.64 - 0.19) = 0.54$ .

Table 4: Effects of Federal Loan Interest Rates on Major and Occupational Choices

Panel	Majors			Occupations
(1)	Biology 0.0133** (0.006)	Microbiological sciences and immunology 0.00171* (0.001)	Pharmacy 0.00161*** (0.001)	Health technologists and technicians 0.0112** (0.006)
(2)	Environmental science or studies 0.00527** (0.002)			Petroleum, mining, and geological engineers 0.00128*** (0.000)
(3)	Engineering 0.00114** (0.001)			Precision/production occupations 0.0132** (0.005)
(4)	Psychology -0.0189*** (0.006)	Other foreign languages and literature -0.00925** (0.004)		Retail sales clerks -0.0174** (0.008)

Notes: The table reports coefficients for  $IR_{t_0} \times PS_{d_0 t_0}$ . The sample is drawn from the NSCG 2003–2019. Regressions include controls for high school graduation year fixed effects, division fixed effects, survey year fixed effects, ethnicity–gender interactions, a quadratic function of age, and parental education. Standard errors, clustered at the high school graduation year and division level, are reported in parentheses. Sample weights are applied. \*\*\* p  $\leq$  0.01, \*\* p  $\leq$  0.05, \* p  $\leq$  0.1.

We next analyze the impact on full-time employment. Following Altonji and Zhong, 2021, we define full-time workers as those working more than 35 hours per week and 41 weeks per year, which account for 78% of the whole sample. We find no evidence that financing costs affect the extensive margin of labor supply. However, they do affect the intensive margin by increasing annual working hours for full-time workers. A one-percentage-point increase in interest rates is associated with a 0.22 percent increase in work hours for students from regions with the lowest private university share, relative to those from regions with the highest share.<sup>20</sup>

*Impact on Job Types.* Next, we analyze whether financing costs affect job choices. Column (1) of Table 6 shows that college graduates with higher federal loan interest rates are more likely to consider salary an important job characteristic.

Consequently, higher interest rates are associated with employment in higher-paying jobs. As shown in the last two columns of Table 6, this manifests as 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 higher financing

<sup>20</sup> $1.44\% \times (0.64 - 0.19) = 0.22\%$ .

Table 5: Effects of Federal Loan Interest Rates on Labor Supply

	(1)	(2)	(3)
	Unemployed	Working full time	ln(annual hours)
$IR_h^{\text{fed}} \times \text{Private}_{h,j}$	-0.0121** (0.006)	-0.000463 (0.018)	0.0144* (0.008)
R-squared	0.015	0.054	0.049
Observations	134045	134045	104107

Notes: The table reports the effects of federal loan interest rates at high-school graduation year on labor supply choices, using the full sample for columns (1) and (2) and the fulltime working sample for column (3). 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. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

costs compel individuals to seek jobs with higher earnings.

Table 6: Effects of Federal Loan Interest Rates on Job Types

	(1)	(2)	(3)
	Salary as an important factor	Self employment	Work in a small firm
$IR_h^{\text{fed}} \times \text{Private}_{h,j}$	0.00329** (0.001)	-0.0213* (0.012)	-0.0200* (0.012)
R-squared	0.005	0.011	0.008
Observations	133731	134045	123023

Notes: The table reports the effects of federal loan interest rates at high-school graduation year on labor market choices on the type of job and what they consider as important factors when considering a job, 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.1 provides further descriptive evidence that self-employment and employment in small firms are associated with lower earnings, fewer advancement opportunities, lower benefits, and less job security, but a higher degree of independence and responsibility (though not statistically significant).<sup>21</sup> This suggests a trade-off between salary and amenities: self-employment and small-firm jobs may offer higher non-monetary amenities, such as independence, but lower monetary payoffs. Workers facing higher college financing costs prioritize salary over amenities when choosing jobs.

<sup>21</sup>All job characteristics are measured by workers' revealed importance, except for salary, which is measured by log annual earnings.

*Impact on occupation.* In addition, we find that college financing costs affect the choice of occupation. Because federal loan interest rates do not affect full-time employment, we restrict our analysis to the full-time sample, where occupation measures are most meaningful.<sup>22</sup>

Using Equation (4), we calculate the average initial earnings and earnings growth by age for each occupation.<sup>23</sup> Column (2) of Table 7 indicates that individuals facing higher interest rates are more likely to work in occupations characterized by higher earnings growth. Specifically, a one percentage point increase in interest rate is associated with a 0.022 percentage point (4.26%) increase in occupation-specific earnings growth.<sup>24</sup> Using the alternative estimates of major-specific initial earnings and earnings growth from the ACS, as shown in Table E.1, we obtain consistent results.

Table 7: Effects of Federal Loan Interest Rates on Occupation Choices

	(1)	(2)	(3)
	Occ initial earnings	Occ earnings growth	Occ relevant
$IR_{t_0} \times PS_{d_0 t_0}$	0.00837	0.000489***	0.0416*
	(0.012)	(0.000)	(0.023)
R-squared	0.435	0.576	0.020
Observations	104107	104107	102955

Notes: The table reports the effects of federal loan interest rates at high-school graduation year on labor market outcomes, using the full-time working sample. The sample is drawn from the NSCG 2003–2019. Regressions include controls for high school graduation year fixed effects, division fixed effects, survey year fixed effects, ethnicity–gender interactions, a quadratic function of age, and parental education. Standard errors, clustered at the high school graduation year and division level, are reported in parentheses. Sample weights are applied. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Column (3) of Table 7 further suggests that workers with higher financing costs are more likely to work in occupations related to their last majors. A one percentage point increase in interest rate is associated with a 1.87 percentage point (7.70%) increase in the probability of working in an occupation related to their last major.<sup>25</sup> Since prior literature has shown that a good match between major and occupation increases earnings, this provides additional evidence that individuals’ job choices are incentivized by monetary payoffs.

We next analyze the impact on specific occupations. Table 4 shows that graduates facing higher interest rates shift primarily from retail sales clerk positions to health technologists and technicians; petroleum, mining, and geological engineers; and precision production occupations.

<sup>22</sup>This sample is more relevant for our analysis, as preferences and abilities may differ between part-time and full-time workers.

<sup>23</sup>In this context,  $k$  indicates occupation rather than major.

<sup>24</sup>Calculations:  $0.0489 * (0.64 - 0.19) = 0.022$  and  $0.022/0.517 = 4.26\%$ .

<sup>25</sup>Calculations:  $4.16 * (0.64 - 0.19) = 1.87$  and  $1.87/24.3 = 7.70\%$ .

Table 4 further reveals a correspondence between major and occupational shifts: the increase in biology, microbiological sciences, immunology, and pharmacy majors aligns with the increase in health technologists and technicians. Similarly, the increase in environmental science majors corresponds to the increase in petroleum, mining, and geological engineers, and the increase in engineering majors corresponds to the increase in precision production occupations. Conversely, the decline in psychology and foreign languages and literature majors corresponds to the decline in retail sales clerks. Notably, these students are more likely to become engineers than scientists, a choice consistent with the higher average salaries in engineering. Overall, we find that the occupational shift mirrors the changes in majors documented earlier.

### 5.5. *Impact on Labor Market Outcomes*

Having analyzed labor market choices, we now examine how these choices translate into labor market outcomes, including earnings and wage rates. In particular, we focus on the trade-offs between monetary and non-monetary benefits.

*Impact on Earnings.* We first analyze the impact on earnings and wage rates for full-time workers. As shown in Column (1) of Table 8, 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.<sup>26</sup> However, the effect on hourly wage rates is smaller and only marginally significant. This suggests that the positive effect on earnings primarily stems from increased working hours, as shown in Table 5. The benefits of avoiding self-employment, working in large firms, and choosing occupations with high earnings growth lie mainly in the ability to work longer hours, rather than in higher wage rates.

*Impact on job amenities.* Lastly, we analyze the impact on job amenities. The last two columns of Table 8 show that workers with higher federal interest rates are less likely to be satisfied with aspects such as independence and responsibility in their current roles. This suggests that higher salaries may come at the expense of lower job satisfaction, indicating that higher college financing costs prompt individuals to prioritize salary over other job amenities in their employment choices.

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<sup>26</sup> $6.24\% \times (0.64 - 0.19) = 2.81\%$ .

Table 8: Effects of Federal Loan Interest Rates on Earnings and Job Satisfaction

	(1)	(2)	(3)	(4)
	ln(annual earnings)	ln(hourly wage)	Satisfied with independence	Satisfied with responsibility
$IR_{t_0} \times PS_{d_0t_0}$	0.0624** (0.030)	0.0296 (0.024)	-0.0137** (0.006)	-0.0167*** (0.006)
R-squared	0.171	0.184	0.006	0.011
Observations	103850	103413	123,023	123,023

Notes: The table reports the effects of federal loan interest rates at high-school graduation year on labor market outcomes, using the full-time working sample. The sample is drawn from the NSCG 2003–2019. Regressions include controls for high school graduation year fixed effects, division fixed effects, survey year fixed effects, ethnicity–gender interactions, a quadratic function of age, and parental education. Standard errors, clustered at the high school graduation year and division level, are reported in parentheses. Sample weights are applied. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

## 6. Alternative Mechanisms and 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.

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

Table E.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, Completion, and Further Education.** 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 E.3 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 E.3. These results collectively support the conclusion that our analysis using the NSCG data is unlikely to be affected by selection issues.

Table E.4 further shows that interest rates do not influence the decision to attend public universities, pursue a double major, change majors from bachelor’s to graduate degree, or obtain a graduate degree. This suggests that our findings on labor market outcomes are not driven by these alternative channels.

## 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.<sup>27</sup>

As shown in Appendix Appendix E.4, our baseline results remain robust after including this control. Consistent with prior literature, we also find that higher local unemployment

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<sup>27</sup>As 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. The US Territories do not report unemployment rates, so the number of observations drops slightly.

rates at graduation are associated with a higher probability of unemployment, lower hourly wages, and lower annual earnings.

### *6.3. Using Lagged Private Share*

In the baseline specification, we interact federal loan interest rates with the division-level share of students attending private universities in the high school graduation year. A potential concern is that interest rates might influence students' sorting into private universities, thereby affecting the private share. Although Table E.4 demonstrates that interest rates do not impact the likelihood of attending public universities, we conduct a robustness check using the lagged one-year private share instead of the current year's share. As shown in Appendix Appendix E.5, our results remain consistent and robust when employing the lagged private share.

## **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 financing costs 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, 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 ( $\lambda_1^{major}$ ) would reflect the initial labor market return of the major, and the coefficient on its interaction term with age ( $\lambda_2^{major}$ ) would reflect its growth as age (serving as a proxy for years of professional experience) increases. In the main text, we call  $\lambda_1^{major}$  the “*Major Initial Earnings*”, and  $\lambda_2^{major}$  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.

*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.

*Job satisfaction regarding the degree of independence* is a dummy variable equal to 1 if the individual reports that they are satisfied with the principal job’s degree of independence.

We categorize “very satisfied”, “somewhat satisfied”, and “somewhat dissatisfied” as 1, and “very dissatisfied” as 0.

*Job satisfaction regarding the level of responsibility* is a dummy variable equal to 1 if the individual reports that they are satisfied with the principal job’s level of responsibility, and 0 otherwise. We categorize “very satisfied”, “somewhat satisfied”, and “somewhat dissatisfied” as 1, and “very dissatisfied” 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.<sup>28</sup>

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

<sup>28</sup>Source: <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.

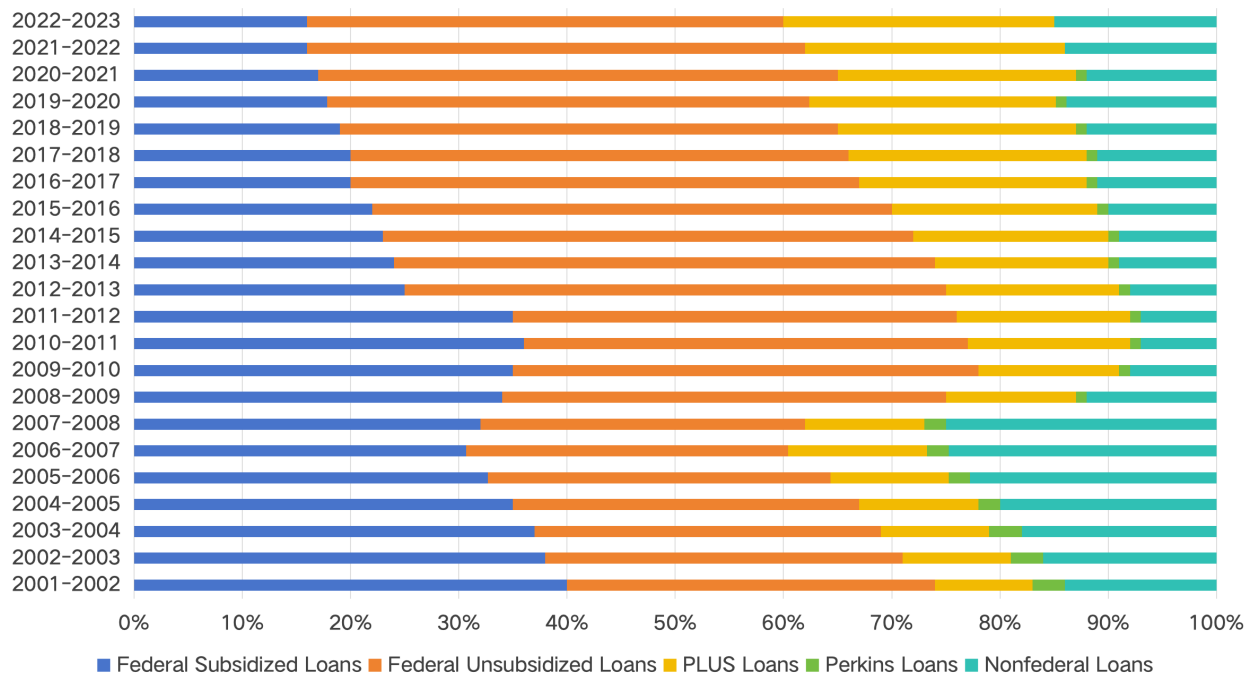
### *Appendix B.2. Other Types of Federal Loans besides Subsidized and Unsubsidized Loans*

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. Summary Statistics

Table C.1: Summary Statistics

Variable	Mean	SD
<b>Full sample (Count = 134,045)</b>		
High school graduation year	2000	5.448
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
Total interest payment (in 10k)	0.692	0.888
Whether borrow loans from the school, banks, federal or state government	0.594	0.491
Whether borrow loans from parents or other relatives, to be repaid	0.086	0.281
Whether receive financial assistance from parents, spouse, other relatives, not to be repaid	0.637	0.481
Whether receive financial assistance from personal savings	0.289	0.453
Major initial earnings	13.577	0.255
Major earnings growth	0.001	0.006
Double major in college	0.161	0.367
Obtain BA degree from a public institution	0.642	0.479
Obtain grad degree	0.304	0.460
Change major from BA to grad degree	0.376	0.484
Unemployment	0.030	0.171
Working full-time	0.726	0.446
Self-employment	0.050	0.217
Work in a small firm	0.100	0.300
Degree of independence is satisfied	0.971	0.168
Level of responsibility is satisfied	0.968	0.176
Salary is important	0.996	0.059
<b>Full-time worker sample (Count = 104,107)</b>		
ln(earnings)	10.930	0.633
ln(annual hours)	7.739	0.166
ln(hourly wage rate)	3.214	0.544
Occupation earnings growth	0.002	0.008
Occupation related to major	0.542	0.498

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	Count
1991-2015			
Total number of college freshmen (thousands)	149.898	69.699	225
Fraction of college freshmen enrolled in private school	0.372	0.113	225
1999-2015			
Tuition fee	13494.61	4706.712	153
Total cost of college	26295.72	5825.699	153
Average amount of financial aids	6763.709	2112.342	153

Notes: The table reports the weighted mean and standard deviation, and total cell count of school characteristic variables we calculated from IPEDS. The upper panel of the table reports average number of college freshmen in thousands and the fraction of college freshmen enrolled in private school. These statistics are available from 1991 onward. The lower panel of the table reports average annual tuition, annual total cost, financial aid, and student loan amounts per enrolled student. These statistics are available from 1999 onward. 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. Additional Empirical Results

Table D.1: Amenities Related to Job Types

	(1)	(2)
	Self-employment	Work for a small firm
Salary (ln(annual earnings))	-0.025*** (0.003)	-0.063*** (0.004)
Opportunities for advancement	-0.031** (0.012)	-0.095*** (0.016)
Benefits	-0.212*** (0.039)	-0.313*** (0.036)
Job security	-0.069** (0.031)	-0.125*** (0.035)
Degree of independence	0.060*** (0.017)	0.111*** (0.033)
Level of responsibility	0.016 (0.014)	0.016 (0.023)
Intellectual challenge	-0.008 (0.021)	-0.0003 (0.029)
Job location	0.011 (0.020)	-0.038 (0.030)
Contribution to society	0.014 (0.010)	0.018 (0.015)
R-squared	0.026	0.049
Observations	211748	211748

Notes: Table D.1 reports the correlation between self-employment/small-firm jobs and job characteristics, including salary, advancement opportunities, and degree of independence, etc. All job characteristics are measured by workers' revealed importance, except for salary, which is measured by log annual earnings. The data are from the NSCG (2003–2019). Standard errors are in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## Appendix E. Robustness Checks

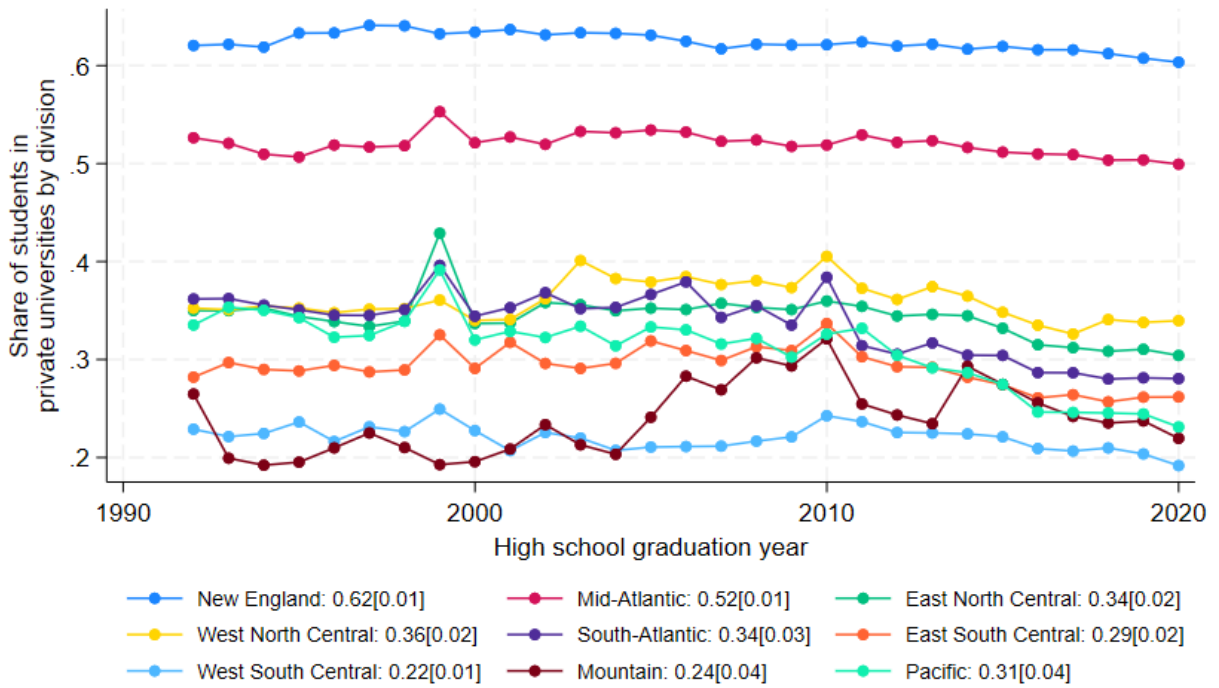
### Appendix E.1. Parallel Trends

Figure E.1: Examination of Parallel Trends in Division Characteristics, by Private Share



Notes: Demographic variables are from the NSCG 2003–2019, unemployment rates from the U.S. Bureau of Labor Statistics, and GDP data from the Bureau of Economic Analysis. Institutional level statistics, including the number of enrolled students and tuition, are from the IPEDS.

Figure E.2: Private Share by Division Over Time



Notes: Data source: IPEDS. For each division and year, we add up the "total number of full-time first-time degree/certificate seeking undergraduates" among all institutions, and among all private institutions. The fraction of the two sums is the share of students enrolled in private institutions by division and year. The figure shows the time trend of these fractions for all 9 divisions. The numbers in the figure legend are mean [sd].

Appendix E.2. Results from the ACS

Table E.1: Effects of Federal Interest Rates on Major and Occupation Choices (ACS Data)

	(1)	(2)	(3)	(4)
	Major-specific initial earnings	Major-specific earnings growth	Occ-specific initial earnings	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, clustered at the high school graduation year and division level, are reported in parentheses. Sample weights are used. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Appendix E.3. Alternative Potential Channels

Table E.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, clustered at the high school graduation year and division level, are reported in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table E.3: 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, clustered at the high school graduation year and division level, are reported in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table E.4: Effects of Federal Interest Rates on College and Graduate School Outcomes

	(1)	(2)	(3)	(4)
	Attend public universities	Double major	Change major	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 sample is drawn from the 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, clustered at the high school graduation year and division level, are reported in parentheses. Sample weights are used. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Appendix E.4. Controlling for the Unemployment Rate at College Graduation

Table E.5: Effects of Federal Loan Interest Rates on College Financing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Take loan for college	Loan borrow amount (in 10k)	Interest payment (in 10k)	Loans from government or banks	Loans from parents	Financial support from parents	Own Savings
$IR_{t_0} \times PS_{d_0t_0}$	-0.0530*** (0.017)	-0.489*** (0.090)	-0.0159 (0.032)	-0.0723*** (0.023)	0.0530** (0.020)	-0.0298*** (0.009)	0.0438** (0.021)
Unemployment Rate	0.0157*** (0.004)	0.123*** (0.028)	0.0384*** (0.011)	0.0128*** (0.004)	-0.0262*** (0.005)	-0.00219 (0.002)	-0.00351 (0.004)
R-squared	0.209	0.132	0.146	0.147	0.188	0.022	0.057
Observations	127412	127412	122547	118128	118128	118128	89240

Notes: The sample is drawn from the NSCG 2003-2019. 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, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors, clustered at the high school graduation year and division level, are reported in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table E.6: Effects of Federal Loan Interest Rates on Education and Labor Market Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Major-specific earnings growth	Unemployed	Self employment	Work in a small firm	Satisfied with independence	Satisfied with responsibility	Salary as an important factor
$IR_{t_0} \times PS_{d_0t_0}$	0.000332* (0.000)	-0.0131** (0.006)	-0.0220* (0.012)	-0.0204* (0.012)	-0.0130** (0.006)	-0.0159*** (0.006)	0.00301** (0.001)
Unemployment Rate	-0.00000649 (0.000)	0.00308* (0.002)	-0.00235 (0.003)	0.00134 (0.002)	-0.00520*** (0.001)	-0.00507*** (0.002)	0.000711** (0.000)
R-squared	0.401	0.015	0.011	0.008	0.008	0.012	0.005
Observations	131683	131683	131683	120962	120962	120962	131393

Notes: The sample is drawn from the NSCG 2003-2019. 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, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. The regressions on labor market outcomes further control for survey year fixed effects. Standard errors, clustered at the high school graduation year and division level, are reported in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table E.7: Effects of Federal Loan Interest Rates on Labor Market Outcomes (Cont'd)

	(1)	(2)	(3)	(4)	(5)
	ln(annual earnings)	ln(annual hours)	ln(hourly wage)	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)	0.000490*** (0.000)	0.0462* (0.024)
Unemployment Rate	-0.0324*** (0.007)	-0.000366 (0.002)	-0.0276*** (0.006)	-0.0000433 (0.000)	-0.0147*** (0.005)
R-squared	0.160	0.048	0.176	0.576	0.022
Observations	102182	102437	101763	102437	101319

Notes: The sample includes full-time workers from the NSCG 2003-2019. 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, division fixed effects, survey year fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors, clustered at the high school graduation year and division level, are reported in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Appendix E.5. Using Lagged Private Share

Table E.8: Effects of Federal Loan Interest Rates on College Financing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Take loan for college	Loan borrow amount (in 10k)	Interest payment (in 10k)	Loans from government or banks	Loans from parents	Financial support from parents	Own Savings
$IR_{t_0} \times PS_{d_0t_0-1}$	-0.0525*** (0.017)	-0.468*** (0.087)	-0.00956 (0.031)	-0.0698*** (0.022)	0.0472** (0.020)	-0.0283*** (0.010)	0.0405* (0.022)
R-squared	0.205	0.127	0.143	0.146	0.182	0.022	0.056
Observations	129692	129692	124715	120133	120133	120133	90618

Notes: The sample is drawn from the NSCG 2003-2019. 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, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors, clustered at the high school graduation year and division level, are reported in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table E.9: Effects of Federal Loan Interest Rates on Education and Labor Market Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Major-specific earnings growth	Unemployed	Self employment	Work in a small firm	Salary as an important factor	Satisfied with independence	Satisfied with responsibility
$IR_{t_0} \times PS_{d_0t_0-1}$	0.000312* (0.000)	-0.0126** (0.006)	-0.0209* (0.012)	-0.0187 (0.012)	-0.0136** (0.007)	-0.0177*** (0.006)	0.00327** (0.001)
R-squared	0.401	0.015	0.011	0.008	0.006	0.011	0.005
Observations	134045	134045	134045	123023	123023	123023	133731

Notes: The sample is drawn from the NSCG 2003-2019. 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, division fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. The regressions on labor market outcomes further control for survey year fixed effects. Standard errors, clustered at the high school graduation year and division level, are reported in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table E.10: Effects of Federal Loan Interest Rates on Labor Market Outcomes (Cont'd)

	(1)	(2)	(3)	(4)	(5)
	ln(annual earnings)	ln(annual hours)	ln(hourly wage)	Occ earnings growth	Occ relevant
$IR_{t_0} \times PS_{d_0t_0-1}$	0.0580** (0.029)	0.0147* (0.008)	0.0260 (0.023)	0.000432** (0.000)	0.0441* (0.023)
R-squared	0.171	0.049	0.184	0.576	0.020
Observations	103850	104107	103413	104107	102955

Notes: The sample includes full-time workers from the NSCG 2003-2019. 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, division fixed effects, survey year fixed effects, interactions between ethnicity and gender, age quadratic function, and parental education. Standard errors, clustered at the high school graduation year and division level, are reported in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.