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The Price of Borrowing for College: Student Loan Interest Rates, Educational Choices, and Career Tradeoffs

Naijia Guo
The University of Hong Kong

Ling Zhong
Southwestern University of Finance and Economics
and IZA@LISER

IZA@LISER NETWORK
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Abstract

Federal student loan interest rates affect college financing, education and job choices, and career outcomes. Using U.S. microdata, we exploit changes in federal loan rates over time and regional variation in expected loan reliance. Higher interest rates reduce student loan take-up and the amount borrowed without raising total interest payments, and students shift toward funding sources that do not require repayment. Students facing higher borrowing costs sort into higher-earning majors and occupations, increase labor supply, and move away from self-employment and small-firm jobs. Affected individuals earn more but report lower satisfaction with job independence and responsibility.

JEL classification

I23, J24, H81

Keywords

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

Corresponding author

Ling Zhong
zhongling1804@gmail.com

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1. Introduction

Student debt has become a defining feature of the U.S. higher education system. By 2026, Americans owed approximately $1.83 trillion in student loans, and federal loans accounted for 92.3% of this debt.[1] About 42.8 million Americans hold federal student loan debt, and the average borrower owes roughly $38,290.[2] While a large literature examines the consequences of student loan debt, much less is known about how federal loan interest rates shape students' financing decisions, educational choices, and subsequent labor market outcomes.

Federal student loan interest rates set the price of borrowing money to finance college. When that cost rises, students may turn away from loans and rely more heavily on family resources or personal savings – leaving fewer resources after graduation. This negative wealth shock can alter the trade-offs students face when choosing what to study and what jobs to pursue. In particular, they may increase the weight placed on pecuniary returns relative to nonpecuniary job amenities, shifting major choice, occupation selection, labor supply, earnings, and job satisfaction.

This paper studies how federal student loan interest rates affect college financing, educational choices, and labor market outcomes. We exploit changes in federal loan interest rates over time together with cross regional differences in students' expected reliance on loan financing. Students from regions with a larger private university sector face higher college costs and rely more heavily on student loans, making their financing decisions more sensitive to federal loan rates. We use the regional share of first year students enrolled in private universities as a measure of exposure to interest rate changes. We then estimate a continuous difference in differences design comparing cohorts who faced different federal loan rates across regions with different exposure to those rates.

Using data from the National Survey of College Graduates (NSCG) from 2003 to 2019, we first show that federal loan interest rates have substantial effects on how students finance college. For students from regions with the median share of private university enrollments, a one-percentage-point decrease in interest rates increases the amount borrowed by approximately $1,614 and raises the likelihood of taking out a student loan by 1.8 percentage points.[3] However, total interest payments remain largely unchanged, as lower borrowing at higher interest rates offsets the mechanical increase in financing costs. Instead, higher rates change

[1]Source: `https://www.federalreserve.gov/releases/g19/20231207/`; `https://studentaid.gov/data-center/student/portfolio`.

[2]Source: `https://fsapartners.ed.gov/knowledge-center/library/electronic-announcements/2023-08-30/federal-student-aid-posts-new-quarterly-reports-fsa-data-center`.

[3]In our sample, the share of students attending private universities ranges from 0.19 to 0.64, with a median of 0.35.

the composition of college financing: students rely less on loans and more on family resources and personal savings. These findings imply that higher interest rates intensify the immediate financial burden of paying for college and leave fewer resources available after graduation.

We next trace how these changes in college financing shape subsequent educational and career decisions. The first margin of adjustment appears in students' major choices. Students exposed to higher interest rates are more likely to choose majors with higher expected earnings growth and, later, occupations with stronger earnings potential. Students become more likely to major in STEM fields, particularly by shifting away from psychology and foreign languages and toward biology, environmental science, and engineering. Quantitatively, a one percentage point increase in the interest rate raises major specific earnings growth by 23.6 percent and occupation-specific earnings growth by 3.3 percent. These patterns suggest that higher interest rates at college entry alter not only how students pay for college, but also how they evaluate the returns to different fields of study. Higher financing costs effectively operate as a negative wealth shock, intensifying financial pressure and inducing students to prioritize majors with higher monetary returns.

The same earnings-oriented response continues after graduation. Instead of seeking flexibility or entrepreneurial opportunities, individuals exposed to higher interest rates move toward jobs that offer more predictable financial returns. They supply more labor, as indicated by lower unemployment and longer working hours, and are less likely to be self-employed or employed at small firms. At the same time, they sort into occupations that align better with their fields of study, suggesting a stronger focus on maximizing the payoff to educational investment. They are also more likely to report salary as an important job attribute. These patterns point to a coherent behavioral response: higher borrowing costs lead individuals to place greater weight on earnings when choosing both what to study and what kind of work to pursue.

These behavioral adjustments translate into distinct labor market outcomes. Individuals facing higher financing costs earn more: a one-percentage-point increase in interest rates raises annual earnings by 2.17 percent for those from regions with the median share of private university enrollments. 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 strategy. First, we show that regions with high and low shares of private university enrollments exhibit similar trends in demographic characteristics, college attributes,

and economic conditions. 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 detect 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. Furthermore, interest rates do not influence labor market outcomes through other educational margins, including attendance at public universities, double majoring, major switching, or graduate study. Our estimates are robust to controlling for local unemployment rates at both college entry and graduation, ruling out business-cycle confounders. Finally, our findings hold using alternative measures of private enrollment share, including lagged and initial shares.

This study contributes to the extensive literature on student loans by shifting attention from the amount borrowed to the price of borrowing. Much of the existing literature 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 these analyses are often tied to specific institutions, programs, or states (Stinebrickner and Stinebrickner, 2008; Rothstein and Rouse, 2011; Marx and Turner, 2019; Barr et al., 2021). We study a distinct margin of college finance: the interest rate students face when borrowing against future income to pay for college. By combining changes in federal loan interest rates over time with regional differences in expected reliance on student loans, we exploit plausibly exogenous variation in borrowing costs. This variation allows us to identify the causal effects of interest rates on financing behavior, educational investments, and subsequent labor market outcomes in 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. These studies focus on credit availability and ask how students respond when the amount they can borrow changes. We complement this work by studying interest rates, which change the terms of borrowing rather than the borrowing limit itself.

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 shedding light on a different channel through which student loans may affect individual outcomes. While most previous work emphasizes that higher student debt increases repayment pressure and steers individuals toward careers with higher earnings potential, we show that when loan amounts adjust endogenously to interest rate changes, greater indebtedness may simply signal lower borrowing costs. This, in turn, eases financial constraints and enables students to choose majors and occupations that better align with their intrinsic interests, rather than being driven primarily by financial considerations.

The rest of the paper is organized as follows: Section 2 develops a conceptual framework that discusses the impact on student loan interest rates. Section 3 discusses the institutional background of US federal student loans. Section 4 introduces the datasets used in the analysis. Section 5 details our empirical approach and identification strategy. Section 6 presents empirical results on various educational and labor market outcomes. Section 7 conducts the robustness checks. Lastly, Section 8 concludes.

2. Conceptual Framework

In this section, we develop a conceptual framework for how student loan interest rates shape college financing choices, education and career paths, and the resulting earnings and job amenities after graduation. The framework centers on an intertemporal trade-off: borrowing boosts college resources but requires future repayment, while using household resources during college reduces later resources. Interest rate changes thus alter not only the cost of borrowing but also the relative appeal of debt versus household financing. A higher rate makes financing gaps costlier, prompting more household resources to be used during college, leaving fewer for later – a negative wealth effect that raises the value of choosing a higher-wage path.

2.1. Model Setup

Consider a student who makes college financing and education choices over two periods. Period 0 is the college stage, and period 1 is the work stage after graduation.[4] In the college stage, the student chooses loan amount, b, and household resources, a.

College tuition is fixed at $T > 0$. Student loans are capped by tuition, so $0 \leq b \leq T$. The gross student loan repayment rate is R. If the student borrows b in the college stage,

[4]Later in the empirical sections, we refer to these periods as t_0 and t_1, respectively.

she repays $R \times b$ in the work stage. So a higher federal student loan interest rate correspond to a higher value of R.

The student has gross household resources $A > 0$ available across the two stages. If the household allocates a during college, the remaining resources $A - a$ are available in the work stage and earn a fixed gross return R_f. Thus, $0 \leq a \leq A$. Household resources are not frictionless. Let $n(a)$ denote the resource cost (opportunity costs) of transferring household resources to the student during college, and let $N(a) = a - n(a)$ be the net amount that reaches the college-stage budget. We assume that N is twice continuously differentiable and satisfies

$$N(0) = 0, \qquad N'(a) > 0, \qquad N''(a) < 0, \qquad N'(0) = 1.$$

Thus, household resources relax the college-stage budget constraint, but with diminishing marginal returns.

Work-stage outcomes are summarized directly by earnings and nonpecuniary job amenities. Let w denote wage income and let $\psi(w)$ denote the nonpecuniary amenity associated with the resulting career path, such as independence, responsibility, or flexibility. These outcomes can be interpreted as arising from an underlying education or career choice, but we do not model that choice explicitly. The key tradeoff is that higher earnings may be associated with lower nonpecuniary amenities.[5] Assume that ψ is twice continuously differentiable and satisfies

$$\psi'(w) < 0, \qquad \psi''(w) \leq 0.$$

The college-stage and work-stage consumption levels are

$$c_0 = N(a) + b - T,$$

and

$$c_1 = w + R_f(A - a) - Rb.$$

The two budget equations capture this timing channel. Loans increase resources available during college but require repayment after graduation, while household resources used during college reduce resources available in the work stage.

The student-household unit solves

$$\max_{a,b,w} \ \log c_0 + \beta \log c_1 + \psi(w),$$

[5] As evident in Appendix Table E.1.

subject to

$$
\begin{aligned}
c_0 &= N(a) + b - T, \\
c_1 &= w + R_f(A - a) - Rb, \\
0 \le a \le A, &\quad 0 \le b \le T, \quad w \ge 0, \quad c_0, c_1 > 0.
\end{aligned}
$$

Our analysis focuses on an interior solution:

$$0 < a^* < A, \qquad 0 < b^* < T, \qquad w^* > 0.$$

An interior solution with positive household resource use requires the loan repayment rate to exceed the return on household resources, $R > R_f$. We assume parameters are such that the solution is interior over the range of repayment rates considered.

2.2. Comparative Statics

Proposition 1. *Suppose the solution is interior on an interval of student-loan repayment rates R. If $N'(a) > 0$, $N''(a) < 0$, $\psi'(w) < 0$, and $\psi''(w) \le 0$, then*

$$\frac{da^*}{dR} > 0 \qquad \textit{and} \qquad \frac{db^*}{dR} < 0.$$

This implies that as student loan interest rates rise, student borrowing decreases and the use of household resources during college increases.

Appendix A provides proofs for this proposition and the next. This proposition highlights a financing-substitution mechanism. Student loans and household resources both relax the college-stage budget constraint, but they have different intertemporal costs. When R rises, borrowing becomes more expensive relative to household resources. The student-household responds by shifting away from student loans and toward household resources.

Proposition 2. *Suppose the solution is interior on an interval of student-loan repayment rates R. If $N'(a) > 0$, $N''(a) < 0$, $\psi'(w) < 0$, $\psi''(w) \le 0$, and $N(a) < T$ then*

$$\frac{dw^*}{dR} > 0 \qquad \textit{and} \qquad \frac{d\psi(w^*)}{dR} < 0$$

This suggests that when household resources do not fully cover tuition ($N(a) < T$), an increase in student loan interest rates pushes students toward education and career paths with higher-wage and lower nonpecuniary amenities.

This proposition shows how financing conditions can affect educational and career choices. When $N(a) < T$, student loans finance the remaining tuition gap. A higher repayment rate makes this gap more expensive and induces the household to allocate more resources to the college stage. This leaves fewer resources for the work stage, creating a negative wealth effect that raises the value of choosing a higher-wage path.

Empirically, this higher w^* can appear through several margins: choosing majors with higher lifetime earnings potential, entering occupations with higher returns, or sorting into work arrangements that offer higher salary but lower amenities. While the model abstracts from these distinctions and captures them in reduced form, the empirical analysis can separately identify these margins, and treats them as different manifestations of a shift toward career paths with higher pecuniary returns and lower nonpecuniary amenities.

At the same time, a higher repayment rate, R, can reduce borrowing, and therefore may limit the increase in future repayment obligations, Rb. This is the debt-repayment channel emphasized in much of the student loan literature. The model highlights *an additional channel: interest rates can affect education and career choices by changing the cost of financing college through student loans and household resource allocation at the time of entry.* When student loans are needed to finance college ($N(a) < T$), this wealth channel dominates the repayment channel and shifts students toward higher-wage paths with lower amenities.[6]

We next bring these model predictions to the data.

3. Institutional Background

3.1. Federal Student Loan Interest Rates

Federal student loans have long played a central role in financing higher education in the United States. The modern federal lending system dates back to the National Defense Education Act of 1958 and expanded substantially with the introduction of the Direct Loan Program in the early 1990s. Under this system, the federal government lends directly to students through their educational institutions, making federal loan terms an important policy parameter in college financing decisions.

The federal student loan program includes several loan types. Direct Subsidized Loans are available to undergraduate students with demonstrated financial need, with the federal government covering interest during specified periods. Direct Unsubsidized Loans are available to students regardless of financial need, but borrowers are responsible for all accrued

[6]In the model, the pressure to choose a higher-wage track is clearest when household resources do not fully cover tuition. We treat this condition as a conceptual qualification rather than an empirically observed object, since the data record financing sources but not the dollar value of non-loan support.

interest. Direct PLUS Loans are available to graduate or professional students and to parents of dependent undergraduate students who pass a credit check, and are used to cover educational costs not met by other financial aid. Subsidized and unsubsidized loans generally carry lower interest rates than PLUS loans and private loans.

Our analysis focuses on subsidized and unsubsidized loans for two reasons. First, these loans are the main federal borrowing instruments used by students. Between 2010 and 2023, subsidized and unsubsidized loans together accounted for about 75% of all student loans issued, as shown in Appendix Figure B.3. Second, their interest rates provide a direct measure of the price students face when borrowing to finance college. Because these rates vary over time, they create variation in the cost of loan financing across cohorts.[7]

We summarize the interest rates for Subsidized and Unsubsidized Direct Loans for undergraduate and graduate students during the repayment period from 1994 to 2015 in Appendix Table B.1.[8] 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. Before 2006, federal student loans had variable interest rates tied to market fluctuations, with rates set to be a fixed premium to Treasury rates. Since 2006, federal student loans have carried fixed interest rates for the duration of the loan. Unsubsidized loans consistently have interest rates equal to or higher than those of subsidized loans.[9]

3.2. Interest Rates and Exposure to Loan Financing

In the empirical analysis, we study the effects of federal loan interest rates on undergraduates. Our primary interest rate measure is the average rate on subsidized and unsubsidized loans, the two main federal loan types used by students. Figure 1 shows that federal loan interest rates fluctuate substantially over time. During our sample period, from 1992 to 2014 high school graduates, the average federal loan interest rate is 5.9 percent, with a standard deviation of 1.7 percentage points.[10]

The effect of these interest rate changes is likely to vary across students depending on

[7]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.

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

[9]Appendix Table B.2 also provides the interest rates during in-school, grace, and deferment periods. Before 2006, interest rates during these periods were slightly lower than repayment period rates. This distinction disappeared after 2006. Subsidized loans have been unavailable to graduate students since 2012.

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

their expected reliance on loan financing. Students in regions with a larger private university sector tend to face higher college costs and rely more heavily on student loans. We therefore use the regional share of first year students enrolled in private universities as a measure of exposure to federal interest rate changes. Consistent with this interpretation, Figure 1 plots the difference in average college loan amounts between regions with high and low shares of private university enrollments and shows that this gap is negatively correlated with federal loan interest rates. This pattern provides motivating evidence that borrowing in high private share regions is more responsive to federal interest rates.

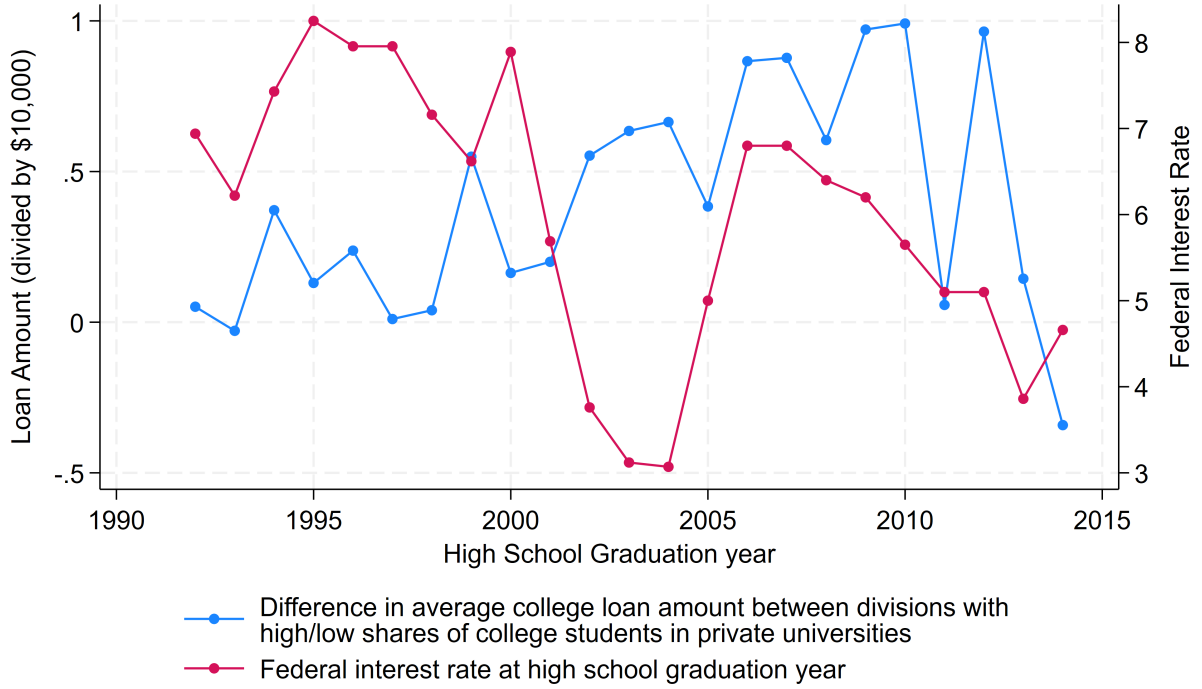

Figure 1: Trends in Federal Loan Interest Rates and the College Loan Gaps

4. Data

Our main data source is the National Survey of College Graduates (NSCG), covering the 2003, 2010, 2013, 2015, 2017, and 2019 waves. The NSCG is administered by the National Center for Science and Engineering Statistics within the National Science Foundation and surveys U.S. residents aged 23 to 76 with at least a bachelor's degree. Each wave is a stratified, nationally representative sample of college graduates. We treat the data as repeated cross sections and use survey weights, adjusted for the pooled sample, throughout

the analysis.[11]

The NSCG is well suited for our analysis because it links information on college financing, educational choices, and labor market outcomes. It reports whether respondents borrowed to finance their higher education and the total amount borrowed, as well as educational attainment, field of study, employment status, hours worked, annual earnings, occupation, and job satisfaction. The survey also reports the year and census division of high school graduation, which allows us to assign federal loan interest rates and regional college-financing conditions at the time students entered the college decision period.

We restrict the sample to individuals who graduated from high school in or after 1992 and no later than 2015. We focus on individuals who obtained their bachelor's degree in the United States and hold only one bachelor's degree, treating multiple majors within the same bachelor's degree as part of the same undergraduate spell.[12] We also restrict the sample to U.S. citizens and permanent residents, since non-permanent residents are generally not eligible for federal student loans. These restrictions leave us with 134,045 individual-year observations.

Table 1 presents summary statistics for the main variables used in the analysis. In our sample, 60.5 percent of college graduates borrowed for college, and the average loan amount is \$19,127 when nonborrowers are included. Among borrowers, the average loan amount is \$31,601. The table also summarizes key labor market outcomes, including unemployment, self-employment, small-firm employment, earnings, work hours, occupation, and job satisfaction. Among college graduates in our sample, 3% are unemployed, 73% work full time, 5% are self-employed, and 10% work in a small firm. For full-time workers (defined as those working more than 35 hours per week and more than 41 weeks per year), average annual earnings are \$55,826 in 2013 dollars.

We supplement the NSCG with data from the Integrated Postsecondary Education Data System (IPEDS). We use IPEDS from 1991 to 2020 to construct the share of first-year students enrolled in private four-year institutions at the census-division-by-year level.[13] This measure captures regional differences in exposure to federal loan interest rates, since students in regions with larger private university sectors face higher college costs and are more likely to rely on loan financing. We merge this measure to the NSCG by respondents' census division and year of high school graduation. IPEDS also provides institution-level information on

[11] Appendix C.1 provides additional details on the NSCG sampling structure and the construction of the analysis sample.

[12] Appendix C.1 describes how we handle respondents who report multiple bachelor's degrees or multiple majors.

[13] Appendix C details the construction of the measure.

Table 1: Summary Statistics

Variable	Mean	SD
Full sample (Count = 134,045)		
High school graduation year	2000	5.448
Take loan for college	0.605	0.489
College loan amount (in 10k)	1.913	2.362
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
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
Full-time worker sample (Count = 104,107)		
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.

tuition, total cost of attendance, and financial aid, which we use to examine whether colleges respond to changes in federal loan interest rates. Appendix Table D.1 reports summary statistics for the IPEDS data.

5. Empirical Approach

To study the impact of federal loan interest rates on college financing, education, and labor market outcomes, we exploit variation in federal loan interest rates across high-school

graduation cohorts. Because federal loan rates are set nationally, their level varies across cohorts but not across regions within a cohort. We therefore combine this time-series variation with cross-regional differences in students' expected reliance on loan financing.

Our measure of regional exposure is the share of first-year students enrolled in private universities in the respondent's high-school graduation division and year. Regions with a larger private university sector tend to have higher college costs, since public universities typically charge lower in-state tuition. Students from these regions are therefore more likely to rely on student loans, making their financing decisions more sensitive to federal loan interest rates. The empirical design compares cohorts who faced different federal loan rates across regions with different exposure to loan financing. We implement this comparison using the following continuous difference-in-differences specification:

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

Here, i indexes individuals, d_0 denotes the census division of high-school graduation,[14] t_0 denotes the year of high school graduation, and t denotes the survey year. The variable IR_{t_0} is the federal loan interest rate in t_0, the year of high school graduation. The variable $\mathrm{PS}_{d_0t_0}$ is the share of first-year students enrolled in private universities in division d_0 and year t_0. Because IR_{t_0} varies only by cohort, its main effect is absorbed by the high-school graduation year fixed effects. β_2 is the coefficient of interest, which captures whether outcomes respond more strongly to federal loan interest rates in regions with greater expected reliance on student loans.

The specification includes high-school graduation year fixed effects, δ_{t_0}, which absorb cohort-level factors such as national college tuition trends, federal policy changes, commercial interest rates, and aggregate business cycles. It also includes high-school graduation division fixed effects, δ_{d_0}, which absorb time-invariant regional differences. The vector X_{it} includes gender-by-race/ethnicity indicators, a quadratic function of age, and parental education. For time-varying outcomes, we additionally include survey year fixed effects, δ_t. All specifications use NSCG survey weights. Standard errors are clustered at the division-by-cohort level.

The key identifying assumption is that, absent changes in federal loan interest rates, outcomes in regions with different private enrollment shares would have evolved similarly across cohorts. We provide several pieces of evidence in support of this assumption. Appendix Figure F.1 compares trends in demographic characteristics (age, gender, ethnicity, and parental education), college characteristics (incoming freshman enrollment and tuition),

[14]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.

and economic conditions (GDP per capita and unemployment rate) between regions with high and low private enrollment shares.[15] These characteristics evolve similarly across the two groups. Appendix Figure F.2 shows that private enrollment shares differ substantially across divisions but are relatively stable within divisions over time, suggesting that the exposure measure captures persistent differences in regional higher education markets rather than short-run responses to federal loan rates.

Our identification strategy requires that regional exposure to federal loan rates is not proxying for other time-varying regional shocks. High-school graduation year fixed effects absorb national shocks common to all students in the same cohort, including aggregate business cycles and national changes in credit markets. To further account for local economic conditions that may evolve differently across regions with different private enrollment shares, we control for division-specific unemployment rates at high-school graduation and at college graduation, interacted with private share. The results remain robust to these controls. We also verify that the estimates are not sensitive to the measure of private enrollment shares in the high-school graduation year by estimating alternative specifications using lagged private shares and the initial private shares measured in 1992.

We organize the outcome analysis following the sequence highlighted in the conceptual framework. We first examine college financing, including student loan take-up, loan amounts, total interest payments, and the use of government or bank loans, family loans, non-repayable family support, and personal savings. We then turn to educational choices, including major choice, public university attendance, double majoring, major switching, and graduate degree attainment. The analysis next considers labor market choices and outcomes, including unemployment, self-employment, firm size, work hours, earnings, hourly wages, and occupation choice. Finally, we study job satisfaction, focusing on satisfaction with job independence and responsibility. Appendix C provides detailed definitions of these variables.

6. Empirical Results

6.1. Impact on Student Loans

We begin by examining how federal loan interest rates affect student borrowing. A higher interest rate raises the price of borrowing, but its effect on repayment burden is not mechanical because students can adjust the amount they borrow. This distinction is central to our analysis: interest rates may affect students not only by changing repayment obligations, but also by changing the financing costs at the time of college entry.

[15] By high private share, we mean the private share is above 45%, which is the median of the private shares among all divisions.

Table 2 reports the effects of federal loan interest rates on loan take-up, loan amounts, and imputed interest payments. Column (1) shows that higher interest rates significantly reduce the probability of taking out a student loan. A one-percentage-point increase in federal loan interest rates lowers the probability of borrowing by 5.1 percentage points in a region where all first-year students attend private universities, relative to a region with no private university enrollment. Evaluated at the median private enrollment share in our sample, 35 percent, this implies a 1.8 percentage point reduction in the probability of borrowing.

Table 2: Effects of Federal Loan Interest Rates on Student Loans

	(1) Take loan for college	(2) Loan borrow amount (in 10k)	(3) Interest payment (in 10k)
$IR_{t_0} \times PS_{d_0 t_0}$	-0.051***	-0.461***	-0.007
	(0.017)	(0.084)	(0.031)
R-squared	0.205	0.127	0.143
Observations	129,692	129,692	124,715

Notes: The table reports estimates of the effect of federal loan interest rates on student loan take-up, amount borrowed, and interest payment. The data includes NSCG 2003-2019. The regression controls for high school graduation year fixed effects, census 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.

Column (2) shows a similar response on the intensive margin. A one-percentage-point increase in interest rates reduces student loan principal by approximately $1,614 for students from regions with the median private enrollment share.[16] These results show that students respond strongly to federal loan interest rates by reducing their reliance on loan financing.

Column (3) examines whether higher interest rates translate into higher total interest payments. We impute interest payments under a ten-year fixed repayment schedule, using the loan composition assumptions described in Appendix C.4. The estimated effect is small and statistically insignificant. Thus, although higher rates mechanically raise the cost of each dollar borrowed, students borrow less when rates are high, leaving total interest payments largely unchanged.

These results show that federal loan interest rates primarily affect the quantity of student borrowing rather than total interest payments. Higher rates reduce loan take-up and loan principal, suggesting that students respond by substituting away from loan financing. The next subsection examines whether this reduction in borrowing is accompanied by greater

[16] Calculation: ($4,610 × 35% = $1,614).

reliance on other sources of college financing.

6.2. College Financing

We next examine how students adjust the broader composition of college financing. Table 3 reports effects on different sources of funding, including loans from government or banks, loans from parents or relatives, non-repayable family support, personal savings, and financial aid grants.

Columns (1) and (2) show that an increase in interest rates reduces the use of repayable financing, including those from the government or banks and from parents. Moreover, Columns (3) and (4) show that this decline in loan financing is accompanied by greater reliance on non-repayable parental support and personal savings.[17] Column (5) further shows that interest rates have no effect on the likelihood of receiving financial aid grants from the college.

These patterns suggest that students respond to higher interest rates by shifting away from loans and toward household resources such as parental assistance and own savings. This financing substitution is consistent with the first proposition of the model: when borrowing becomes more expensive, students reduce loan use and rely more heavily on household resources. The absence of an effect on financial aid grants also suggests that the shift in financing is not primarily driven by institutional grant responses.

Table 3: 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	(5) Financial aid & grant
$IR_{t_0} \times PS_{d_0 t_0}$	-0.070***	-0.030***	0.045**	0.043**	0.0006
	(0.022)	(0.009)	(0.020)	(0.021)	(0.017)
R-squared	0.146	0.022	0.182	0.056	0.084
Observations	120,155	120,155	120,155	90,618	120,155

Notes: The table reports estimates of the effects of federal loan interest rates on students' alternative college financing channel take-up, including whether they borrow from the government or banks, whether they receive assistance or loans from parents, whether use their own savings, and whether the recieve financial aid and grant from the school. The data includes NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. *** p<0.01, ** p<0.05, * p<0.1.

Discussion. The borrowing and financing results provide empirical support for the financing-substitution mechanism in Proposition 1. When federal loan interest rates R rise, students substitute away from borrowing b and toward household resources a. This substitution changes the financing composition without significantly increasing total interest payments.

[17]Information on the use of personal savings is available only from 2015 onward, while the others are available from 2013.

However, higher interest rates make borrowing student loans more expensive and motivate households to allocate more resources to the college stage, leaving fewer for the work stage – creating a negative wealth effect.

This interpretation changes how loan amounts should be understood. Much of the student loan literature treats borrowing levels as a measure of debt burden or financing need. Our results suggest that this interpretation is incomplete when borrowing costs vary. Larger loan balances are not necessarily evidence of worse financing conditions when they arise because borrowing has become cheaper. Instead, higher borrowing in low-interest-rate periods can reflect an optimizing response to lower borrowing costs and greater ability to smooth college costs over time. In this sense, lower interest rates generate a positive wealth effect: they reduce the cost of financing college and allow students to preserve more household resources for later periods. This wealth effect is the channel emphasized in Proposition 2: changes in financing conditions can alter the value of choosing higher-wage education and career paths. The next sections examine whether this financing response translates into changes in educational choices, labor market behavior, and job amenities.

6.3. Impact on Education Choices

The financing results show that higher federal loan interest rates reduce borrowing and shift students toward parental support and personal savings. We next examine whether this change in financing conditions affects students' educational choices, as predicted by Proposition 2. Major choice is a natural first margin to study because it shapes the expected earnings profile of the education investment.

To characterize the earnings profile associated with each major, we estimate major-specific initial earnings and earnings growth using the NSCG. Specifically, we estimate:

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

where Y_{it} is log annual earnings. The coefficients λ_{1k} and λ_{2k} are allowed to vary by major k. We interpret λ_{1k} as major-specific initial earnings and λ_{2k} as major-specific earnings growth. We then assign these estimated major-level measures to individuals based on their undergraduate major and use them as dependent variables in Equation (1). These dependent variables are multiplied by 100 so that the estimates can be interpreted in percentage point units.

Table 4 reports the results. Column (1) shows no significant effect on major-specific initial earnings. Column (2), however, shows that students exposed to higher federal loan interest rates are more likely to choose majors with higher earnings growth. Valued at the median private enrollment share of 35 percent, a one percentage point increase in federal

Table 4: Effect of Federal Loan Interest Rates on College Major Choice

	(1) Major-specific initial earnings	(2) Major-specific earnings growth	(3) Major in STEM
$IR_{t_0} \times PS_{d_0 t_0}$	-0.185	0.034*	0.035**
	(0.925)	(0.018)	(0.016)
R-squared	0.456	0.401	0.038
Observations	134,045	134,045	134,045

Notes: The dependent variables are the major-specific initial earnings and earnings growth. The data includes NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. *** p<0.01, ** p<0.05, * p<0.1.

loan interest rates raises major-specific earnings growth by $0.034 \times 35\% = 0.0119$, which corresponds to a 23.6 percent increase relative to the mean of 0.0504.[18] This result suggests that students facing tighter financing conditions at college entry place greater weight on the longer-run earnings profile of their major. Appendix Table F.1 shows that the results are robust when major-specific initial earnings and earnings growth are estimated using the American Community Survey.

We then examine whether this shift toward majors with higher earnings growth is reflected in specific fields of study. Column (3) of Table 4 shows that students exposed to higher federal loan interest rates are more likely to major in STEM fields. Table 5 provides a more disaggregated view. The estimates show movement away from psychology, foreign languages, and literature, and toward fields such as biology, microbiological sciences and immunology, pharmacy, environmental science, and engineering. These field-level shifts are consistent with the mechanism in Proposition 2: when higher interest rates make college financing more dependent on household resources available during enrollment, students are more likely to choose educational paths with stronger pecuniary returns.

The last column of Table 5 also reports selected occupation-level responses. These patterns foreshadow the labor market results in Section 6.4, where we examine whether the shift toward higher-return majors is accompanied by movement into higher-return occupations and jobs with different nonpecuniary amenities.

6.4. Impact on Labor Market Choices

The education results show that students exposed to higher federal loan interest rates are more likely to choose majors with stronger earnings growth. We next examine whether this shift carries over into work-stage choices. In the conceptual framework, w^* summarizes

[18] Calculation: $0.034 \times 35\% = 0.0119$. $0.0119 \div 0.0504 = 23.6\%$.

Table 5: Effects of Federal Loan Interest Rates on Major and Occupational Choices

Panel	Majors			Occupations
(1)	Biology	Microbiological sciences and immunology	Pharmacy	Health technologists and technicians
	0.013**	0.002*	0.002***	0.011**
	(0.006)	(0.001)	(0.001)	(0.006)
(2)	Environmental science or studies			Petroleum, mining, and geological engineers
	0.005**			0.001***
	(0.002)			(0.000)
(3)	Engineering			Precision/production occupations
	0.0011**			0.013**
	(0.0005)			(0.005)
(4)	Psychology	Other foreign languages and literature		Retail sales clerks
	-0.019***	-0.009**		-0.017**
	(0.006)	(0.004)		(0.008)

Notes: The table reports coefficients for $\text{IR}t_0 \times \text{PS}d_0t_0$. The sample is drawn from the NSCG 2003–2019. The regression controls, clustering, and weight specifications are the same as Table 2. *** p<0.01, ** p<0.05, * p<0.1.

the earnings component of the education and career path chosen in response to financing conditions. Empirically, this higher-return path can appear through three margins: greater labor supply, movement toward jobs with more predictable pecuniary returns, and sorting into occupations with stronger earnings growth or closer links to the field of study.

Impact on Labor Supply. Table 6 presents the estimated effects on employment and labor supply. Column (1) shows that a one-percentage-point increase in interest rates is associated with a 0.42 percentage point decline in the unemployment rate for students from regions with the median private enrollment share.[19] This result aligns with the model implication that tighter financing conditions increase the value of work-stage income, making individuals less likely to remain unemployed while searching for preferred opportunities.

We next examine full-time employment. Following Altonji and Zhong (2021), we define full-time workers as those working more than 35 hours per week and more than 41 weeks per year. Full-time workers account for 78 percent of the sample. We find no evidence that financing costs affect this extensive margin of labor supply. However, among full-time workers, higher interest rates increase annual work hours. A one percentage point increase in interest rates raises annual work hours by 0.49 percent for students from regions with the

[19] $1.2 \times 35\% = 0.42$.

median private enrollment share.[20] The labor supply results are consistent with a greater weight placed on pecuniary returns in the work stage.

Table 6: Effects of Federal Loan Interest Rates on Labor Supply

	(1)	(2)	(3)
	Unemployed	Working full time	ln(annual hours)
$IR_h^{fed} \times Private_{h,j}$	-0.012**	-0.000463	0.014*
	(0.006)	(0.018)	(0.008)
R-squared	0.015	0.054	0.049
Observations	134,045	134,045	104,107

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, clustering, and weight specifications are the same as Table 2. *** p<0.01, ** p<0.05, * p<0.1.

Impact on Job Types. We next examine whether financing costs affect the types of jobs individuals choose. Column (1) of Table 7 shows that college graduates exposed to higher federal loan interest rates are more likely to report salary as an important job characteristic. This provides direct evidence that financing conditions are associated with greater attention to pecuniary rewards when choosing jobs.

The last two columns of Table 7 show that higher interest rates reduce the likelihood of self-employment in non-incorporated businesses and employment at small firms. Our measure of self-employment excludes owners of incorporated businesses and therefore captures more informal or less structured forms of self-employment. These patterns suggest that individuals exposed to higher financing costs seek jobs with higher earnings and move away from job types that may offer flexibility or independence.

Appendix Table E.1 provides descriptive evidence on this tradeoff. Self-employment and small-firm employment are associated with lower earnings, fewer advancement opportunities, lower benefits, and less job security, while offering greater independence and responsibility.[21] This pattern maps closely to the conceptual framework: the empirical shift away from these jobs is consistent with movement toward high earnings, but potentially away from work arrangements with greater nonpecuniary amenities. In this sense, job type choices provide evidence on both the earnings (w) and amenity ($\psi(w)$) dimensions of the model.

[20] $1.4\% \times 35\% = 0.49\%$.

[21] All job characteristics are measured by workers' revealed importance, except for salary, which is measured by log annual earnings.

Table 7: Effects of Federal Loan Interest Rates on Job Types

	(1) Salary as an important factor	(2) Self employment	(3) Work in a small firm
$IR_h^{fed} \times Private_{h,j}$	0.003**	-0.021*	-0.020*
	(0.001)	(0.012)	(0.012)
R-squared	0.005	0.011	0.008
Observations	133,731	134,045	123,023

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.

Impact on Occupation Choice. We also examine whether financing costs affect occupation choice. Because occupation measures are most meaningful for individuals with stable labor market attachment, we restrict this analysis to full-time workers.[22]

To characterize the earnings profile associated with each occupation, we use Equation (2) to estimate occupation-specific initial earnings and earnings growth, allowing the λ_1 and λ_2 coefficients to vary by occupation rather than by major. We then assign these occupation-level measures to individuals based on their occupation and use them as dependent variables in Equation (1).

Column (2) of Table 8 shows that individuals exposed to higher interest rates are more likely to work in occupations with higher earnings growth. A one percentage point increase in interest rates is associated with a 0.017 percentage point increase in occupation-specific earnings growth for students from regions with the median private enrollment share, corresponding to a 3.32 percent increase relative to the mean.[23] Appendix Table F.1 shows that the results are similar when occupation earnings profiles are estimated using the ACS. This provides a direct empirical counterpart to the model's higher-w^* response: individuals exposed to higher financing pressure sort into occupations with stronger earnings growth.

Column (3) of Table 8 further shows that workers exposed to higher financing costs are more likely to work in occupations related to their last major. A one percentage point increase in interest rates raises the probability of working in an occupation related to one's

[22]This sample is most relevant for occupation-based outcomes because preferences, constraints, and job characteristics may differ between part-time and full-time workers.

[23]Calculations: ($0.049 \times 35\% = 0.017$) and ($0.017/0.517 = 3.32\%$).

Table 8: Effects of Federal Loan Interest Rates on Occupation Choices

	(1)	(2)	(3)
	Occ initial earnings	Occ earnings growth	Occ relavant
$IR_{t_0} \times PS_{d_0 t_0}$	0.837	0.049***	0.042*
	(1.161)	(0.018)	(0.023)
R-squared	0.435	0.576	0.020
Observations	104,107	104,107	102,955

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. The regression controls, clustering, and weight specifications are the same as Table 2. *** p<0.01, ** p<0.05, * p<0.1.

last major by 1.47 percentage points, or 6.05 percent relative to the mean.[24] Since major-occupation match has been shown to increase earnings, this result suggests that individuals facing higher financing costs are more likely to choose jobs that maximize the payoff to their earlier educational investment.

Finally, Table 5 reports selected occupation-level shifts. Graduates exposed to higher interest rates move away from retail sales clerk positions and toward health technologists and technicians, petroleum, mining, and geological engineers, and precision production occupations. These occupational shifts mirror the major shifts documented above. The increase in biology, microbiological sciences, immunology, and pharmacy majors corresponds to an increase in health technologists and technicians. The increase in environmental science corresponds to an increase in petroleum, mining, and geological engineering occupations, while the increase in engineering corresponds to an increase in precision production occupations. Conversely, the decline in psychology, foreign languages, and literature corresponds to a decline in retail sales clerk occupations.

6.5. Impact on Labor Market Outcomes

The previous section shows that students exposed to higher federal loan interest rates make labor market choices that place greater weight on pecuniary returns. We now examine whether these choices translate into realized labor market outcomes. This section studies whether moving toward higher-paying careers leads to higher earnings w^*, and whether it comes with changes in nonpecuniary aspects $\psi(w^*)$ of the job.

Impact on Earnings. We first examine annual earnings and hourly wages among full-time workers. Column (1) of Table 9 shows that a one-percentage-point increase in federal loan interest rates at college entry raises annual earnings by 2.17 percent for graduates from

[24]Calculations: $(4.2 \times 35\% = 1.47)$ and $(1.47/24.3 = 6.05\%)$.

regions with the median private enrollment share.[25] The effect on hourly wage rates is smaller and only marginally significant. This suggests that the increase in annual earnings is driven primarily by higher work hours, as documented in Table 6, with changes in wage rates playing a smaller role.

Table 9: Effects of Federal Loan Interest Rates on Earnings and Job Satisfaction

	(1) ln(annual earnings)	(2) ln(hourly wage)	(3) Satisfied with independence	(4) Satisfied with responsibility
$IR_{t_0} \times PS_{d_0 t_0}$	0.062**	0.030	-0.014**	-0.017***
	(0.030)	(0.024)	(0.006)	(0.006)
R-squared	0.171	0.184	0.006	0.011
Observations	103,850	103,413	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. The regression controls, clustering, and weight specifications are the same as Table 2. *** p<0.01, ** p<0.05, * p<0.1.

Impact on job satisfaction. We next analyze whether higher earnings come with changes in nonpecuniary job amenities. The last two columns of Table 9 show that workers exposed to higher federal loan interest rates are less likely to be satisfied with job independence and responsibility. These outcomes map directly to the amenity dimension of the conceptual framework: the higher w^* path appears to be associated with lower satisfaction with aspects of the job that capture autonomy and responsibility, as reflected in lower $\psi(w^*)$.

We also examine whether these effects differ by parental education. Splitting the sample by whether the father has a college degree, we find no evidence of heterogeneous effects between individuals from lower- and higher-educated families, as shown in Appendix Tables E.2 and E.3.

Overall, the results provide coherent findings across stages of the life cycle. The price of borrowing changes how students finance college, and this financing response carries into the education and career paths they choose. Higher interest rates push individuals toward paths with stronger pecuniary returns, but the resulting earnings gains are accompanied by lower satisfaction with autonomy and responsibility. The main implication is that changes in student loan interest rates generate a wealth effect that influences how college students trade off earnings against nonpecuniary job amenities.

[25] $6.2\% \times 35\% = 2.17\%$.

7. Alternative Mechanisms and Robustness Checks

While the preceding sections link interest rates to financing choices and subsequent outcomes, it is important to consider whether other mechanisms could explain these patterns. In this section, we examine several alternative explanations for these patterns. We focus on four concerns: (1) colleges may respond to interest rates by changing prices or aid; (2) changes in interest rates may alter who enters or completes college; (3) local labor market conditions may be correlated with federal loan rates; and (4) the regional private enrollment share used to measure exposure may itself respond to interest rates.

7.1. College Pricing and Institutional Responses

A first alternative explanation is that federal loan interest rates affect students indirectly through institutional responses. If colleges adjust tuition, total cost of attendance, or financial aid when federal loan rates change, then our estimates may partly reflect changes in college pricing rather than students' financing responses.

We test this possibility using IPEDS data. We construct division-by-year measures of tuition, total cost of attendance, and financial aid, weighting institutions by the number of first-year students. We then estimate a regional version of our baseline specification:

$$Y_{d_0t_0} = \alpha_0 + \alpha_1 \mathrm{PS}_{d_0t_0} + \alpha_2 \mathrm{IR}_{t_0} \times \mathrm{PS}_{d_0t_0} + \xi_{d_0} + \xi_{t_0} + e_{id_0t_0}. \tag{3}$$

Because the dependent variables are measured at the division-by-year level, this specification excludes individual-level controls.

Appendix Table F.2 provides little evidence that federal loan interest rates affect tuition, total cost of attendance, or financial aid. Recalled that in Table 3, we examine individual-level outcomes in the NSCG and find no significant relationship between federal loan interest rates and the likelihood that students receive financial aid or grants. These results suggest that neither college tuition nor aid allocation mechanisms systematically adjust to changes in federal loan interest rates. This finding helps rule out an institutional pricing channel. It also distinguishes our setting from policies that directly expand borrowing capacity, such as the creation of Grad PLUS, which Black et al. (2025) show led to higher program prices. In contrast, changes in interest rates occur more frequently and do not directly increase loan limits, making immediate tuition responses less likely. The evidence therefore supports the interpretation that our main results operate through students' financing choices rather than through college pricing behavior.

7.2. Selection into College Completion and Other Education Channels

A second concern is sample selection. The NSCG is a sample of college graduates, so our estimates could be affected if federal loan interest rates change who attends college, who completes college, or which types of students appear in the graduate sample. For example, lower interest rates could increase college enrollment or completion, thereby changing the composition of observed graduates rather than changing the choices of comparable students.

We examine this possibility in two ways. First, we use IPEDS to study whether federal loan interest rates affect the number of first-year college students. Second, we use the NSCG sampling weights to construct division-by-year counts of college graduates, where the inverse of the sampling weight represents the number of individuals each respondent stands for. We then estimate Equation (3) using either first-year enrollment or the number of college graduates as the dependent variable.

Columns (1) and (2) of Appendix Table F.3 show no significant effect on college enrollment or completion. This suggests that the main results are unlikely to be driven by changes in the size of the population that enrolls in or completes college. This finding is also consistent with prior work showing that borrowing constraints have limited effects on college completion (Keane and Wolpin, 2001; Cameron and Taber, 2004; Stinebrickner and Stinebrickner, 2008; Ionescu, 2009; Johnson, 2013).

We also examine whether federal loan interest rates change the observable composition of college graduates. Using the individual-level specification in Equation (1), we estimate effects on fathers' and mothers' education among NSCG respondents. The last two columns of Appendix Table F.3 show no significant relationship between federal loan interest rates and parental education. These results further reduce concerns that our findings are driven by selection into the NSCG sample.

Finally, we consider whether our labor market findings could be explained by other educational margins rather than the major and occupation channels emphasized above. Appendix Table F.4 shows little evidence that federal loan interest rates affect public university attendance, double majoring, major switching between the bachelor's and graduate degree, or graduate degree attainment. The absence of effects on these margins suggests that the main education response operates through field of study rather than through broad changes in college type, degree structure, or further education.

7.3. Local Labor Market Conditions

A third concern is that federal loan interest rates may be correlated with macroeconomic or local labor market conditions that also affect career outcomes (Kahn, 2010; Oreopoulos et al., 2012). High-school graduation year fixed effects absorb national shocks common to all

students in the same cohort, including aggregate business cycles and national credit market conditions. However, the estimates could still be affected if local labor market conditions evolve differently across regions with different private university enrollment shares.

To address this concern, we control for division-specific unemployment rates at both high school graduation or college graduation, and interact these unemployment rates with private university enrollment share. The unemployment rates are measured for the census division of the respondent's high school location using data from the U.S. Bureau of Labor Statistics.[26]

Appendix F.4 and Appendix F.5 show that the baseline results remain robust after adding controls for division-specific unemployment rates at high school graduation and college graduation, as well as their interactions with shares of private university students. This reduces the concern that our estimates are driven by differential exposure to local labor market shocks rather than by changes in college financing conditions.

7.4. Alternative Measures of Regional Exposure

A final concern is that the share of private university students used to measure exposure may itself respond to federal loan interest rates. In the baseline specification, we interact federal loan interest rates with the division-level share of first-year students attending private universities in the respondent's high-school graduation year. If interest rates affect sorting into private universities, then this exposure measure could be endogenous.

Two pieces of evidence reduce this concern. First, Appendix Table F.4 shows that federal loan interest rates do not significantly affect the likelihood of attending a public university, suggesting that students are not systematically switching between public and private institutions in response to rate changes. Second, we re-estimate the baseline models using alternative exposure measures that are predetermined with respect to current interest rates: the one-year lagged private share and the initial private share measured in 1992.

Appendix F.6 and Appendix F.7 show that the results remain consistent under both alternative measures. These robustness checks indicate that the findings are not driven by contemporaneous changes in private university enrollment share. Instead, the private share appears to capture persistent regional differences in expected reliance on loan financing.

[26]Because we do not observe the division of the college attended, we use the high school division as a proxy. Most students attend college in their home division, so this measure provides a reasonable, though imperfect, proxy for local economic conditions at graduation. Unemployment rate data are from the U.S. Bureau of Labor Statistics, Regional and State Unemployment, 1993-2024. U.S. territories do not report unemployment rates, so the number of observations drops slightly.

7.5. Summary

These exercises support the main interpretation of the paper. The results do not appear to be driven by college pricing responses, selection into college completion, broad changes in educational attainment, local labor market conditions, or endogenous changes in the exposure measure. The evidence instead points back to the mechanism emphasized throughout the paper: federal loan interest rates affect the way students finance college, and these financing conditions shape subsequent education and career choices.

8. Conclusion

This paper studies how the price of student borrowing shapes college financing, educational choices, and labor market outcomes. We focus on federal student loan interest rates, which determine the cost of borrowing for students who finance college expenses through loans and repay them after graduation. To identify their effects, we combine changes in federal loan interest rates over time with regional differences in expected reliance on loan financing, measured by the share of first-year college enrollment in private universities. This continuous difference-in-differences design allows us to compare cohorts exposed to different federal loan rates across regions with different exposure to those rates.

Federal loan interest rates shape how students finance college. Higher rates reduce student loan take-up and the amount borrowed, without leading to higher total interest payments. Students shift their financing away from loans provided by the government, banks, or parents and toward non-repayable parental support and personal savings. These results suggest that loan amounts capture not just debt and financing needs, but also the intertemporal cost of borrowing. When rates rise, future repayment becomes costlier, prompting greater reliance on family resources and creating a negative wealth shock.

The higher financing cost is followed by changes in education and career choices. Students exposed to higher federal loan interest rates are more likely to choose majors with higher earnings growth and to enter occupations with stronger earnings potential. They also supply more labor, are less likely to be unemployed, self-employed, or employed at small firms, and are more likely to work in jobs related to their field of study. These choices lead to higher annual earnings. At the same time, affected individuals report lower satisfaction with job independence and responsibility. The evidence points to a mechanism that begins with college financing and extends into the career path: higher borrowing costs shift students toward choices with stronger pecuniary returns, but these choices may come at the cost of nonpecuniary job amenities.

More broadly, the paper shows that the price of credit can shape human capital and career decisions before repayment even begins. In the student loan setting, interest rates

influence how students finance college, smooth costs over time, and subsequently sort across fields of study and occupations. This perspective broadens the evaluation of student loan policy by placing borrowing costs at the center of an intertemporal allocation problem: how young people finance education affects the trade-off between earnings and job amenities.

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Appendix A. Proof of the Propositions

Proof. At an interior optimum, the first-order conditions are

$$\frac{N'(a)}{c_0} = \frac{\beta R_f}{c_1}, \tag{A.1}$$

$$\frac{1}{c_0} = \frac{\beta R}{c_1}, \tag{A.2}$$

$$\frac{\beta}{c_1} = -\psi'(w). \tag{A.3}$$

Dividing (A.1) by (A.2) gives

$$N'(a^*) = \frac{R_f}{R}.$$

Since $N'' < 0$, a higher student-loan repayment rate lowers the required marginal net return to family financing and therefore raises gross family financing:

$$\frac{da^*}{dR} = -\frac{R_f}{R^2 N''(a^*)} > 0. \tag{A.4}$$

Net family support also rises:

$$\frac{dN(a^*)}{dR} = N'(a^*)\frac{da^*}{dR} > 0.$$

Equations (A.2) and (A.3) imply

$$c_0^* = -\frac{1}{R\psi'(w^*)}.$$

The work-stage budget and the identity $b^* = T + c_0^* - N(a^*)$ imply

$$-\frac{\beta+1}{\psi'(w^*)} = w^* + R_f(A - a^*) - RT + RN(a^*).$$

Differentiating this equation with respect to R yields

$$\frac{dw^*}{dR} = \frac{T - N(a^*)}{1 - (\beta+1)\psi''(w^*)/[\psi'(w^*)]^2} > 0 \quad \text{if} \quad N(a^*) < T. \tag{A.5}$$

Thus the effect of R on the education track is positive when net family support is below tuition and negative when net family support exceeds tuition.

For borrowing, use

$$b^* = T + c_0^* - N(a^*).$$

It is enough to show that $dc_0^*/dR < 0$, since $dN(a^*)/dR > 0$. From the first-order conditions,

$$c_0^* = -\frac{1}{R\psi'(w^*)}.$$

Let $p = \psi'(w^*) < 0$ and $q = \psi''(w^*) \leq 0$. Then

$$\frac{dc_0^*}{dR} = \frac{1}{R^2 p} + \frac{q}{Rp^2}\frac{dw^*}{dR}.$$

If $N(a^*) < T$, then $dw^*/dR \geq 0$, so $dc_0^*/dR < 0$. It follows that $db^*/dR < 0$.

□

Appendix B. More Background Information about Student Loans

Appendix B.1. Subsidized and Subsidized 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.[27]

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

[27]Source: `https://studentaid.gov/manage-loans/repayment/plans`.

Figure B.2: Repayment Plans

	Plans	Eligibile Loans	Monthly Payment Amount
Fixed Payment Repayment Plans	Standard Repayment Plans	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 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		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)	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
	Pay As You Earn (PAYE)		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.

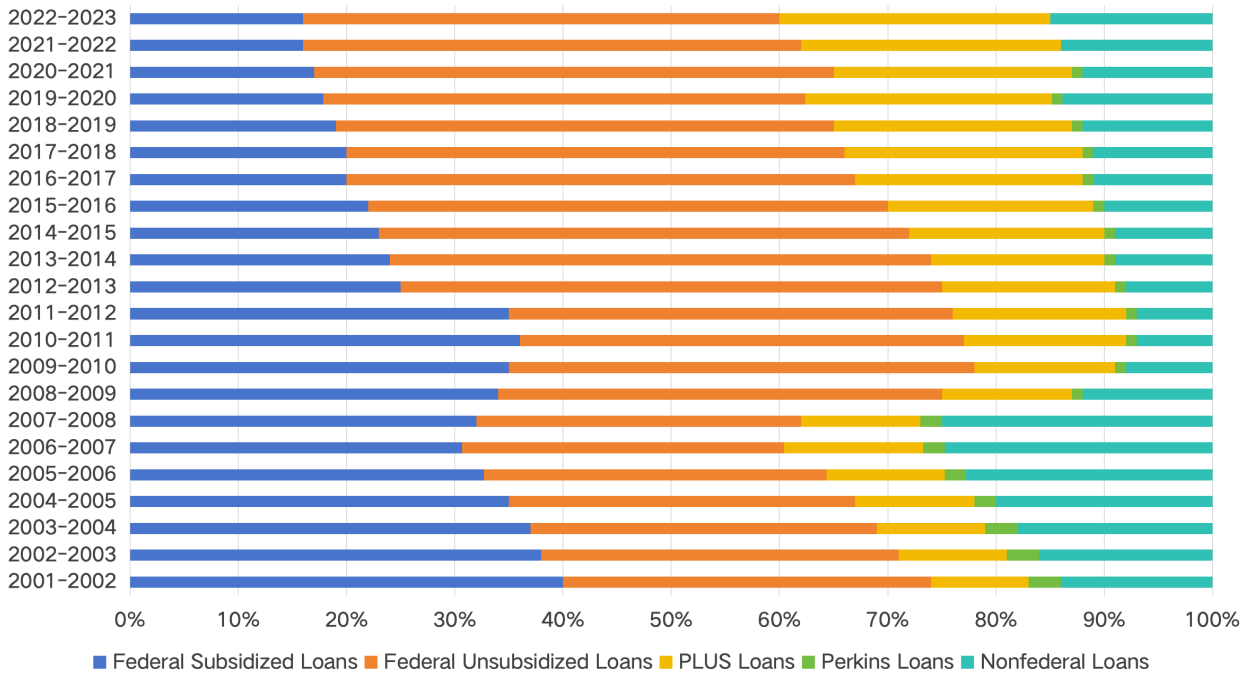
Appendix B.2. Other Types of Federal Loans besides Subsidized and Unsubsidized Loans

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, Statisa.

Appendix C. Data Construction and Definition of Dependent Variables

Appendix C.1. Additional Data Details

Appendix C.1.1. NSCG Sampling Structure

The National Survey of College Graduates (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. The sampling frame differs across waves. The 2003 NSCG sample is a representative subset of individuals in the 2000 Decennial Census long form with at least a bachelor's degree. Since 2010, the NSCG has employed a rolling panel sampling structure. The 2010 NSCG sample is drawn from individuals in the 2010 American Community Survey with at least a bachelor's degree. Beginning in 2013, approximately three quarters of each sample consisted of returning respondents from the previous survey wave, while the remaining quarter consisted of new respondents drawn from the current-year American Community Survey sample of individuals with at least a bachelor's degree.

Appendix C.1.2. Treatment of Multiple Bachelor's Degrees and Multiple Majors in NSCG

Some respondents report multiple bachelor's degrees. If an individual reports multiple bachelor's degrees awarded in the same year, each with a different major, we treat these reports as a single undergraduate degree with multiple majors. In this case, the primary major reported for the first bachelor's degree is used as the first major. If an individual reports multiple bachelor's degrees awarded in different years, we treat these as distinct undergraduate degrees and exclude the respondent from the analysis sample, regardless of whether the reported fields of study are the same or different.

Appendix C.1.3. IPEDS Sample and Construction of Private Enrollment Share

The IPEDS sample used to construct regional exposure includes four-year public and private institutions and excludes online institutions. The resulting dataset contains 65,031 institution-year observations. For each census division and year, we calculate the share of first-year students enrolled in private universities as the number of full-time, first-time, degree- or certificate-seeking undergraduates enrolled in private four-year institutions divided by the corresponding total across private and public four-year institutions. This measure is then merged to the NSCG using the respondent's census division and year of high school graduation.

Appendix C.1.4. IPEDS Measures of College Costs and Financial Aid

We also use IPEDS to construct division-by-year measures of tuition, total cost of attendance, and financial aid. Tuition is measured using published tuition and fees. Total

cost of attendance includes tuition and fees, books and supplies, room and board, and other reported expenses. Financial aid is measured as grant aid from federal, state, local, and institutional sources. These institution-level measures are aggregated to the census-division-by-year level using enrollment weights. All monetary variables are converted to 2013 dollars before aggregation.

Appendix C.2. Variables from NSCG

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

College loan is the numerical value for the college loan amount, including federal loans and private loans. Respondents select from intervals: did not borrow, 1-10k, 10-20k, 20-30k, 30-40k, 40-50k, 50-60k, 60-70k, 70-80k, 80-90k, 90k and above. We convert the categorical variable to a continuous value by assigning the midpoint of each range. For the "90k and above" category, we assign 95k, and for respondents who did not borrow or complete a degree, we assign 0.

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

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

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

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

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

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

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

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

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

STEM major is a dummy variable equal to 1 if the first major of the first BA degree is Biological Sciences, Environmental Sciences, Agricultural Sciences, Computer Science, Mathematics, Engineering, Health and related fields, Nursing, Physical and related Sciences, or Other Science and Engineering related fields.

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.

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.

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(earnings) is the natural logarithm of annual base earnings from the principal job.

ln(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(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.

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

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 C.3. 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 $s \in \{\text{public}, \text{private}\}$ 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 C.4. Construction of Imputed Interest Payments

The NSCG reports the amount borrowed to finance education, but this amount reflects loan principal and does not include interest payments. To study whether changes in federal loan interest rates affect repayment obligations, we impute total interest payments using a standard fixed-payment repayment schedule.

Let $Loan$ denote the reported loan principal. Let ir_s denote the monthly average interest rate for subsidized and unsubsidized federal loans, and let ir_p denote the monthly interest rate for PLUS loans. We assume a repayment period of 10 years, corresponding to 120 monthly payments. Total repayment is calculated as

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

$$Interest\ Payment = Total\ Payment - Loan. \tag{C.2}$$

This calculation assumes that 70 percent of the loan principal accrues the average subsidized and unsubsidized loan interest rate, while the remaining 30 percent accrues the PLUS loan interest rate. The 70 percent share is motivated by the loan composition shown in Appendix Figure B.3, where subsidized and unsubsidized federal loans account for the majority of student loans. The remaining share consists primarily of PLUS loans, although some borrowing may come from other sources.

Several qualifications apply to this imputation. First, the reported loan amount in the NSCG may include federal loans, state government loans, commercial loans from banks, and

loans from parents or relatives. Second, the interest rate applied to the remaining 30 percent of borrowing is an approximation, since some of these loans may carry higher rates, as in the case of private loans, or zero interest, as in the case of some family loans. However, non-federal loans account for a relatively small share of total student loans during the relevant period, mitigating this concern. Third, we use a 10-year fixed repayment schedule because it corresponds to the standard fixed payment repayment plan. Income-driven repayment plans became more widely used only after the late 2000s and therefore have limited overlap with the cohorts in our main analysis.

The imputed interest payment measure allows us to distinguish changes in loan principal from changes in total repayment obligations. This distinction is important because higher interest rates mechanically increase the cost of each dollar borrowed, but may also induce students to reduce the amount borrowed.

Appendix D. Summary Statistics of the IPEDS data

Table D.1: 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	13494.610	4706.712	153
Total cost of college	26295.720	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 $s \in \{\text{public}, \text{private}\}$, 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 E. Additional Empirical Results

Table E.1: Amenities Related to Job Types

	(1)	(2)
	Self-employment	Work for a small firm
Salary (ln(annual earnings))	-0.025***	-0.063***
	(0.003)	(0.004)
Opportunities for advancement	-0.031**	-0.095***
	(0.012)	(0.016)
Benefits	-0.212***	-0.313***
	(0.039)	(0.036)
Job security	-0.069**	-0.125***
	(0.031)	(0.035)
Degree of independence	0.060***	0.111***
	(0.017)	(0.033)
Level of responsibility	0.016	0.016
	(0.014)	(0.023)
Intellectual challenge	-0.008	-0.0003
	(0.021)	(0.029)
Job location	0.011	-0.038
	(0.020)	(0.030)
Contribution to society	0.014	0.018
	(0.010)	(0.015)
R-squared	0.026	0.049
Observations	211,748	211,748

Notes: Table E.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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table E.2: Effects of Federal Loan Interest Rates on Education Financing Decisions by Father's Educational Attainment

	(1) Take loan for college	(2) Loan borrow amount (in 10k)	(3) Loans from government or banks	(4) Loans from parents	(5) Financial support from parents	(6) Own Savings
Father's Education Attainment < College:						
$IR_{t_0} \times PS_{d_0t_0}$	-0.048*	-0.582***	-0.083***	0.029	-0.048***	0.038
	(0.028)	(0.122)	(0.029)	(0.034)	(0.015)	(0.029)
R-squared	0.228	0.140	0.139	0.106	0.033	0.070
Observations	62,098	62,098	57,590	57,590	57,590	43,441
Father's Education Attainment ≥ College:						
$IR_{t_0} \times PS_{d_0t_0}$	-0.047**	-0.317**	-0.055*	0.057**	-0.012	0.051
	(0.023)	(0.160)	(0.030)	(0.028)	(0.014)	(0.032)
R-squared	0.149	0.102	0.099	0.205	0.021	0.059
Observations	67,594	67,594	62,543	62,543	62,543	47,177
Difference in coef.	0.001	0.265	0.029	0.028	0.036	0.013
p-value diff.	0.972	0.188	0.492	0.528	0.091	0.761

Notes: The table reports estimates of the effect of federal loan interest rates on education financing decisions, by father's educational attainment. The data are from the NSCG (2003–2019). Panel A presents results for individuals whose fathers do not have college degrees, while Panel B presents results for those whose fathers have college degrees. The regression controls for high school graduation year fixed effects, census 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. Standard errors in parentheses.

Table E.3: Effects of Federal Loan Interest Rates on Labor Market Outcomes by Father's Educational Attainment

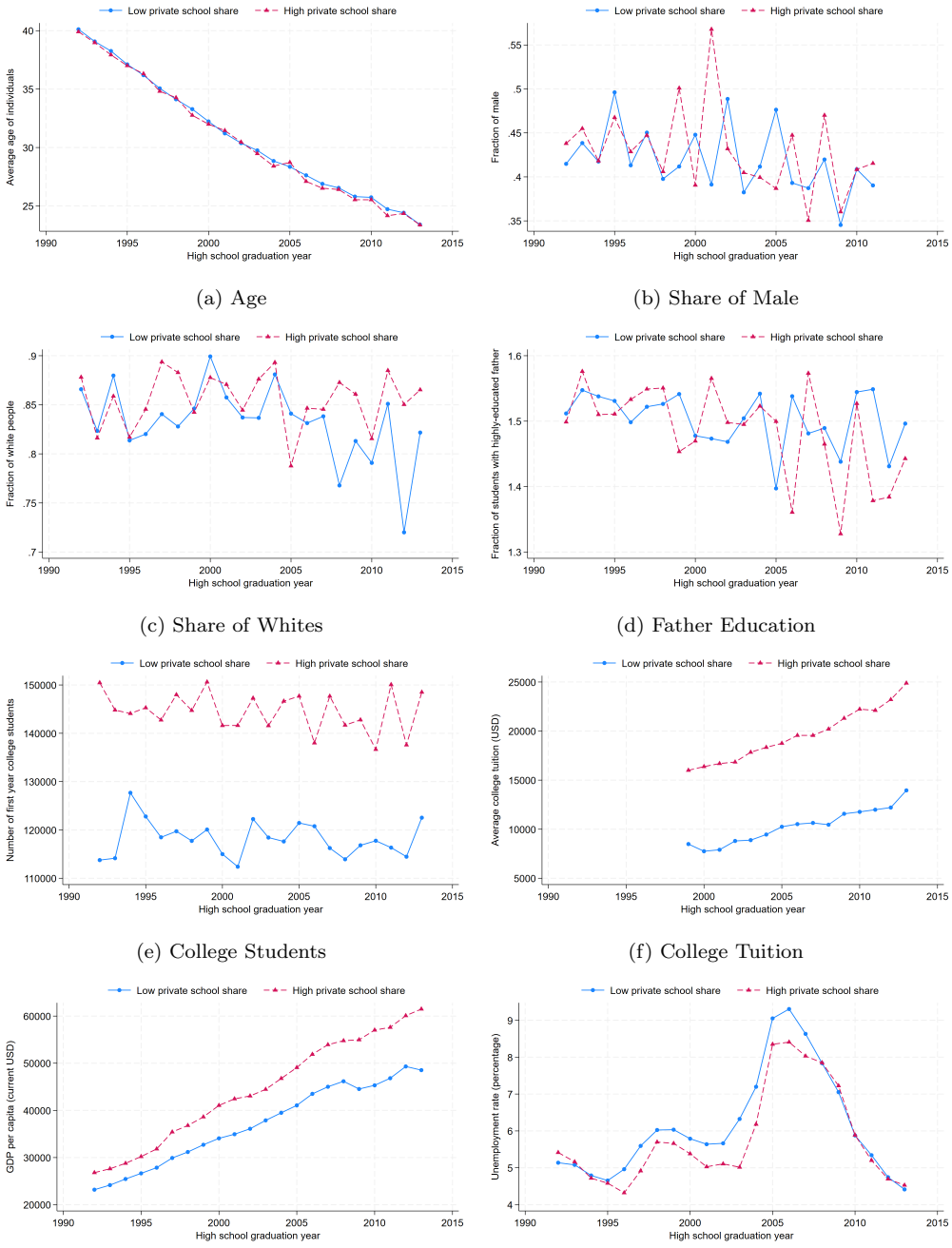
	(1) ln(annual earnings)	(2) ln(annual hours)	(3) Satisfied with independence	(4) Satisfied with responsibility
Father's Education Attainment < College:				
$IR_{t_0} \times PS_{d_0t_0}$	0.062	0.006	-0.016*	-0.017*
	(0.040)	(0.013)	(0.009)	(0.009)
R-squared	0.163	0.063	0.009	0.017
Observations	49,892	49,985	59,165	59,165
Father's Education Attainment ≥ College:				
$IR_{t_0} \times PS_{d_0t_0}$	0.066	0.023**	-0.010	-0.017*
	(0.041)	(0.009)	(0.009)	(0.009)
R-squared	0.176	0.045	0.010	0.015
Observations	53,958	54,122	63,858	63,858
Difference in coef.	0.004	0.016	0.007	-0.000
p-value diff.	0.942	0.306	0.601	0.978

Notes: The table reports estimates of the effect of federal loan interest rates on labor market outcomes, by father's educational attainment. The data are from the NSCG (2003–2019). Panel A presents results for individuals whose fathers do not have college degrees, while Panel B presents results for those whose fathers have college degrees. The regression controls for high school graduation year fixed effects, census 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. Sample weights are used. *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses.

Appendix F. Robustness Checks

Appendix F.1. Parallel Trends

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



(a) Age

(b) Share of Male

(c) Share of Whites

(d) Father Education

(e) College Students

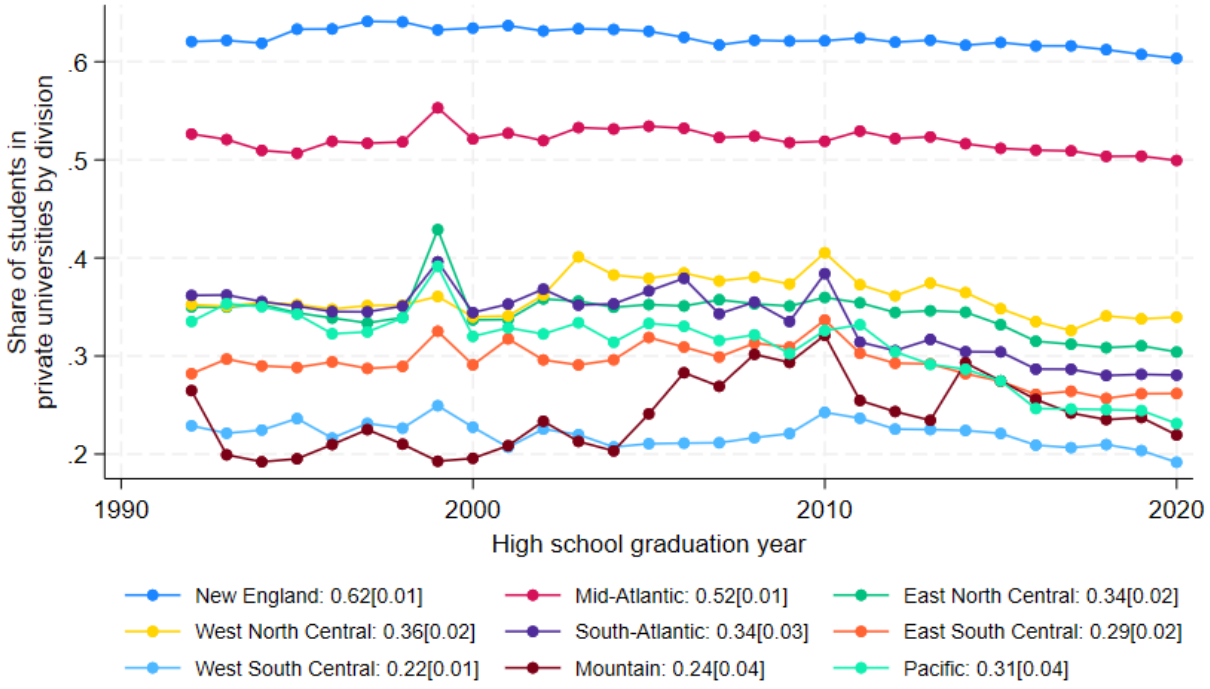
(f) College Tuition

(g) GDP Per Capita

(h) Unemployment Rate

Notes: This figure plots trends from 1993 to 2013 for various demographic variables, college characteristics, and economic outcomes, separately for divisions with low and high private enrollment shares. 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. Institution-level statistics, including enrollment and tuition, are from the IPEDS.

Figure F.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] for each division across all years.

Appendix F.2. Results from the ACS

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

	(1) Major-specific initial earnings	(2) Major-specific earnings growth	(3) Occ-specific initial earnings	(4) Occ-specific earnings growth
$IR_{t_0} \times PS_{d_0t_0}$	-0.852	0.110**	0.878	0.146*
	(0.753)	(0.043)	(1.10)	(0.088)
R-squared	0.053	0.054	0.808	0.078
Observations	133,516	133,516	100,809	100,809

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, clustering, and weight specifications are the same as Table 2. *** p<0.01, ** p<0.05, * p<0.1.

Appendix F.3. Alternative Potential Channels

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

	(1) ln(tuition)	(2) ln(total costs)	(3) ln(financial aid)
$IR_{t_0} \times PS_{d_0t_0}$	0.019	0.006	0.006
	(0.027)	(0.009)	(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 calculation of division-level mean tuition, total cost, and financial aid statistics is as described in the notes under Table D.1. 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 F.3: Effect of Federal Loan Interest Rates on Selection into College Graduates

	(1) # freshmen	(2) # college graduates	(3) Father's education	(4) Mother's education
$IR_{t_0} \times PS_{d_0t_0}$	30.64	5.689	-0.126	-0.056
	(40.47)	(7.421)	(0.112)	(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 an 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 F.4: Effects of Federal Interest Rates on College and Graduate School Outcomes

	(1) Attend public universities	(2) Double major	(3) Change major	(4) Obtain grad degree
$IR_{t_0} \times PS_{d_0t_0}$	0.023	0.023	0.016	0.008
	(0.020)	(0.017)	(0.026)	(0.020)
R-squared	0.059	0.012	0.033	0.065
Observations	134,045	134,045	55,488	134,045

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 follows Equation (3). *** p<0.01, ** p<0.05, * p<0.1.

Appendix F.4. Controlling for the Unemployment Rate at High School Graduation

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

	(1) Take loan for college	(2) Loan borrow amount (in 10k)	(3) Interest payment (in 10k)	(4) Loans from gov't or banks	(5) Loans from parents	(6) Financial support from parents	(7) Own Savings
$IR_{t_0} \times PS_{d_0t_0}$	-0.053***	-0.496***	-0.016	-0.079***	0.052***	-0.030***	0.045**
	(0.016)	(0.081)	(0.031)	(0.022)	(0.018)	(0.009)	(0.021)
UR_{t_0}	0.018	0.157*	0.043	0.048***	-0.031**	0.001	-0.006
	(0.015)	(0.080)	(0.030)	(0.018)	(0.013)	(0.007)	(0.014)
$UR_{t_0} \times PS_{d_0t_0}$	-0.004	-0.190	-0.028	-0.056	0.022	0.010	0.016
	(0.030)	(0.189)	(0.077)	(0.036)	(0.027)	(0.016)	(0.032)
R-squared	0.208	0.128	0.144	0.147	0.185	0.022	0.056
Observations	127,416	127,416	122,551	118,132	118,132	118,132	89,243

Notes: The sample is drawn from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We additionally include the division-specific unemployment rates at high school graduation and their interaction with private enrollment shares. *** p<0.01, ** p<0.05, * p<0.1.

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

	(1) Major-specific earnings growth	(2) Major in STEM	(3) Occ earnings growth	(4) Occ relevant	(5) Unemployed	(6) Work in a small firm	(7) Self employment
$IR_{t_0} \times PS_{d_0t_0}$	0.034*	0.035**	0.050***	0.042*	-0.010*	-0.022	-0.022*
	(0.018)	(0.015)	(0.018)	(0.023)	(0.006)	(0.014)	(0.012)
UR_{t_0}	0.000	0.005	-0.008	0.007	-0.010*	-0.011	0.008
	(0.014)	(0.013)	(0.014)	(0.015)	(0.005)	(0.009)	(0.007)
$UR_{t_0} \times PS_{d_0t_0}$	0.019	0.001	0.020	0.011	0.014	0.024	-0.014
	(0.027)	(0.028)	(0.027)	(0.035)	(0.012)	(0.017)	(0.015)
R-squared	0.401	0.038	0.576	0.021	0.015	0.012	0.008
Observations	131,687	131,687	102,440	101,322	131,687	120,965	120,965

Notes: The sample is drawn from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We additionally include the division-specific unemployment rates at high school graduation and their interaction with private enrollment shares. *** p<0.01, ** p<0.05, * p<0.1.

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

	(1) ln(annual earnings)	(2) ln(annual hours)	(3) ln(hourly wage)	(4) Salary as an important factor	(5) Satisfied with independence	(6) Satisfied with responsibility
$IR_{t_0} \times PS_{d_0t_0}$	0.069**	0.016*	0.034	0.003**	-0.012*	-0.015**
	(0.029)	(0.008)	(0.023)	(0.001)	(0.007)	(0.006)
UR_{t_0}	-0.017	-0.007	-0.004	-0.001	-0.011***	-0.008*
	(0.014)	(0.005)	(0.012)	(0.001)	(0.004)	(0.004)
$UR_{t_0} \times PS_{d_0t_0}$	0.081***	0.012	0.047	-0.000	0.019**	0.015*
	(0.029)	(0.011)	(0.029)	(0.001)	(0.008)	(0.009)
R-squared	0.157	0.049	0.173	0.004	0.007	0.011
Observations	102,185	102,440	101,766	131,397	120,965	120,965

Notes: The sample includes full-time workers from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We additionally include the division-specific unemployment rates at high school graduation and their interaction with private enrollment shares. *** p<0.01, ** p<0.05, * p<0.1.

Appendix F.5. Controlling for the Unemployment Rate at College Graduation

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

	(1) Take loan for college	(2) Loan borrow amount (in 10k)	(3) Interest payment (in 10k)	(4) Loans from gov't or banks	(5) Loans from parents	(6) Financial support from parents	(7) Own Savings
$IR_{t_0} \times PS_{d_0t_0}$	-0.049***	-0.392***	0.017	-0.070***	0.052**	-0.033***	0.0565**
	(0.018)	(0.095)	(0.032)	(0.023)	(0.020)	(0.010)	(0.023)
UR_{t_1}	0.008	-0.063	-0.026	0.008	-0.024**	0.00234	-0.025***
	(0.008)	(0.054)	(0.021)	(0.010)	(0.010)	(0.004)	(0.008)
$UR_{t_1} \times PS_{d_0t_0}$	0.024	0.566***	0.198***	0.0136	-0.008	-0.014	0.066***
	(0.021)	(0.161)	(0.063)	(0.027)	(0.025)	(0.012)	(0.022)
R-squared	0.209	0.134	0.148	0.147	0.188	0.022	0.057
Observations	127,412	127,412	122,547	118,128	118,128	118,128	89,240

Notes: We denote college graduation year by t_1. The sample is drawn from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We additionally include the division-specific unemployment rates at college graduation and their interaction with private enrollment shares. *** p<0.01, ** p<0.05, * p<0.1.

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

	(1) Major-specific earnings growth	(2) Major in STEM	(3) Occ earnings growth	(4) Occ relevant	(5) Unemployed	(6) Work in a small firm	(7) Self employment
$IR_{t_0} \times PS_{d_0t_0}$	0.031*	0.033*	0.045**	0.043*	-0.011	-0.032**	-0.024**
	(0.019)	(0.018)	(0.019)	(0.026)	(0.007)	(0.013)	(0.012)
UR_{t_1}	0.002	0.002	0.002	-0.010	-0.001	0.012*	0.007
	(0.011)	(0.006)	(0.008)	(0.010)	(0.003)	(0.006)	(0.004)
$UR_{t_1} \times PS_{d_0t_0}$	-0.010	-0.026	-0.021	-0.015	0.013	-0.042***	-0.017
	(0.032)	(0.018)	(0.000)	(0.028)	(0.008)	(0.016)	(0.011)
R-squared	0.401	0.038	0.576	0.022	0.015	0.013	0.008
Observations	131,683	131,683	102,437	101,319	131,683	120,962	120,962

Notes: We denote college graduation year by t_1. The sample is drawn from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We additionally include the division-specific unemployment rates at college graduation and their interaction with private enrollment shares. *** p<0.01, ** p<0.05, * p<0.1.

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

	(1) ln(annual earnings)	(2) ln(annual hours)	(3) ln(hourly wage)	(4) Salary as an important factor	(5) Satisfied with independence	(6) Satisfied with responsibility
$IR_{t_0} \times PS_{d_0t_0}$	0.073**	0.016**	0.040	0.003**	-0.017***	-0.017***
	(0.031)	(0.008)	(0.024)	(0.001)	(0.006)	(0.006)
UR_{t_1}	-0.038***	-0.004	-0.033***	0.001	0.003	-0.004
	(0.014)	(0.004)	(0.010)	(0.000)	(0.003)	(0.003)
$UR_{t_1} \times PS_{d_0t_0}$	0.018	0.010	0.018	0.001	-0.024**	-0.004
	(0.032)	(0.009)	(0.025)	(0.001)	(0.011)	(0.009)
R-squared	0.160	0.049	0.176	0.005	0.008	0.012
Observations	102,182	102,437	101,763	131,393	120,962	120,962

Notes: We denote college graduation year by t_1. The sample includes full-time workers from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We additionally include the division-specific unemployment rates at college graduation and their interaction with private enrollment shares. *** p<0.01, ** p<0.05, * p<0.1.

Appendix F.6. Using Lagged Private Share

Table F.11: Effects of Federal Loan Interest Rates on College Financing

	(1) Take loan for college	(2) Loan borrow amount (in 10k)	(3) Interest payment (in 10k)	(4) Loans from government or banks	(5) Loans from parents	(6) Financial support from parents	(7) Own Savings
$IR_{t_0} \times PS_{d_0(t_0-1)}$	-0.052***	-0.468***	-0.010	-0.070***	0.047**	-0.028***	0.041*
	(0.017)	(0.087)	(0.031)	(0.022)	(0.020)	(0.010)	(0.022)
R-squared	0.205	0.127	0.143	0.146	0.182	0.022	0.056
Observations	129,692	129,692	124,715	120,133	120,133	120,133	90,618

Notes: The sample is drawn from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We replace the private enrollment rate at high school graduation with the lagged one-year private enrollment rate. *** p<0.01, ** p<0.05, * p<0.1.

Table F.12: Effects of Federal Loan Interest Rates on Education and Labor Market Outcomes

	(1) Major-specific earnings growth	(2) Major in STEM	(3) Occ earnings growth	(4) Occ relevant	(5) Unemployed	(6) Work in a small firm	(7) Self employment
$IR_{t_0} \times PS_{d_0(t_0-1)}$	0.031*	0.034**	0.043**	0.044*	-0.013**	-0.023*	-0.019
	(0.018)	(0.016)	(0.018)	(0.023)	(0.006)	(0.014)	(0.012)
R-squared	0.401	0.038	0.576	0.020	0.015	0.012	0.008
Observations	134,045	134,045	104,107	102,955	134,045	123,023	123,023

Notes: The sample is drawn from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We replace the private enrollment rate at high school graduation with the lagged one-year private enrollment rate. *** p<0.01, ** p<0.05, * p<0.1.

Table F.13: Effects of Federal Loan Interest Rates on Labor Market Outcomes (Cont'd)

	(1) ln(annual earnings)	(2) ln(annual hours)	(3) ln(hourly wage)	(4) Salary as an important factor	(5) Satisfied with independence	(6) Satisfied with responsibility
$IR_{t_0} \times PS_{d_0(t_0-1)}$	0.058**	0.015*	0.026	0.003**	-0.014**	-0.018***
	(0.029)	(0.008)	(0.023)	(0.001)	(0.007)	(0.006)
R-squared	0.171	0.049	0.184	0.005	0.006	0.011
Observations	103,850	104,107	103,413	133,731	123,023	123,023

Notes: The sample includes full-time workers from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We replace the private enrollment rate at high school graduation with the lagged one-year private enrollment rate. *** p<0.01, ** p<0.05, * p<0.1.

Appendix F.7. Using Private Share in 1992

Table F.14: Effects of Federal Loan Interest Rates on College Financing

	(1) Take loan for college	(2) Loan borrow amount (in 10k)	(3) Interest payment (in 10k)	(4) Loans from government or banks	(5) Loans from parents	(6) Financial support from parents	(7) Own Savings
$IR_{t_0} \times PS_{d_0 1992}$	-0.047**	-0.460***	0.004	-0.067***	0.043*	-0.033***	0.041*
	(0.019)	(0.099)	(0.035)	(0.025)	(0.023)	(0.010)	(0.023)
R-squared	0.205	0.127	0.143	0.146	0.182	0.022	0.056
Observations	129,692	129,692	124,715	120,133	120,133	120,133	90,618

Notes: The sample is drawn from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We replace the private enrollment rate at high school graduation with the initial private enrollment rate (in 1992). *** p<0.01, ** p<0.05, * p<0.1.

Table F.15: Effects of Federal Loan Interest Rates on Education and Labor Market Outcomes

	(1) Major-specific earnings growth	(2) Major in STEM	(3) Occ earnings growth	(4) Occ relevant	(5) Unemployed	(6) Work in a small firm	(7) Self employment
$IR_{t_0} \times PS_{d_0 1992}$	0.035*	0.043**	0.050**	0.051**	-0.013**	-0.024	-0.019
	(0.020)	(0.017)	(0.020)	(0.024)	(0.007)	(0.015)	(0.013)
R-squared	0.401	0.038	0.576	0.020	0.015	0.012	0.008
Observations	134,045	134,045	104,107	102,955	134,045	123,023	123,023

Notes: The sample is drawn from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We replace the private enrollment rate at high school graduation with the initial private enrollment rate (in 1992). *** p<0.01, ** p<0.05, * p<0.1.

Table F.16: Effects of Federal Loan Interest Rates on Labor Market Outcomes (Cont'd)

	(1) ln(annual earnings)	(2) ln(annual hours)	(3) ln(hourly wage)	(4) Salary as an important factor	(5) Satisfied with independence	(6) Satisfied with responsibility
$IR_{t_0} \times PS_{d_0 1992}$	0.069**	0.015	0.034	0.004***	-0.013*	-0.016**
	(0.032)	(0.009)	(0.026)	(0.001)	(0.007)	(0.007)
R-squared	0.171	0.049	0.184	0.005	0.006	0.011
Observations	103,850	104,107	103,413	133,731	123,023	123,023

Notes: The sample includes full-time workers from the NSCG 2003-2019. The regression controls, clustering, and weight specifications are the same as Table 2. We replace the private enrollment rate at high school graduation with the initial private enrollment rate (in 1992). *** p<0.01, ** p<0.05, * p<0.1.