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Go big or buy a home: The impact of student debt on career and housing choices ☆

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ABSTRACT

Student debt decreases post-bachelor school enrollment and earnings growth but does not delay first-time home ownership. We introduce a life-cycle human capital model with wealth heterogeneity and financial frictions and show that high debt balances distort career choices because returns to further education depend on current income. Student debt impacts home ownership in two ways. First, it deters ownership via the traditional wealth channel. Second, it increases ownership by discouraging further education in favor of early labor market entry. Finally, we discuss the impact of student borrowing under different loan repayment schemes.

1. Introduction

Student debt plays an increasingly important role in determining the financial position of recent college graduates. Between 1993 and 2016, the percentage of students who had borrowed at any time during their undergraduate degree rose from 45 percent to 68 percent – see Fig. 1. In that time, the median cumulative amount borrowed rose from $14,329 to $29,115 (in 2020 US dollars).[1] In this paper, we show that student debt distorts the decision to pursue graduate education and purchase a home; however, this latter effect is masked by selection into graduate programs by enrollees who enjoy the amenities offered by careers linked to post-graduate education.

Leveraging supply-side shifts in institution-level grants as an instrumental variable, we analyze the impact of increased student debt at graduation on employment, earnings trajectories, advanced degree attainment, and home ownership. Our primary findings

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[1] Real incomes for bachelor's degree recipients rose as well. However, monthly student loan payment as a percent of monthly income (one year after graduation) increased between 1993 and 2016. Increasing student debt has been the result of a combination of both demand and supply factors. Between 1993-2016, median real net cost of college increased by 25% for 4-year college seniors.

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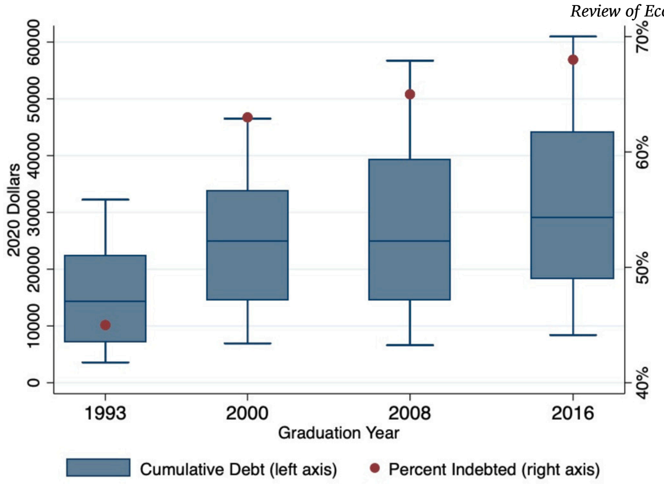


Note: Cumulative debt includes all individual student loans (federal and private, excluding parental loans) ever borrowed for undergraduate education. Loan value is adjusted using the annual Consumer Price Index (CPI-U). The portion of the box plot is defined by two lines at the 25^{th} percentile and 75^{th} percentile with boundaries at the 10^{th} percentile and 90^{th} percentile. Source: Baccalaureate and Beyond Longitudinal Study (B&B:1993/94, B&B:2000/01, B&B:2007/08, B&B:2015/16).

Fig. 1. Evolution of Student Debt (bachelor's degree graduates).

highlight that increased student debt leads to substantial under-investment in post-bachelor education and reduces earnings growth significantly over the long term, while its net impact on first-time home ownership timing appears negligible. Increasing student debt balances by 10% ($2,364 relative to the average debt of $23,640) reduces the likelihood of obtaining a post-bachelor degree by about 1 percentage point—from an average of 22% four years after graduation and 45% ten years after graduation. Increasing student debt balances by 10% also increases initial post-graduation annual earnings, generating a 3.6% increase for years after graduation, while decreasing them in the longer run, causing a 5.3% decline ten years after graduation. An average $2,364 increase in debt balances thus corresponds to an increase of $1,440 and a decrease of $2,828 relative to the average annual earnings respectively four and ten years after graduation.

A reasonable strategy to interpret our reduced form estimates is to build and estimate a life-cycle model that captures variation in the data as closely as possible. Thus, we introduce a Roy Model (Borjas, 1987) with housing and education choices and endogenous human capital accumulation in the spirit of Ben-Porath (1967). We assume college graduates to enter the labor market with heterogeneous ability, human capital levels, initial savings, and undergraduate student debt balances. We also allow both housing and career decisions to involve non-monetary considerations.

Our model uncovers two primary mechanisms through which student debt influences housing and educational choices. First, debt reduces demand for housing through the traditional wealth effect: graduates burdened by debt have less wealth available for long-term investment. Second, higher debt discourages further education, prompting graduates to enter the labor market earlier and potentially accelerating home ownership for this subgroup. These counteracting effects almost neutralize each other, explaining the negligible net effect of student debt on the timing of home ownership.

High non-monetary returns from post-bachelor degree attendance make further education decisions especially sensitive to initial wealth levels. Post-bachelor degree attendance is valued at an average of $3,929 on top of financial returns, with such valuation varying considerably across the wealth distribution, while the amenity value of housing is $1,155 on average.[2] However, monetary returns in the medium run remain substantial, as post-bachelor degrees confer a wage premium of roughly 30 percent, controlling for ability and existing human capital. It follows that distortions in post-graduate education choices due to student loans, while small initially, imply larger monetary costs later in life.

We conclude by discussing policy options regarding the design of student loan repayment systems. Until recently, federal student loans were modeled after mortgage loans, with fixed monthly repayments over a predetermined period. This design induces a high repayment burden right after graduation, especially for borrowers with lower income. Income-based repayment plans provide valuable insurance, but do not increase human capital accumulation, as adverse selection and labor-supply disincentives offset the reduced repayment burden.

2. Related literature

The main contribution of our work is to highlight how differences in wealth shape labor market outcomes through post-graduate education and housing choices. As such, we also contribute to the quantitative literature that analyzes how initial conditions affect lifetime earnings inequality. Huggett et al. (2011) find that initial conditions, as measured at age 23, determine more than 60% of

[2] This result is consistent with the emerging literature on the existence of significant compensating differentials in career choices (see Sorkin 2018 and Taber and Vejlin 2020).

variation in lifetime utility, the majority of which is determined by initial human capital differences. However, by including frictional labor markets, Griffy (2021) shows that initial wealth also plays a crucial role in determining life-cycle inequality. We contribute to this literature by explicitly modeling multiple dimensions of wealth and human capital accumulation and presenting a detailed description of post-graduate education choices that rationalizes the significant impact of borrowing constraints on long-term labor market outcomes.

Because our empirical experiment and our quantitative exercise leverages student loan design, our paper is also related to this literature. The literature on student borrowing is quite large and has been extensively summarized by Yannelis and Tracey (2022). Empirical evidence on the effects of student debt on post-college earnings points to a positive relationship, at least in the short run. Using a financial aid experiment at NYU Law School, Field (2009) shows that law students who had higher student loan balances were more likely to accept jobs in higher-paying corporate law rather than public interest law. Using a difference-in-difference approach, Gerald and Smythe (2019) study the impact of student debt on various labor market outcomes (income, hourly wages, and hours worked), and conclude that indebted students have initial higher earnings due to higher work hours rather than higher wage rates. Based on a natural experiment at an elite university, Rothstein and Rouse (2011) find that student debt causes college graduates to choose jobs with an initial higher salary instead of low-paid “public interest” jobs. Following a similar approach, Luo and Mongey (2019) show that the initial high wages of indebted students do not translate into higher welfare, as graduates choose less satisfying jobs to prioritize repayment.[3] These two papers lay the foundations of our empirical identification approach, as described in the following section.

Our structural analysis also speaks to the literature on student loan program design within a model of life-cycle earnings and human capital accumulation. Ionescu (2009) finds that repayment flexibility increases college enrollment significantly, whereas relaxation of eligibility requirements has little effect on college enrollment or default rates. Ionescu and Simpson (2016) show that tuition subsidies increase aggregate welfare by increasing college investment and reducing default rates in the private market. In a similar framework, Johnson (2013) finds that tuition subsidies increase college enrollment more than borrowing limits. The general equilibrium effects of income-contingent repayment plans have been analyzed in the literature, more recently by Matsuda and Mazur (2022), who still find them welfare-enhancing. Using Australian data, de Silva (2025) shows that income-based repayment systems induce graduates to strategically reduce labor supply in order to save on repayments. Despite their insurance value, which increase welfare, contingent repayment schemes might depress output.

Higher initial earnings may not necessarily lead to higher lifetime earnings if they are not followed by further human capital investment (Becker 1962, Hause 1972, and Mincer 1974). In this regard, Zhang (2013) find that student debt harms graduate school attendance four years after graduating from a public 4-year college. Similarly, Chakrabarti et al. (2023) show that increased tuition shocks (absorbed via higher levels of student debt) cause individuals to forgo graduate school enrollment. Finally, Morazzoni (2022) discusses student loans' impact on entrepreneurship, concluding that education borrowing is associated with a lower likelihood of opening a firm. We contribute to this literature by providing new causal evidence of the long-term effects of student debt on earnings and career choices through graduate school attendance.

Cooper and Wang (2014), Gicheva and Thompson (2015), and Houle and Berger (2015) show that student debt reduces young households' likelihood of home ownership. Exploiting changes in tuition for public four-year colleges, Bleemer et al. (2020) find that increasing levels of student debt can account for 11 and 35 percent of the decline in young's home ownership over 2007-2015. Mezza et al. (2020) estimate that a \$1,000 increase in student debt decreased first-time home ownership by approximately 1.5 p.p. for public 4-year college graduates who graduated between 1997 and 2005. Differently from these articles, we focus on the impact of student debt on bachelor's degree recipients.[4]

3. Empirical analysis

3.1. Baccalaureate and beyond longitudinal study

The Baccalaureate and Beyond Longitudinal Study (B&B) is a survey of students who completed the requirements for a bachelor's degree in a given academic year.[5] The National Center for Education Statistics (NCES) within the U.S. Department of Education conducts the survey. The B&B draws its cohorts from the National Postsecondary Student Aid Study (NPSAS), which collects data from large, nationally representative samples of students and institutions to examine how students pay for postsecondary education.[6] Hence, the B&B samples are representative of graduating seniors in all majors and colleges.[7]

The first B&B cohort was identified in NPSAS:93 and followed up in 1994, 1997, and 2003. The second cohort was identified in NPSAS:00 and followed up in 2001. The third cohort was identified in NPSAS:08 and was followed up in 2009, 2012, and 2018. The last cohort was identified in NPSAS:16 and was followed up in 2017. Our analysis focuses on the B&B:08/18 cohort, given

[3] Hampole (2022) and Alon et al. (2023), like us, find instead that the tradeoff is only temporary, as occupation choice of indebted students translates into lower earnings in the medium term.

[4] For example, in Mezza et al. (2020), 46% of the sample dropped out without graduating from college, while a fraction of those who did had a post-bachelor degree.

[5] Eligible students are those who (1) enrolled at a college participating in federal student aid programs, and, (2) completed their requirements for their first bachelor's degree during that year.

[6] See Wine et al. (2019) and Cominole et al. (2020) for more information about the B&B data collection and sample design.

[7] However, B&B samples are not representative of graduates at the college or state level.

that graduates were followed up to ten years after graduation and college-level financial aid data were unavailable for years before 2000/01.

The B&B connects multiple data sources, including student interviews, institution records, government databases, and other administrative sources. Hence, the data contain rich information about students' demographic characteristics, family economic background, financial aid, and labor market experiences. In the B&B:08/09 survey, respondents were asked to provide the salary for the job at which the respondent worked the most hours.[8] In the B&B:08/12 and B&B:08/18 surveys, graduates were asked to report the total salary for their current primary job. If the respondents had more than one current job, the job with the most extended duration and the highest number of hours per week was selected as the primary job. In addition, the surveys also asked about graduate school enrollment, attainment, and housing status.

Using harmonized college identifiers, we merge the B&B data with college-level data from the Institutional Post-Secondary Database (IPEDS) and College Scorecard, which include annual data on grants, loans, and instructional expenditure per student (among many other variables) since 2000/01 academic year. We use these college-level data to construct the instrumental variable for student debt.

3.2. Descriptive statistics

We restrict the sample to US citizens and resident students who obtained their bachelor's degrees between the ages of 21-25. This primarily reflects the age distribution of college graduates in the B&B sample being skewed to the right.[9] Another reason to focus on young graduates is that the relationship between student debt and the outcomes of interest (that is, graduate school, earnings, and home ownership) is likely to be different for older graduates.[10] In addition, we restrict the sample to students who first-time enrolled in college between 2001-2004 and did not transfer between colleges. This restriction is necessary, as we use changes in financial aid at the college level as an instrument. In terms of colleges, we exclude private for-profit colleges.

Table 1 provides the main descriptive statistics for students that graduated in 2008 and 2016. After applying the sample restrictions, the final sample includes about 9,000 graduates from the B&B:08/18 survey and about 8,000 from the B&B:16/17 survey. Student characteristics and their distribution across institutions remain broadly similar across cohorts. However, the distribution of student debt shifted upward: in 2008, 72% of graduates held student debt averaging \$23,640, compared to 66% of graduates in 2016, whose average debt rose to \$28,843

Average annual earnings equal \$59,197 ten years after graduation for graduates of the 2008 cohort with no student debt, while indebted graduates report \$51,060 (i.e. about 15% less).[11] Graduate school attainment and home ownership increase substantially over the first ten years after college graduation, reaching 47% and 65% for indebted and non-indebted graduates, respectively. Indebted graduates are less likely to have a graduate degree ten years after graduation, but no significant differences in home ownership emerge from the data. These average differences in outcomes between non-indebted and indebted graduates might capture not only the impact of student debt but also differences in demographics and other students' characteristics. For example, indebted graduates were more likely to be female, less likely to be white, and more likely to attend a moderately-selective private non-profit university. In the next section, we introduce a reduced-form approach to estimate the effect of student debt on post-college outcomes after controlling for these observable characteristics.

3.3. Empirical specification

The relationship between student debt and post-college outcomes (employment, graduate school enrollment, attainment, earnings, and home ownership) can be expressed in the following reduced-form equation:

$$Y_{i,j,\tau} = \alpha_j + \beta Debt_{i,j} + \Gamma X_{i,j} + \epsilon_{i,j,\tau} \ , \tag{1}$$

where $Y_{i,j,\tau}$ is the individual's outcome τ years after graduating from college j, α_j is a vector capturing college characteristics, $Debt_{i,j}$ is the log of the cumulative amount of individual loans borrowed for the undergraduate degree (excluding parental loans), and $X_{i,j}$ is a vector of controls.

We control for college characteristics (α_j) that are likely to influence both students' financial aid and post-college outcomes. To capture college quality, we follow Folch (2021) and model post-college outcomes as a function of the logarithm of average instructional expenditure per student and college selectivity. The college selectivity measure is based on the number of applicants and students admitted and, the 25th/75th percentiles of college entrance test scores (ACT/SAT). In addition, we control for the institution type (public, private, whether is a research institution) and the region where the institution is located.[12]

We also include a rich set of student characteristics ($X_{i,j}$) based on relevant variables used by colleges to put together a student aid package for an academic year. Colleges observe and compute these from the FAFSA application form, a free online application for

[8] Employed graduates reported their salary at a yearly, monthly, or hourly rate. The annual salary was calculated for those who reported it at a frequency other than yearly.

[9] Traditional age college graduates (age 21-23) represent 64% of the B&B:16/17 sample and 65% of the B&B:08/18 sample.

[10] However, reducing/increasing the maximum age in the sample to 23 or 30 yields similar results.

[11] Survey respondents asked about total earnings, so we abstract from taxes and other deductions induced by specific types of borrowing, including mortgages.

[12] States are classified in 8 categories using the U.S. Bureau of Economic Analysis (BEA) classification.

Table 1
Descriptive Statistics.

	B&B:08/18		B&B:16/17	
	Not Indebted	Indebted	Not Indebted	Indebted
Undergraduate Student Debt				
Percentage Indebted at Graduation	28%	72%	34%	66%
Avg. Cumulative Student Debt at Graduation (>0)		$ 23,640		$ 28,843
		[17,759]		[19,221]
p25		$ 12,614		$ 17,500
p50		$ 20,000		$ 27,000
p75		$ 29,891		$ 34,580
College Characteristics				
Public 4-year	68%	59%	58%	53%
Moderately Selective	63%	69%	60%	75%
Very Selective	37%	31%	40%	25%
New England	4%	6%	9%	9%
Mideast	17%	19%	19%	22%
Great Lakes	14%	17%	14%	19%
Plains	8%	13%	7%	9%
Southeast	25%	21%	25%	22%
Southwest	9%	7%	7%	6%
Rocky Mountains	6%	4%	5%	3%
West	17%	12%	14%	10%
Avg. Expenditure per FTE student	$ 9,244	$ 8,432	$ 15,030	$ 11,081
	[8,470]	[6,383]	[15,499]	[8,185]
Student Characteristics				
Female	56%	58%	57%	62%
White	78%	76%	74%	71%
Dependent	81%	80%	79%	83%
Attending In-State College	80%	85%	68%	74%
Avg. Student Financial Need	$ 9,787	$ 15,966	$ 19,266	$ 20,814
	[10,717]	[12,704]	[18,998]	[18,178]
Avg. GPA at graduation	3.4	3.3	3.5	3.3
	[0.5]	[0.4]	[0.4]	[0.5]
Post-college Outcomes				
Avg. Earnings (t+1)	$ 25,435	$ 25,389	$ 28,464	$ 27,863
	[22,887]	[20,892]	[23,915]	[20,866]
Avg. Earnings (t+4)	$ 40,798	$ 39,006		
	[31,011]	[25,614]		
Avg. Earnings (t+10)	$ 59,197	$ 51,060		
	[69,918]	[69,566]		
Graduate School Attainment (t+1)	3%	2%	2%	2%
Graduate School Attainment (t+4)	25%	21%		
Graduate School Attainment (t+10)	47%	43%		
Home-ownership (t+4)	30%	28%		
Home-ownership (t+10)	65%	62%		
Students Obs.	2,400	6,000	3,000	5,000

Note: *Undergraduate Student Debt* is the cumulative loan amount borrowed from enrollment through graduation year. *Dependency* status is used to determine whether financial aid form will be filled including parents' information (if student is dependent) or only from the student's household. *Financial Need* is defined as the difference between the Implied Student Budget (Institution-Based) and the Expected Family Contribution, which is an estimate of the contribution of the students' family to overall college expenses (per year). *Earnings* are defined as total labor earnings for the given year. Graduate school refers to the highest degree attained since bachelor's degree graduation, with Master's Degrees, Post-Master's Certificates, First-Professional Degree and Doctoral Degree all counting towards *Graduate School Attainment*. *Home ownership* indicates both mortgage holders and individuals that owned a home outright at the moment of survey, the latter representing less than 10% of all sub-samples. The number of observations is rounded to comply with privacy requirements. Sample: Bachelor's degree recipients age 21-25 from the Baccalaureate and Beyond Longitudinal Study (B&B:2008/2018 and B&B:2016/2017).

financial aid eligibility where students put all their information. We include graduates' dependency status,[13] whether they enrolled in college in their state of residence, their financial need[14] and other demographics (age, sex, and race/ethnicity). We also add controls to capture graduates' college performance (GPA in college and in high school) and major field of study (10 categories).

[13] Students are considered independent if they meet one of the following criteria: age 24 or older, enrolled in a graduate or professional degree, married, orphan or ward of the court, have legal dependents other than a spouse, a veteran of the U.S. Armed Forces, U.S. Armed Forces active duty. Students under 24 who do not meet these conditions but receive no parental support may also be classified as independent.

[14] Equal to the total student budget minus the federal expected family contribution (EFC). The EFC is calculated according to a formula established by law. Family's income, assets, benefits, family size, and the number of family members who will attend college all contribute to determining each student's EFC.

Even with this rich set of college and student characteristics, we might still face the problem of an omitted variable or misspecification bias. Essential factors (for instance, ability and actual family contribution) that explain student debt and post-college outcomes may not be well measured in Equation (1). This potential omission makes $Debt_{i,j}$ a possible endogenous variable; thus, the OLS estimator of β is likely to be biased.

3.4. Instrumental variable: institutional grants

Students usually receive a year-by-year package of financial assistance determined by college financial aid officers, which is not known in advance at the time of college application. The package includes student loans, scholarships, and grants from the government and the institution itself. Unlike government grants and loans, institutional grants are funded from net revenues and assets of the institution and are the primary source of financial aid funding, followed by loans. To capture the substitution between institutional grants and student loans, similarly to Rothstein and Rouse (2011), Luo and Mongey (2019), we propose an indicator that uses changes in institutional characteristics. The approach involves taking the ratio of the value of total institutional grants issued by the college to the sum of grants and student loans (grant-to-aid henceforth, $Z_{j,t}$)[15]:

$$Z_{j,t} = \left(\frac{inst.grant_{j,t}}{inst.grant_{j,t} + loan_{j,t}}\right)$$

One may still be concerned that $Z_{j,t}$ correlates with unobserved student characteristics, and these characteristics directly impact students' post-graduate decisions. This correlation may arise because students apply and choose colleges based on a bundle of observed college characteristics, which include the cost of college and the amount of institutional grants in their financial offer letter.[16] For this reason, we use as an instrument changes in grant-to-aid rather than its level.[17] The changes happen while students are enrolled in college, which is unlikely to be anticipated for students when deciding on which college to apply to or enroll. To capture these changes in institutional grant availability, we compute the average change in grant to aid during college enrollment (where t_0^i represents the year when the student first enrolled in college and t_g^i the year she graduated) as follows:

$$\Delta Z_{i,j} = \bar{Z}_{i,j} - Z_{i,j,t_0^i} = \frac{\sum_{t=t_0^i+1}^{t=t_g^i} Z_{j,t}}{t_g^i - t_0^i - 1} - Z_{i,j,t_0^i} \tag{2}$$

Fig. A.2 shows how grant-to-aid captures the substitution between institutional grants and student debt for both public and private non-profit colleges in a given academic year (2007/08). The figure shows that lower grant amounts are compensated by higher borrowing almost systematically. For our identification, however, we also need grant-to-aid ratios to change substantially over time in ways that are not systematically related to current levels of grant availability. Fig. A.3 shows substantial variability in grant-to-aid from enrollment to graduation year for students that graduated in 2008.

Our debt measure focuses on the amount of borrowing while enrolled. While debt balances can substantially change post-graduation, we see those changes as part of the post-graduation outcomes. The level of cumulative debt at graduation can be instead modeled as an outcome of individual demand for debt and these supply-side changes in grants:

$$Debt_{i,j} = \mu_j + \delta \Delta Z_{i,j} + \Pi X_{i,j} + u_{i,j} \tag{3}$$

To be useful, the instrument must vary significantly with student debt across institutions. Table 2 shows that the relevance condition is satisfied. We run our specification (columns 1-3) first using only institution-level controls, then including both institution-level and student-level controls. Results are qualitatively similar. We then restrict the sample to universities where we observe at least 6 graduating students. The reason for this choice is to avoid contamination of the institution-level instrument by individual characteristics for institutions with too few observations. The cutoff at 6 students removes 5–10 percent of observations, and results are robust to alternative cutoffs. We will then adopt the restricted sample specification as our preferred one.

For 2008 graduates, on average, one standard deviation increase in the grant to aid measure while enrolled predicts an almost 18% decline in debt, equal to about \$4,250 lower debt balances. Using a probit regression on the probability of being in debt, we find that a one-standard deviation increase in the grant to aid measure approximately a 2 percent lower probability of holding any student debt.[18]

[15] See Section A.1 for more details on IPEDS data and the construction of this variable.

[16] For example, Hoxby and Avery (2014) and Dillon and Smith (2017) argue that low-income students tend to apply to colleges they appear overqualified for. Using the same data we rely on, Luo and Mongey (2019) provide evidence that the majority of students do not apply to many schools and then select based on institutional grants: nearly 80 percent of freshmen FAFSA applicants list only one college in their application form, and less than 4 percent list more than five. Still, the choice of that single application might be influenced by individual characteristics unobservable by the econometrician.

[17] The main difference is that Rothstein and Rouse (2011) exploit changes over time in the variable $Z_{j,t}$ in a single institution rather than a comparison of changes over time across institutions.

[18] A decline in cumulated balances of \$4,250 corresponds to about \$60 less in payments per month for a borrower on a 10-year plan that won't use deferments or pause payments and that graduates with average balances of \$23,640, entirely on federal loans. That same borrower, according to our data, earned an average \$2,750 while spending an average \$770 on rent a month. In practice, initial periods of forbearance are common, and deferments due to graduate school attendance contribute to increasing existing balances. The presented impact of changes in balances at graduation on graduates' budget constraint should thus be seen as a lower bound.

Table 2
First Stage Regression.

	OLS			Probit		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Z_{i,j}$	-0.164**	-0.212 ***	-0.224***	-0.039**	-0.056***	-0.059***
	[0.083]	[0.079]	[0.084]	[0.02]	[0.02]	[0.02]
				-0.013**	-0.017***	-0.018***
				[0.006]	[0.006]	[0.006]
F-statistic	22.25	29.25	28.34	-	-	-
Observations	8,100	8,100	7,600	8,100	8,100	7,600
University Controls	✓	✓	✓	✓	✓	✓
Student Controls		✓	✓		✓	✓
Restricted Sample			✓			✓

Note: *p<0.1; **p<0.05; ***p<0.01. The Probit regression reports the actual parameter estimates, together with average marginal effects in the line below. The dependent variable for the Probit regression is equal to 1 if the individual holds any student debt, and 0 otherwise. The restricted sample includes only individuals graduated from universities from which at least 6 other students are observed at graduation. Sample: graduated between age 21 and age 25. Data comes from Integrated Postsecondary Education Data System (IPEDS) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Standard errors are clustered at the institution level. The number of observation is rounded to comply with privacy requirements.

We also conduct a balancing test to provide further evidence that our estimates have a causal interpretation. Specifically, we regress our instrument on a large set of predetermined student attributes. The objective is to examine whether predetermined student attributes induce shifts in the instrument, conditional on institutional controls which we believe make the instrument exogenous. Results of this exercise are shown in Table A.2. The only coefficient that is statistically significant is one on financial need and that coefficient is only significant at the 5 percent level. Additionally, as shown in the lower panels, based on an F-test we fail to reject the null hypothesis that all the estimated coefficients are jointly equal to zero. Thus, the results reported in Table A.2 give us sufficient confidence that estimates based on our identification strategy are unlikely to be driven by a correlation between changes in institution-level availability of grants and student body composition.

3.5. *The impact of student debt*

Results from the estimation of (1) are given in Table 3. The three columns show the effect of student debt one, four, and ten years after undergraduate degree completion in 2008. We compare the estimation results from a naive OLS or Probit regression with the two-stage estimation (2SLS and IV Probit) for each of our outcome variables.

In line with prior empirical findings, we find that individuals with higher student debt balances tend to earn more in the first years after graduation. An average $2,364 increase in student debt (that is, a 10% growth in average balances) thus corresponds to an increase of $1,392 and $1,440 relative to the average annual earnings respectively one and four years after graduation. However, the positive effect on earnings is reverted ten years after graduation. This amounts to an average decrease in annual earnings of $2,828 in 2018 due to student debt for the 2008 graduating cohort.

We interpret the change in sign of earnings estimates to align with the hypothesis that higher debt balances, or in general, lower net wealth, changes the trade-off between current and future income (see Griffy 2021 or Eeckhout and Sepahsalari 2023). The obvious motive for such earnings front-loading could be the desire to reduce the burden of debt payment on current consumption, and this could be achieved through occupation choice rather than worked hours, especially since the evidence of stronger labor supply is not strong (see Table A.5). In other words, reduced form evidence does not explain this reversal immediately, but there is a smoking gun. Student debt causes a decrease in the likelihood of enrolling in post-bachelor degrees, not only in the short run but also in the long run.

By looking at the marginal effects from the graduate school enrollment rows in Table 3 we find that increasing undergraduate student debt balances by 10% causes an average decrease in the likelihood of enrolling in graduate school by respectively 0.85% one year, and 0.83% four years after obtaining the bachelor's degree. Learning on the job, which has implications for the level and slope of earnings, can also contribute to this result and will be explored in the model section by assuming that workers can endogenously determine the level of investment in their human capital.[19]

We also test whether student debt affects completion from graduate school, and find results that are consistent with our enrollment estimates. These are shown, together with the expanded results on enrollment, on Table A.3. We also would want to make sure that our results on enrollment and completion are not hiding behavioral responses while attending graduate schools induced by student debt, thus making the interpretation of enrollment and completion results more difficult. To this end, we test whether debt balances

[19] Estimates of income losses can seem large. However, the discussion of the joint effects on attendance and home ownership highlights that the impact of debt is highly non-linear, and likely concentrated at the decision thresholds on those discrete choices. Running the same regressions on the impact of having borrowed, that is instrumenting for $\mathbb{1}_{d>0}$ rather than debt levels, implies smaller income effects, given that the average balances at graduation are about $23,640 as reported in Table 1. See Table A.1.

Table 3
Impact of Student Debt on Selected Outcomes (B&B:2008/18).

	2009	2012	2018
	(1)	(2)	(3)
Earnings:			
OLS	0.023	0.020**	-0.031***
	[0.013]	[0.008]	[0.001]
2SLS	0.348***	0.358**	-0.534**
	[0.121]	[0.163]	[0.237]
Graduate school enrollment:			
Probit	-0.013***	-0.007*	-0.002
	[0.004]	[0.004]	[0.004]
	-0.004***	-0.002*	-0.000
	[0.001]	[0.001]	[0.001]
IV Probit	-0.18***	-0.169***	-0.164***
	[0.04]	[0.044]	[0.046]
	-0.085**	-0.083**	-0.07*
	[0.039]	[0.043]	[0.036]
Home ownership:			
Probit	-	-0.005	-0.006*
	-	[0.004]	[0.004]
	-	-0.001	-0.002*
	-	[0.001]	[0.001]
IV Probit	-	0.044	-0.060
	-	[0.093]	[0.087]
	-	0.014	-0.022
	-	[0.031]	[0.033]
University Controls	✓	✓	✓
Student Controls	✓	✓	✓
Restricted Sample	✓	✓	✓
Observations	7,600	7,600	7,600

Note: *p<0.1; **p<0.05; ***p<0.01. Probit and IVProbit regressions report the parameter estimates, together with average marginal effects in the line below. The restricted sample includes only individuals graduated from universities from which at least 6 other students are observed at graduation. *Earnings* represents the (logarithm of) annualized salary for primary job in the given year. *Graduate school enrollment* indicates the individual is enrolled in either a Master's Degrees, Post-Master's Certificates, First-Professional Degree or Doctoral Degree at the given date. Sample: graduated between age 21 and age 25. *Home ownership* covers both mortgage holders and individuals that owned a home outright at the moment of survey. The number of observations is rounded to comply with privacy requirements. Data comes from Integrated Postsecondary Education Data System (IPEDS) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Standard errors are clustered. The number of observation is rounded to comply with privacy requirements.

impact graduation rates for individuals already in graduate school. Results are reported in Table A.6 and show no detectable effect of student debt on the probability of completing a graduate degree conditional on enrollment. A different concern is that the observed substitution between home ownership and graduate school enrollment may primarily reflect relocation decisions.

To address this issue, we re-estimate the main regressions using data from 2009 and 2018—the two years for which we observe respondents' current state of residence. In those years, non-movers account for 79% and 64% of the sample, respectively. The results from these restricted samples closely mirror those obtained using the full sample, as shown in Table A.7.

Idiosyncratic fluctuations in grant provision at the institution level could lead to a contraction in the number of graduate positions at the same institutions. While only a small share of graduates in our sample pursue graduate studies at the same institution where they earned their undergraduate degree (3.9%), some of the effect observed may come from the supply side of graduate enrollment rather than the demand side. Using the Carnegie classification of the institution from which each individual graduated in the 2007–2008 academic year, we can divide our sample in half: graduates from doctoral/research universities, and from all other institutions. Table A.8 confirms that our results hold when across subsamples determined by type of origin institution.

Despite estimates on graduate school suggesting strong wealth effects, we find that graduating with high debt balances does not delay first-time home ownership. Given the strong wealth effects observed on other margins, the null impact on the home ownership extensive margin has a less straightforward interpretation. Furthermore, Table A.9 displays the effect on home value conditional on entering home ownership, which is likewise insignificant. It must first be noted that the choice of graduate school and housing are strongly intertwined: Table 4 makes it clear by looking at how, at least in the medium run, one choice seems to crowd out the other.

An intuitive channel for the strongest response of enrollment choices, compared to home ownership, is a higher non-monetary value attached to education, and the implied career choice. When returns to post-graduate education are in some significant part

Table 4
Graduate School versus Home ownership.

Home ownership	Graduate School		
	Enrolled 2012	Completed 2012	Completed 2018
Home owner in 2018	60.6%	62.5%	59.0%
Renter in 2018	65.2%	63.4%	66.6%
N	7,700	8,200	8,200

Enrollment	Home ownership	
	Mortgage in 2012	Home owner in 2018
Enrolled in 2018	23.0%	20.3%
Not Enrolled in 2018	33.0%	28.8%
N	7,700	8,200

Note: Enrolllment refers to Master's Degrees, Post-Master's Certificates, First-Professional Degree and Doctoral Degree all counting towards *Graduate School Attainment. Home ownership* indicates both mortgage holders and individuals that owned a home outright at the moment of survey. By "Enrolled 2012" we mean the individual is currently enrolled in a post-graduate program at the moment of the survey, while "Completed 2012" indicates that the individual has earned their degree by the moment of the survey.

non-monetary, choices can be more sensitive to initial levels of wealth (see Boar and Lashkari 2021). A complementary hypothesis is that individuals who forgo graduate school because of student debt may enter home ownership earlier, as lower debt balances and higher savings, accumulated by working instead of studying, facilitate earlier purchase. For this mechanism to hold, we posit that some subpopulations' decisions to pursue graduate education are more strongly influenced by wealth. To the extent that graduate school attendance is at least partly driven by idiosyncratic, unobservable preferences, we hypothesize that individuals with lower learning ability are less inclined to pursue further education regardless of their circumstances, and are therefore less sensitive to wealth when deciding whether to enroll.

We identify the ability sub-populations exploiting two different strategies. One is to separate the bachelor degree holders according to their high school grades. The other exploits an intuition similar to Hendricks and Leukhina (2018), who observe that the time it takes for students to accumulate credits towards graduation can be used as a good proxy for student ability. In a similar fashion, we classify students graduating within four years as high ability and those taking five or more years as low ability.[20] Table 5 presents the results, where Models (1) and (2) separate bachelor degree holders according to their grades, while Models (3) separates them according to time to degree completion. While small sample size prevents us from achieving statistical significance consistently, and despite the ability proxies being imprecise at best, we see that high ability students are responding more in their enrollment decision to increases in debt balances across both our specifications. At the same time, the housing response change is now negative for the low ability students, and positive for the high ability ones. We interpret these results as suggestive evidence in the direction of our proposed mechanism, where the observed null effect is not evidence of absence of wealth effects, but rather due to a composition of effects that go in opposite directions.

In the model section we will explicitly account for both monetary and non-monetary returns from graduate degrees and housing, in order to reconcile the observed evidence with the aggregate data the model is built to replicate.

3.6. Discussion

Our empirical results indicate that an additional \$1,000 of debt is associated with approximately \$500 higher earnings in the first years after graduation. Rothstein and Rouse (2011) report that initial post-college salaries are about \$200 higher for every additional \$1,000 of student debt. Similarly, Luo and Mongey (2019) estimate that each additional \$1,000 of student debt raises post-graduation wages by about \$70–\$160; and Alon et al. (2023) find an increase of roughly \$210 in annual earnings upon graduation for every \$1,000 of additional debt. The stronger effects we document may reflect the specific period covered by our sample: graduates in our data entered the labor market at the onset of the Great Recession, facing weaker job opportunities and a stronger incentive for less indebted students to delay employment until securing better matches. Rothstein and Rouse (2011) and Alon et al. (2023) analyze earlier cohorts. Moreover, while student debt balances for the 2008 graduating cohort were relatively high, income-contingent repayment schemes were not yet widespread. In contrast, Luo and Mongey (2019), who use the same data source as we do, combine both the 1991 wave and the 2016–2017 interviews. The broader adoption of income-contingent repayment plans in the later period likely attenuated the initial earnings effects. Alon et al. (2023) also examine the longer-term impact of student debt on earnings. According to their estimates, an additional \$1,000 of debt reduces earnings ten years after graduation by about \$1,270. By comparison, our estimates imply that \$1,000 more debt lowers earnings ten years after graduation by approximately \$1,200.

[20] Hendricks and Leukhina (2018) notice that the cumulated number of credits in a given year has predictive power for the probability of degree completion. In our case, those who take more time to complete the degree are assigned to the "low ability" group. Clearly, this would suggest that by taking the graduating individuals we are selecting a sub-population for whom the left tail of the ability distribution is likely to be unobserved, since many of those enrolled before 2003 might have not graduated at all by 2008. Selection, then, likely goes in the opposite direction and dampens our results.

Table 5
Impact of Student Debt on Home ownership Across Sub-Samples (B&B:2008/18).

	Low Ability			High Ability		
	(1)	(2)	(3)	(1)	(2)	(3)
Home-ownership						
2012	-0.10		-0.147*	0.181***		0.138
	[0.089]		[0.087]	[0.068]		[0.214]
	-0.034		-0.063	0.085		0.049
	[0.036]		[0.059]	[0.073]		[0.115]
Enrollment						
2012		-0.079			-0.183***	
		[0.10]			[0.048]	
		-0.3			-0.097*	
		[0.043]			0.589	
Completion						
2018			-0.168**			-0.211***
			[0.304]			[0.065]
			-0.074			-0.159
			[0.060]			[0.205]
Observations	2,900	700	1,200	4,600	6,300	4,300
University Controls	✓	✓	✓	✓	✓	✓
Student Controls	✓	✓	✓	✓	✓	✓
Restricted Sample	✓	✓	✓	✓	✓	✓

Note: *p<0.1; **p<0.05; ***p<0.01. Probit and IVProbit regressions report the parameter estimates, together with average marginal effects in the line below. We present three alternative classifications of low- and high-ability individuals. Model (1): GPA of $A-$ or above (high ability) versus GPA of B or below (low ability). Model (2): GPA of B or above (high ability) versus $B-$ or below (low ability). Model (3): student has enrolled in bachelor degree in year 2004 (high ability) versus student has enrolled in bachelor degree in year 2003 or earlier (low ability). The restricted sample includes only individuals graduated from universities from which at least 6 other students are observed at graduation. Sample: graduated between age 21 and age 25. Data comes from Integrated Postsecondary Education Data System (IPEDS) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Standard errors are clustered at the institution level. The number of observation is rounded to comply with privacy requirements.

To place our results on education within the literature, we observe that Chakrabarti et al. (2023) find that a \$5,000 increase in tuition causally reduces the probability of graduating with a graduate degree by 3.1 percentage points. Similarly, Zhang (2013) shows that a \$1,000 increase in student debt reduces the likelihood of attending graduate school by 2.7 percentage points for public college students, with no significant effect on completion once enrolled, and no impact on post-graduate enrollment among graduates of private universities. The most comparable result in our analysis concerns the probability of completion rather than enrollment, reported in Table A.3, where we find that an increase of \$10,000 in student debt balances reduces the probability of obtaining a post-graduate degree by 3.4%.

Finally, we compare our results on home ownership with Mezza et al. (2020), who find that an additional \$1,000 of student debt reduces home ownership by about 1 percentage point. The discrepancy with our null effect largely reflects sampling differences. Our analysis is restricted to graduates of four-year bachelor's programs at public and private not-for-profit institutions, excluding private for-profit and two-year programs, which together account for over one-fourth of U.S. graduates. Following Looney and Yannelis (2015), we make this restriction to account for the substantial heterogeneity between students at not-for-profit four-year colleges and all others. Consequently, our sample is likely positively selected relative to Mezza et al. (2020) in terms of academic ability. As shown in Table 5, the effect of student debt on home ownership should be more negative when the full sample of former college enrollees is considered. This divergence may also reflect our exclusion of college dropouts, who are unlikely to respond to debt through the post-graduate enrollment channel. Given that, as Looney and Yannelis (2024) show, completion rates and debt balances are negatively correlated (at least at the institutional level), our restriction further skews the sample toward higher-ability, lower-debt individuals.

4. The life-cycle model

The life-cycle model described in this section blends the Ben-Porath (1967) human capital model presented in Huggett et al. (2011), extended to include student debt and housing, with a Roy model of career choice (Borjas 1987), where one career requires an education investment on access. The aim is to build a structural model that not only replicates the intuition of the previous section, but can also be used to perform policy analysis.

4.1. Setting

Agents are economically active at age 23, immediately after graduation. They enter the labor market being heterogeneous in ability (a), human capital (h), liquid wealth (k), and student debt (d), and live for T periods deterministically. During working age, agents can decide to enroll in graduate school: if they do, they access a different career path. Workers also sequentially choose labor and human capital investment within their career, savings and housing and non-housing consumption while they pay for student debt (if any).

Preferences. Each agent maximizes expected lifetime utility over non-durable consumption. We assume flow utility to be CRRA with parameter σ. Enrollment in post-bachelor degree and housing are both associated with an amenity value, indicated respectively by ξ and $s(H)$, where H indicates house size.

Human Capital. Individuals sequentially choose how many hours to work (l_t) and invest in human capital ($1 - l_t$). Human capital evolves according to the following Ben-Porath law of motion:

$$h_{t+1} = e^{z_{t+1}}(h_t + a((1 - l_t)h_t)^{\alpha}), \quad z_{t+1} \sim N(\mu_z, \sigma_z^2) \tag{1}$$

which depends on individual's ability (a) and with risk coming from human capital idiosyncratic shocks (z_{t+1}). Individuals can enroll in graduate school every period. If they do, they attend for S periods. While enrolled, human capital grows in every period at rate γ, workers pay tuition (p_g), and consume using a combination of their liquid savings (k) and graduate student loans (d_g). Their human capital in graduate school thus grows by:

$$h_{t+1} = ae^{z_{t+1}}(1 + \gamma)h_t, \quad z_{t+1} \sim N(\mu_z, \sigma_z^2) \tag{2}$$

Attending graduate school yields amenity value ξ. In expectation, students with higher ability a accumulate more human capital during a post-bachelor degree. This also captures the fact that individuals with better abilities might be able to access better programs.

Individuals may enroll in higher education at any point, but doing so entails a partial loss of accumulated human capital, reverting them to their initial level at labor market entry. This friction implies that sorting choices made at the beginning of a worker's career can become hard to reverse as workers accumulate experience, yielding longer-term costs due to permanent under-investment in human capital.[21]

Labor Income. Hourly earnings are priced competitively to reflect their marginal productivity. Assuming a representative firm that uses human capital from workers in both educational groups, earnings are determined by the human capital augmented number of hours worked, multiplied by the equilibrium rental rate (R_j):

$$w_{j,t}(l_t, h_t) = R_j l_t h_t \ , \tag{3}$$

where j indicates the educational group the worker is in, $j = \{B, G\}$. Human capital is more productive for workers with graduate school education: $R_G > R_B$. Therefore, assuming workers in both educational groups make identical human capital investments outside college, differences in earnings would grow as workers accumulate human capital.

Workers are subject to *i.i.d.* shocks that change their labor market status. In every period, they transition from employment to unemployment with probability π_i, where $i = B, G$ indicates whether they hold a post-bachelor degree or not. Once in unemployment, the probability of moving back to employment is $1 - \pi_i$. While unemployed, they earn home production b but cannot invest in human capital. Workers are assigned pension transfers proportional to their lifetime earnings when they retire.

Financial Markets. Agents can save in liquid assets k. Workers can borrow short-term, using the rate r_-, but they face a credit card borrowing constraint (ϕ) that depends on their current income. Positive savings ($k > 0$) yield a constant risk-free rate r_+.

Student Loans. The traditional and most common option for repaying student loans at the time of our estimates is the 10-year fixed payment plan. Like a mortgage, the borrower makes regular payments over 120 months to repay the principal and interest balance. Annual student loan payments (P_d) can be obtained as:

$$P_d = \frac{d_0}{\frac{(1+r_d)^{10}-1}{r_d(1+r_d)^{10}}} \ , \tag{4}$$

where d_0 is the student debt at the time of college graduation and r_d is the gross interest rate on student loans. If a worker enrolls in graduate school, payments are suspended and graduate school debt, equal to the unpaid part of total graduate school costs, p_G, adds to the student's balance. After graduation, undergraduate and graduate student debt are consolidated, and a new standard repayment plan begins.

Housing. Workers can buy a house at any moment of their life as long as their life span is long enough that they can cover the 30-year mortgage and they have enough liquid assets to use as a downpayment. Houses vary in size H, and so in price, $P_0(H)$ according to:

$$P(H) = p_0 H^{-\kappa} \tag{5}$$

The parameter κ captures a (constant) elasticity of housing supply, as standard in the urban literature (see Hsieh and Moretti (2019)). While we abstract from equilibrium effects in the housing market, equation (5) represents a reduced form approximation of housing supply. If a worker chooses not to own their house, she has to rent (P_r). The rental price is determined by assuming a 5% annual rent yield on the average house price P_0. Individuals can ask for a 30-year fixed mortgage to pay the house price (P_o).

[21] This choice is appropriate for some post-bachelor degrees, particularly the professional ones, where previous experience is hardly valuable for the career implied by the degree. But it is less appropriate to capture the role some other degrees, such as MBAs and executive MBAs, play in the employment of workers with some years of experience. Executive degrees, however, represent less than 3% of all post-bachelor degrees in the data.

At mortgage origination, individuals face two constraints: **(1)** they must make a downpayment (1-λ); **(2)** their monthly debt payments (student and mortgage debt) cannot exceed a proportion of their income (ψ). Home owners must always pay the mortgage payment ($P_m(H)$) until mortgage balances are zero, following:

$$P_m(H) = \frac{(1-\lambda)P_0(H)}{\frac{(1+r_m)^{30}-1}{r_d(1+r_m)^{30}}} \tag{6}$$

There is no possibility of default or asking for a second mortgage. Home ownership is an absorbing state, so if an individual is home owner in a given year, then they will stay as home owner at all future dates. Homeowners can downsize or upsize their housing, but in doing so they face a cost proportional to their home's price, τ, that proxies frictions (fees, taxes, etc.) faced by owners willing to sell their home.

4.2. Recursive formulation

We write future values in recursive expressions by adding a $'$. The choice-specific value functions are denoted indicating the discrete state - for instance, V_H^G indicates the value function of a home owner with a house of size H and with a post-bachelor degree (G).

4.2.1. Retired workers

At retirement age, $t = t_R$, workers are assigned pension transfers (p) that are proportional to their last earnings ($w = w_{t_R - 1}$). Retired workers make consumption and saving decisions using their savings from working age (k_{t_R-1}). If they own a home (of size H), they pay the residual parts of their mortgage ($m(H)$) in equal amounts ($P_m(H)$) until full repayment. Otherwise, if they are renters (r), they need to rent and pay P_r every period. Retired workers cannot buy a house, as mortgage duration exceeds their life expectancy. We assume the terminal condition for liquid assets to be equal to zero and, thus, no bequests. The last two constraints imply that agents are subject to a budget constraint, possibly depending on their current income, and that consumption cannot be negative. The recursive problem for renters, for $t = t_R, ..., T$, is:

$$\begin{aligned} &V_{r,t}(a,w,k) = \max_{k'} u(c) + \beta V_{r,t+1}(a,w,k') \\ &c + k' + P_r = (1+r)\cdot k + pw \\ &m_T = 0, k_T = 0,\ k' \geq \phi,\ c \geq 0, \end{aligned} \tag{7}$$

The problem for home owners, with mortgage payment $P_m(H)$ is:

$$\begin{aligned} &V_{H,t}(a,w,k,m) = \max_{k'} u(c) + s(H) + \beta V_{H,t+1}(a,w,k',m') \\ &c + k' + P_m(H) = (1+r)\cdot k + pw \\ &\quad m'(H) = \left(1+r_m\right) m(H) - P_m(H) \\ &\qquad k_T = 0,\ k' \geq \phi,\ c \geq 0 \end{aligned} \tag{8}$$

4.2.2. Workers

Agents enter working age ($t = 1, ..., t_{R-1}$) and face two discrete choices every period: whether to enroll in graduate school ($j = \{B, G\}$) and whether to buy a house or not ($\mathcal{H} = \{r, H\}$). These two decisions can be taken simultaneously and in any order, so that individuals can in principle enter home ownership while in graduate school, and enter graduate school while paying a mortgage, or enter both simultaneously. Workers' problem also entails saving (k) and choosing how many hours to work (l) and investing in further human capital ($1 - l$) in every period. Hence, the dynamic program contains continuous and discrete choices as in Iskhakov et al. (2017).

For notational convenience, we collect human capital and unemployment shocks in $e = \{z, u\}$, and all the other idiosyncratic states in $x = \{a, h, k, d, m\}$, where d and m indicates student debt and mortgage balances. The recursive problem for renters without graduate school education, while employed, is thus[22]:

$$\begin{aligned} &V_{r,t}^B(x,e) = \max_{k',l} \left\{ u(c) + \beta \mathbb{E}[\tilde{V}_{r,t+1}^B(x',e')] \right\} \\ &\quad c + k' + (P_r + P_d) = (1+r)\cdot k + w_B(l,h) \\ &\quad h' = e^{z'}(h + a((1-l)h)^\alpha) \\ &\quad d' = (1+r_d)d - P_d \geq 0 \\ &\quad k' \geq \phi,\ c \geq 0 \text{ , where:} \end{aligned} \tag{9}$$

[22] The level of ϕ will depend on the employment status (u) of the worker, requiring strictly positive savings in unemployment.

$$\mathbb{E}[\tilde{V}^B_{r,t+1}(x',e')] = \mathbb{E}\left[\max\left\{V^B_{r,t+1}, V^G_{r,t+1}, V^B_{H,t+1}, V^G_{H,t+1}\right\}\right],$$

and where constraints are the usual dynamic budget constraint, the law of motion of human capital, the law of motion of student debt, and the usual borrowing constraint. Home owners with housing payment $P_m(H)$ face the following problem:

$$\begin{aligned}
V^B_{H,t}(x,e) &= \max_{k',l}\left\{u(c)+s(H)+\beta\mathbb{E}[\tilde{V}^B_{H,t+1}(x',e')]\right\}\\
c+k' &+ (P_m(H)+P_d) = (1+r)\cdot k + w_B(l,h)\\
h' &= e^{z'}(h+a((1-l)h)^{\alpha})\\
d' &= (1+r_d)d - P_d \geq 0\\
m'(H) &= \left(1+r_m\right)m(H) - P_m(H)\\
k' &\geq \phi, \text{ and } c \geq 0, \text{ , where:}\\
P_m(H) &= \begin{cases} \lambda P_0(H), & \text{at origination}\\ \frac{r_d(1+r_m)^{30}(1-\lambda)P_h(H)}{(1+r_m)^{30}-1} & \text{after origination}\end{cases}\\
\mathbb{E}[\tilde{V}^B_{H,t+1}(x',e')] &= \mathbb{E}\left[\max_H\left\{V^B_{H,t+1}, V^G_{H,t+1},\right\}\right]
\end{aligned} \tag{10}$$

In the first period of home ownership, $P_m(H)$ equals to the downpayment required to buy the house. After that period, housing payments are determined by Equation (6). Defining $\bar{G}$ as the number of periods required to get the degree, the recursive problem of the individual attending graduate school for $g \leq \bar{G}$ is:

$$\begin{aligned}
V^G_{r,t}(x,e,g) &= \max_{k'}\left\{u(c)+\xi+\beta\mathbb{E}[V^G_{r,t+1}(x',e',g')]\right\}\\
c+k' &+ P_r + p_g = (1+r)\cdot k + d_g\\
h' &= (1+g)\cdot h\\
d' &= (1+r_d)\cdot d + d_g\cdot \mathbf{1}_{s=1}\\
k' &\geq 0,\ c \geq 0
\end{aligned} \tag{11}$$

The full cost of graduate school, p_G, is assumed to be covered by graduate student debt.[23] After graduating, the recursive problem is identical to Equation (9) with $w_G = R_g l_t h_t$. Unemployed workers' problem is analogous, with earnings replaced by b, no human capital investment decision and with a probability to find a job of $1-\pi_G$ for workers with a graduate degree and $1-\pi_B$ for workers with a bachelor degree.

4.3. Calibration

We set parameters for the model in two steps. First, we externally calibrate some parameters using estimates that are common in the literature or by estimating them independently – see Table 6. The remaining parameters, collected in Table 8, are obtained using the simulated method of moments (SMM) to minimize distance from a set of empirical moments.

4.3.1. External parameters

The unit of time is a semester, which corresponds to the length of the initial grace period, during which student loan payments are not required. Each period time in the model represents two quarters. Individuals start making decisions when they graduate from college. After finishing college, they start working and repaying their student debt. Agents retire at the age of 65 and die when they are 80. We follow standard calibration in the literature on preferences: yearly discount factor equals 0.96, and the constant relative risk aversion in the utility function is 2. Home production b is calibrated to match the Federal poverty threshold for an individual living alone in 2008 ($991 a month). The transition to unemployment probability for bachelor holders π_B is set to 5.5% and the probability for post-bachelor degree holders π_G is 4.5%, matching the average number of employment to unemployment transition of the two groups (see Menzio et al. 2016).[24] Pension payments equal 64 percent of the last earned income, which is equal to the median replacement rate as computed based on Social Security Administration tables (see Biggs and Springstead 2008). We assume there are two housing types, with the ratio of large-to-small size of 1.1.[25]

[23] Notice that, because we assume that the borrowing constraint with liquid assets during graduate school is tighter, forcing individuals to keep positive liquid assets, relaxing the assumption that graduate school costs are covered by graduate debt would have minimal quantitative implications.

[24] Our modeling of unemployment risk abstracts from transitions into and out of unemployment depending on age, as they do in the data. Using flow data from the Current Population Survey, we calculate age-dependent transition rates for college-educated workers, and calibrate an age-dependent unemployment rate risk accordingly. We then run the SMM routine, and replicate all our main results. This robustness exercise leaves all our main results unaffected.

[25] While we fix a ratio of large-to-small, we want to avoid the choice of absolute size having a role in shaping our results. For this reason, we include the average size as part of our general calibration exercise.

Table 6
External Parameters.

	Parameter	Value	Description	Source
Preferences				
	T	126	Periods	-
	R	88	Working Periods	-
	β	0.985	Discount Factor (Yearly)	-
	σ	2	Risk Aversion	-
Labor Market				
	p_g	\$ 50,000	Total Cost of Graduate School	IPEDS
	$\bar{G}$	4	Graduate School Periods	NCES
	y_p	0.83	Income in retirement (Replacement Rate)	Biggs and Springstead (2008)
	π_B, π_G	$\{5.5\%, 4.5\%\}$	Separation Probability	Menzio et al. (2016)
	b	\$991	Home Production	Federal poverty threshold (2008)
Financial Markets				
	ϕ	$-$\$ 5,000	Credit Card Limit (when employed)	SCF
	r^+	1%	Interest on liquid assets	FRB (2014)
	r^-	11%	Borrowing Rate	FRB (2014)
	r_d	5.5%	Interest on mortgages	Department of Education and PMMS
Housing				
	λ	0.2	Downpayment	Greenwald (2018)
	$P_r/\bar{P}_0$	5%	Yearly Rent-to-Price Ratio	Case-Shiller index (2008-2012)
	τ	10%	Housing Transaction Cost	Global Property Guide
	κ	2^{-1}	Housing Supply Elasticity	Saiz (2010) (average, big+small)
Policy				
	r_{ibr}	10%	Repayment Rate for IBR	Consumer Financial Protection Bureau

The annual interest rate for student loans and the 30-year fixed rate mortgage is calibrated to the 2004-2008 average rate of 5.5%. The risk free interest rate for savings is set at 1% and credit card borrowing rate is fixed at an annual 11 percent. For the borrowing constraint when employed, we set a credit card borrowing limit of $-$\$5,000, targeting a median rate of credit limit to annual labor income for college graduates of 20 percent. When the individual is unemployed, we impose $\phi = 0$. We set the rental rate to a yearly rate of 5% of the house price. The parameters that determine the loan-to-value (LTV) are chosen to match institutional features of the US mortgage market. For the LTV parameter, we fix a downpayment ratio of 0.2, implying a LTV of 80%. This does not fully capture the distribution of the LTV in Freddie Mac data, which has two masses point around 80% and 90%, but accounts for the fact that the first mass point is typically populated by younger first-time buyers and thus seems more appropriate for pinning down the problem of first home ownership (see Greenwald 2018).

4.3.2. Distribution of initial characteristics

While college graduates typically do not have substantial wealth, they may have access to alternative sources of wealth that are not directly measured. We assume students leave college with zero liquid assets but receive an exogenous transfer from their parents. We use the Expected Family Contribution (EFC),[26] with an average transfer of \$16,344 (μ_k) and a standard deviation of \$17,455 (σ_k).

Using the B&B data, we impose an average debt balance of \$17,021. We observe a percentage of 76% of borrowers, with cumulative average balances of \$23,640 (μ_d) and a standard deviation of 17,759 (σ_d). We then calibrate the initial human capital to match the initial post-graduation earnings of bachelor degree holders.

Finally, we must determine the correlation between ability and student debt ($\rho_{k,d}$), and between ability and initial assets ($\rho_{k,a}$). These parameters have an essential interpretation because, if correctly identified, they inform about the bias that an econometrician would be subject to when estimating Equation (1) via OLS. We calibrate these parameters jointly with other structural parameters to match the critical properties of the earnings and home ownership profiles.

4.3.3. Model fit and discussion

Fig. 2 compares the model-generated life-cycle profiles for earnings, enrollment in post-graduate degrees, and home ownership with their data counterparts. The model replicates well overall earnings dynamics and earning dynamics by education subgroups. The pattern in enrollment replicates gradual entry into postgraduate studies, with slightly more than a third of college-educated workers pursuing further education during their active years.[27]

Target moments are in Table 7, while internal parameter values are in Table 8. We use housing parameters to discipline both house prices and rents. Because rents are proportional to the average price, we can interpret P_0 as driving rental prices. We follow Blundell et al. (2016) to calculate rent expenditures from the Panel Study on Income Dynamics. We find the average yearly rent paid by households between 22 and 60 years old, where the head has a college degree, and in the years 2008-2018 to be equal to \$14,944,

[26] The EFC is calculated according to a formula established by law that considers the student's family's income, assets, and benefits (such as unemployment or Social Security).

[27] Entry into home ownership reaches about 85% by age 50 in both the data and the model, after which the life-cycle profile remains essentially flat. Consequently, the restriction that individuals cannot initiate new mortgages after age 55, as discussed in **Section 4.1**, has no effect on our quantitative results.

Note: Source: Current Population Survey (CPS), model estimates. USD amounts are in thousands.

Fig. 2. Life-Cycle Model (model and data).

Table 7
Target Moments.

Moments	Source	
	Data	Model
A. Earnings		
Earnings Profiles, bachelor holders	[1.0, 1.323, 1.416, 1.383]	[1.0, 1.373, 1.462, 1.488]
Earnings Profiles, post-bachelor holders	[1.189, 1.743, 1.971, 1.896]	[1.108, 1.634, 1.882, 1.941]
Standard Deviation of log-earnings	0.870	0.608
Skewness of log-earnings	−1.122	−1.121
B. Housing and Enrollment Profiles		
Home Ownership	[73.2%, 82.5%, 86.4%]	[49.5%, 77.1%, 86.5%]
Post-bach Enrollment	[8.6%, 28%, 34.5%]	[9%, 28.4%, 34.5%]
Average Home Price	$260,565	$245,079
Home Price Dispersion	$110,780	$124,671

Note: Empirical moments are taken from the Current Population Survey (individuals with at least a bachelor degree), the Model column uses model estimates. We divide life-cycle profiles into four age blocks: 22-32, 33-43, 44-54, and 55-64. Then the earnings profiles report the average of each block divided by the average of the 22-32 block for ba holders. The home ownership profiles report ownership rates for age blocks 33-43, 44-54, and 55-64. Post-bachelor enrollment rates are reported for ages 25, 30, and 35.

which is reassuringly similar to what we have as the model estimate. Housing parameters are identified mainly by life-cycle profile moments - the level being more responsive to changes in the average value of the housing amenity $\bar{s}$, and the slope varying primarily with changes in rental prices (and home prices in general).

The ratio of earnings across education groups and the selection effect by the ratio between the slopes of earnings broadly identifies the skill premium ν_G. In addition, the wage growth of the two education groups primarily identifies the mean value for the ability parameter in the Ben-Porath production function. Wage growth depends mainly on human capital accumulation, and the parameters a and α are crucial drivers of its production technology. In particular α can be identified by the relative magnitude of the slopes of income profiles: when technology is more linear, the difference between returns in human capital investments shrinks and so should the growth of post-graduate holders earnings over the life-cycle relative to bachelor degree holders.[28] In addition, the skewness

[28] Our calibration of α is notable smaller than the one generally used in the life-cycle literature. It must be noted, however, that we are concentrating on a subset of workers, and that the human capital investment choices are modeled in the context of multiple sources of leverage affecting the marginal cost of such investment.

Table 8
Internal Parameters.

Parameter	Description	Value	Interpretation
	Initial Distribution		
$\rho_{a,d}$	Correlation (ability, debt)	0.132	-
$\rho_{a,k}$	Correlation (ability, assets)	0.026	-
	Graduate School Parameters		
ξ	Lifetime amenity value, post-bachelor	8.795	\$3,929*
γ	Human Capital from post-bachelor	1.335	38% increase in h
ν_G	Skill Premium	0.299	$R_G = 1.299 \cdot R_B$
	Housing Parameters		
$\bar{s}$	Average Housing Amenity	4.76	\$1,155*
P_0	House Price	8.902	\$1,021 monthly rent
σ_H	Housing Size Dispersion	4.299	\$124,671 price dispersion
	Ben Porath Parameters		
α	Production Elasticity	0.278	-
a	Ability	0.347	-
σ_a	Ability Dispersion	0.040	-
σ_z	Human Capital Risk	0.159	-

Note: Internal calibration using Simulated Method of Moments. $*$: these values are computed as the average across the cross sectional distribution of individuals.

of earnings helps discipline the riskiness of the human capital accumulation process, σ_z: as it grows, more workers are stuck in a low-accumulation state, skewing the earnings distribution.

The amenity value of post-bachelor degrees is primarily identified by age-specific enrollment levels, with the early enrollment numbers driven by the human capital boost from attending a post-bachelor degree, γ: a higher value mitigates the cost of late enrollment, all else equal, by allowing graduates to regain some of the human capital lost due to higher education enrollment.

4.4. *The impact of student debt: model and data*

Empirical evidence in **Section 3.5** highlights the impact of student debt on earnings and higher education enrollment, pointing to a front-loading in earnings, lower earnings growth, and lower graduate school enrollment/attainment. Because the model allows us to control for ability explicitly, we could run the ideal specification in (1) on simulated data as a validation exercise. Table 9 displays the model's estimated impact of an increase in debt on earnings, education, and housing and compares it with our empirical estimates. In the model, indebted graduates have 0.22% higher earnings for each 1% of additional student borrowing one year after graduation but 0.11% lower earnings ten years later. The model also qualitatively replicates the impact of debt on graduate school attendance and home ownership, with point estimates within (or at least close) the 95% confidence interval of empirical estimates.

Our results imply a substitution effect between housing and education choices induced by debt balances. To illustrate that, Table A.10 reports the impact of debt balances on home ownership for graduates who will not attend graduate school (in Panel A). Consistent with our intuition, and with empirical results presented in Table 5, housing responds positively for the sub-population of graduates who will not enroll in a post-bachelor degree. Results for post-bachelor degree attendance, in Panel B, confirm the intuition, as the impact of student debt is stronger for home owners.[29]

Quantitatively, the effect of debt on discrete choices is stronger, in part because the model cannot fully account for quality/price adjustment in demand: only one type of graduate school is available. In addition, not accounting for receiving bequests and inter-vivo transfers makes the home ownership profile steeper in the model than in the data, and the home ownership choice more sensitive to disposable income. Even in presence of financial frictions, it can be surprising that net wealth can play such a dramatic role in shaping higher education enrollment. However, part of what drives enrollment choices in the model depends on non-monetary returns, which operate as luxury goods. The model summarizes these motives by allowing a non-negative compensating differential, ξ. A prominent role of ξ makes education choices more sensitive to wealth effects.

The model can draw longer-term conclusions on the impact of debt financing for education and, more generally, of the effects of having wealth heterogeneity at the beginning of workers' careers. The first-order consequence of being asset-poor is to reduce human capital investments because of an intertemporal substitution induced by the rigid payment schedule of US college debt plans. There are two main trade-offs involved in the higher education enrollment choice. First, workers that do not pursue additional education start with higher disposable income, even at the expense of lower income growth compared to the more human capital-intensive careers. Attending school allows postponing payments, but new debt adds to the existing one. Compounding the burden of additional borrowing puts considerable pressure on future disposable consumption, thus discouraging enrollment. On the other hand, workers can still repay while working and then enroll when their debt burden has been reduced.

[29] The substitution can be seen via the unconditional life-cycle profiles by debt balances, as shown in Fig. A.4: in the early years, home ownership is higher for indebted bachelor holders. By age 30, the relationship is already reversed.

Table 9
The Impact of Student Debt.

Moments	Data	Model
Earnings		
$\partial y_{t+1}/\partial d_t$	0.348	0.226
	[0.106, 0.590]	
$\partial y_{t+4}/\partial d_t$	0.358	0.075
	[0.03, 0.683]	
$\partial y_{t+10}/\partial d_t$	−0.534	−0.111
	[−0.060, −1.008]	
Graduate School Enrollment		
$\partial P(G)_{t+1}/\partial d_t$	−0.18	−0.151
	[−0.12, −0.26]	
$\partial P(G)_{t+4}/\partial d_t$	−0.169	−0.497
	[−0.081, −0.257]	
Home Ownership		
$\partial P(H)_{t+4}/\partial d_t$	0.044	−0.007
	[−0.138, 0.226]	
$\partial P(H)_{t+10}/\partial d_t$	−0.06	−0.281
	[−0.242, 0.122]	

Note: Empirical results are from Table 3 from Section 2. For enrollment and home ownership, we report the Probit coefficient. The 95% confidence interval is reported between square brackets. The model regression controls for ability, liquid wealth, and human capital.

The second consideration regarding higher education enrollment is that we model human capital accumulation as a risky investment. Choosing to attend a post-bachelor degree has significant returns on average, yet our estimates of σ_z point to high uncertainty about lifetime income prospects for graduates investing in their skills. This risk is a heavier burden for those graduates who will leave graduate school with large (and compounding) debt balances. Workers whose undergraduate borrowing is above the average level will start with higher earnings, partly because they are most likely to be working rather than being enrolled. This allows them to build saving buffers that make meeting loan payments more manageable. After some years, the sorting effects affect earnings, creating a broad and persistent gap.

4.5. Amenity values

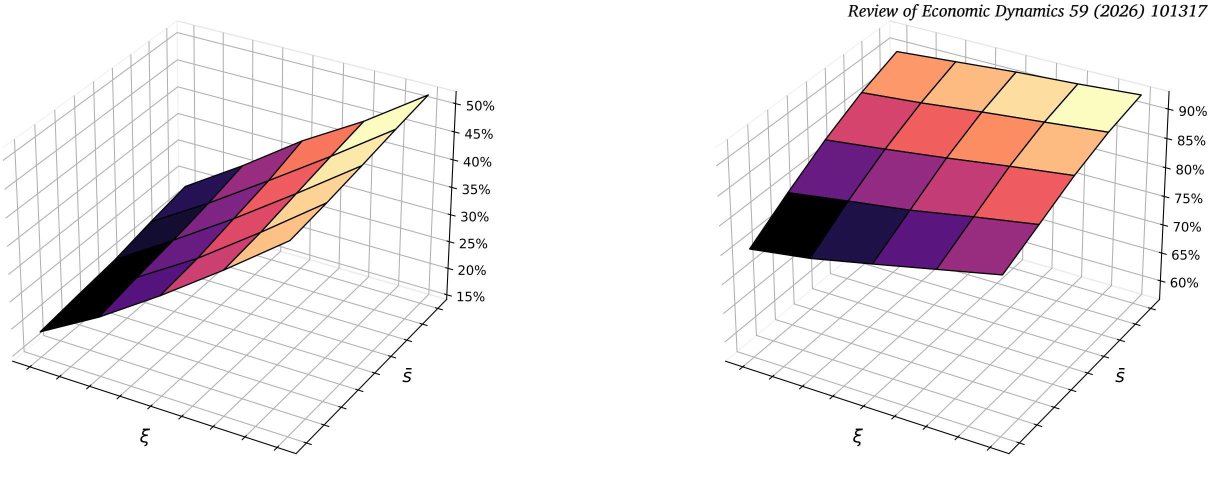
The biggest unobserved driver of our model dynamics is the role of amenities. To shed light on their impact, we first perform a simple exercise where we perturb each parameter within a 10%-wide interval relative to its calibrated value. Fig. 3 shows the results for the overall levels of home ownership and post-bachelor degree enrollment as we vary the values of housing and graduate school amenities, respectively ξ and $\bar{s}$. Post-bachelor enrollment levels respond strongly to changes in ξ, while housing is unaffected. Conversely, $\bar{s}$ has a large impact on home ownership, but also a small, positive impact on post-bachelor degree attendance, with small negative impacts on long-run earnings. The reason for the positive impact on enrollment is clear: a higher value of home ownership increases the returns to saving technologies that increase the chances of housing purchases in the future. For the same reason, earnings decrease for both groups in the long run, as agents put more weight on liquid savings rather than Ben-Porath human capital accumulation.

From the logic discussed thus far, we should observe an increased sensitivity to wealth of each variable as the corresponding amenity value grows. Table A.11 and Table A.12 collect the impact on the wealth elasticity of enrollment and housing decisions when amenity values change. As expected, higher amenity values on education make it more sensitive to wealth levels. However, we also see that increasing ξ makes housing moderately more sensitive to wealth levels, and the converse happens when $\bar{s}$ grows.[30]

The next exercise exploits the model structure to uncover the impact of amenity values across the income distribution. The left panel in Fig. 4 shows the heterogeneity in graduate school attendance valuations, an exercise in the spirit of Athreya et al. (2019).[31] Differences in the consumption–equivalent amount of ξ for low and high levels of disposable income explain the consequential impact of debt on education: while monetary considerations are almost the only elements poorer workers will consider in evaluating the returns to higher education, the picture for richer individuals is different. Graduates in the right tail of the income distribution plotted

[30] Education and housing choices are alternative to each other in the very first years post-graduation, and excess sensitivity of education to wealth can change the timing of home ownership, but in the long run the higher incomes enjoyed by individuals with post-graduate degrees make home ownership more likely. In this sense, the two choices can be complementary.

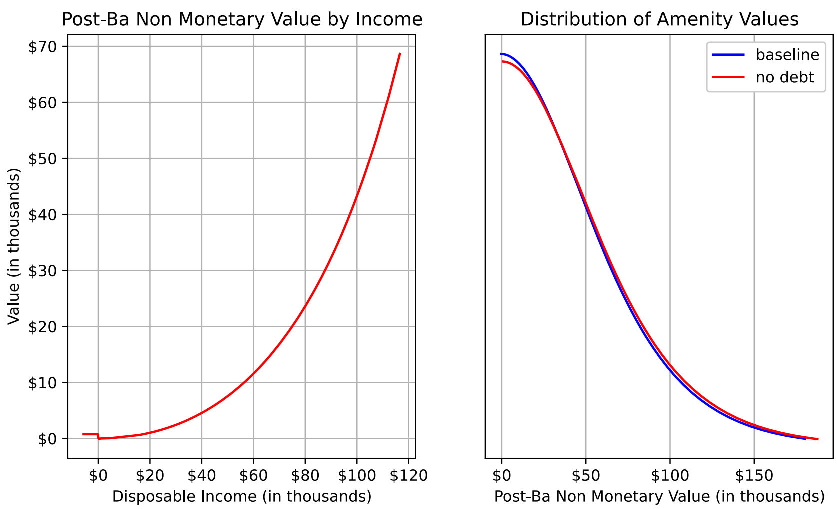
[31] To compute the amenity value of graduate school in dollar terms, we use ξ and then calculate the amount of consumption increase that would yield equivalent flow utility to grad school attendance and the value of the human capital-intensive career graduate school gives access to. Similarly, we compute the monetary equivalent value of housing amenity by calculating the average reduction in house prices that would produce the same home ownership profile if $s = 0$. While average amenity values look small from a life-cycle perspective, there is substantial heterogeneity in how graduates value these two choices.



(a) Enrollment up to Age 35

(b) Home ownership, Ages 55-64

Fig. 3. Home ownership and Post-Bachelor Enrollment for Different Amenity Values.



Note: Monetary equivalent value for ξ across renters of age 25. Source: Model estimates.

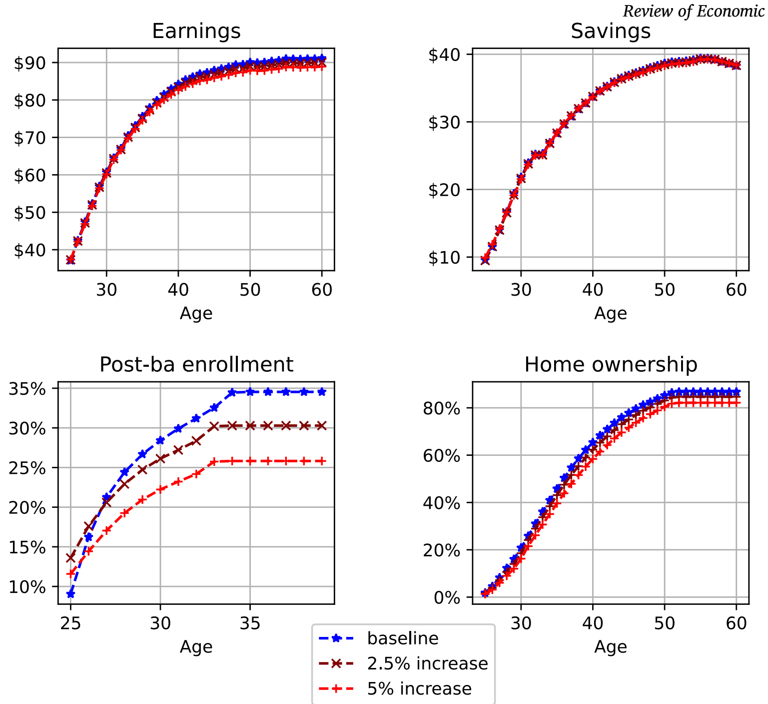
Fig. 4. Non-Monetary Value of Post Ba Enrollment.

in the right panel of Fig. 4 will consider post-graduate education worth the equivalent of hundreds of thousands of dollars in terms of lifetime income. The right panel also shows how debt balances affect this distribution by shifting it dramatically to the left, especially for relatively less wealthy individuals.

While we abstract from explicit parental status in the model and only include parental transfers as a feature of the starting distribution, these estimates can help us think of how differences in asset positions at a young age could prevent social mobility.[32] Our model shows that non-monetary returns and the present value of monetary returns are positively correlated. As they give up graduate school, indebted graduates are financially worse off in present value terms while front-loading their earnings profile.

In order to insulate the importance of the amenity value of graduate attendance from its heterogeneous impact across the income distribution, we perform the following exercise. We assume the average monetary equivalent of ξ is transferred to graduate enrollees. It can then be interpreted as a consumption transfer enjoyed while in graduate school. We report how this change affects simulated life-cycle profiles in earnings, home ownership and enrollment in Table A.13. Home purchases over the life cycle, average home

[32] The interaction dynamics between starting wealth, large amenity values, and monetary returns in our model are consistent with Boar and Lashkari (2021), which show that young Americans from wealthier families sort into professions with higher amenity values, and with Luo and Mongey (2019), who argue that indebted graduates give up on amenities to repay debt after graduation.



Note: Counterfactual simulation with an increase in P_0. Source: Model estimates.

Fig. 5. Impact of Increased House Prices.

prices, and home price dispersion replicate closely those calculated in the baseline case. However, post-bachelor degree enrollment changes along two dimensions: overall participation declines when measured cumulatively over the life cycle, and those who do enroll tend to do so earlier than in the baseline.

While richer individuals value graduate school more in the baseline, amenity values in this exercise provide a boost in utility that is decreasing in disposable income. As shown in the second panel of Table A.14, most of the decline in enrollment comes then from non-indebted individuals, as intuition would suggest. Highly indebted students actually increase their enrollment, although the increase is small compared to the reduced enrollment numbers of the debt-free graduates. The reduced importance of the amenity motive for richer graduates also operates to lessen the slightly negative ability sorting into post-bachelor degrees that we observe in the baseline case. We also replicate the main regressions from Table 9, and find (i) almost no change in the home ownership regressions, (ii) a weaker, but still strongly negative, effect of student debt on enrollment, (iii) a weaker impact on incomes, with the sign reversal occurring earlier, consistently with the change in timing of enrollment.[33] This exercise provides important nuance to our findings, by showing that both amenity values and borrowing constraints, together with the implicit backloading of earnings for post-bachelor degree enrollees, drive highly indebted graduates away from further education.

4.6. The role of house prices

Having established that post-graduate education choices can shape the life-cycle profile of home ownership, we now study the role of housing in shaping graduates' income and enrollment profiles. Fig. 5 displays how agents in our model would respond to a growth in the average house price index, P_0. Graduates face a direct wealth effect (rent increases proportionally) and a reduced return on their housing investment when housing prices rise. As expected, rising home prices reduce home ownership. However, our model predicts minor reactions in housing demand. Enrollment responds more strongly: the wealth effect dominates, as graduates with low ability see the trade-off between renting and owning as fundamentally unchanged, while the cost front-loading needed to attend a post-bachelor degree is now more significant. The drop in enrollment is quite pronounced when looking at later years – the enrollment profile is also flatter, with early enrollment being more common.

As highlighted from the discussion of Fig. A.5, early enrollment has greater net human capital returns - therefore, a flatter enrollment profile can result in higher income even if overall entry into post-bachelor degrees ends up being lower. The response of income is not obvious ex-ante. Because increasing home prices translate into higher rents, all individuals are poorer when they start working since everyone is assumed to graduate without owning any real estate. The income effect could, in principle, offset the benefits of earlier enrollment by lowering the Ben-Porath investment in human capital. Balancing these two opposite forces, income profiles are very similar across the different scenarios.

[33] Results are collected in Table A.15.

In practice, house prices rise gradually. We propose an additional exercise, whereby individuals face an increase in real house prices of 1.4% per year for the first 12 years, and flat real house prices afterwards.[34] The decline in enrollment is small and only appears late in life, when wealth effects materialize. The gap in home ownership, as expected, widens with age. Interestingly, the impact of rising rents and home prices is extremely small on liquid savings and earnings. The impact of rising home prices is thus more muted once we allow prices to rise gradually. Table A.17 confirms the robustness of our baseline specification to the presence of a housing trend. Consistent with the distribution of enrollment choices across debt balances in Table A.16, we see a stronger effect of student debt on enrollment in this case than in the baseline, while the housing coefficients are quantitatively very close in the two scenarios.

4.7. Income based repayment

In the aftermath of the GI Bill, Friedman (1955) noticed that conventional mortgage-type loans work well for home loans but not for investment in human capital because of lack of collateral and asymmetric information. While the first problem implies an undue risk for borrowers, both problems indicate excessive risk for lenders: with conventional mortgage-type loans, there will be underinvestment in human capital.[35] Changes to old repayment plans and the creation of new ones have expanded generous income-based repayment (or income-contingent loans, ICL) options to a growing number of borrowers in the US.

A quantitative exercise is necessary to assess how income-based repayment plans moderate the effects of initial student loan debt. On the one hand, enrollment in income-driven repayment plans reduces the ratio of student loan payments to monthly wages, increasing disposable income. On the other hand, it can extend the repayment period significantly relative to a 10-year plan, thereby potentially increasing the total interest paid by the student loan borrower over the life of the loan, and it can provide adverse incentives to human capital accumulation because it acts as an additional proportional tax on income.

This section introduces an income repayment plan as an alternative repayment scheme. The income repayment plan is defined to replicate the *Pay As You Earn Repayment Plan (PAYE)* introduced in 2012. Payments amount to a proportional share τ of discretionary income (defined as income exceeding a minimum threshold $\underline{y}$), but cannot exceed in any period the amount that the graduate would pay with the installments of a Stafford 10-year plan. The plan goes on for 20 years, and at the end of the repayment period, the remaining balances are forgiven. Formally, payment in each period will equal:

$$P_d^{PAYE} = \min\{\tau_{IBR} * (w(l,h) - \underline{y}), P_d) \tag{12}$$

To reproduce the PAYE system, we need $\tau_{IBR} = 10\%$ and $\underline{y} = b$. The forgiven amount is additional income for taxing purposes. In the standard plan, overall balances stay flat for the first ten years due to a combination of deferment and additional (graduate) debt, then fast deleveraging brings balances to zero by age 45. On the other hand, with IBR, initial payments can be lower than the minimum amount required to contain the mechanical growth of balances, spurring a growth that peaks in the mid-30s as incomes catch up with interest payments. While the PAYE system is far from an ideal ICL, as argued among others by Barr et al. (2019), the current experiment is useful, especially for extrapolating current trends, keeping the current legal framework unchanged.

Fig. 6 and Table A.18 display the comparative statics between the baseline scenario and one in which all graduates automatically enroll in IBR. Post-bachelor degree enrollment increases, with the boost to education dominating in the early years. Income effects push up housing demand, and overall home ownership grows compared to baseline. Because of the insurance value of IBR, the precautionary motive for holding liquid assets decreases: as a result, the increased home ownership is more of a transformation of wealth from liquid into illiquid assets than a large increase in wealth overall. While home ownership for individuals aged 50 and older increases by more than 13%, total wealth at retirement is merely 3% higher. The impact on housing and enrollment choices can appear large for a change in the payment scheme that in some cases might even induce larger total payments. An important but overlooked feature of the PAYE program is its provision by which all remaining balances at the end of the 20-year repayment period are forgiven. Our model simulations indicate that the average borrower has positive balances for more than 20 years after graduation, because IBR induces lower payments and allows owed amounts to grow. The PAYE program, on top of reducing the burden of student debt when disposable income is low, is thus producing a substantial wealth effect.[36]

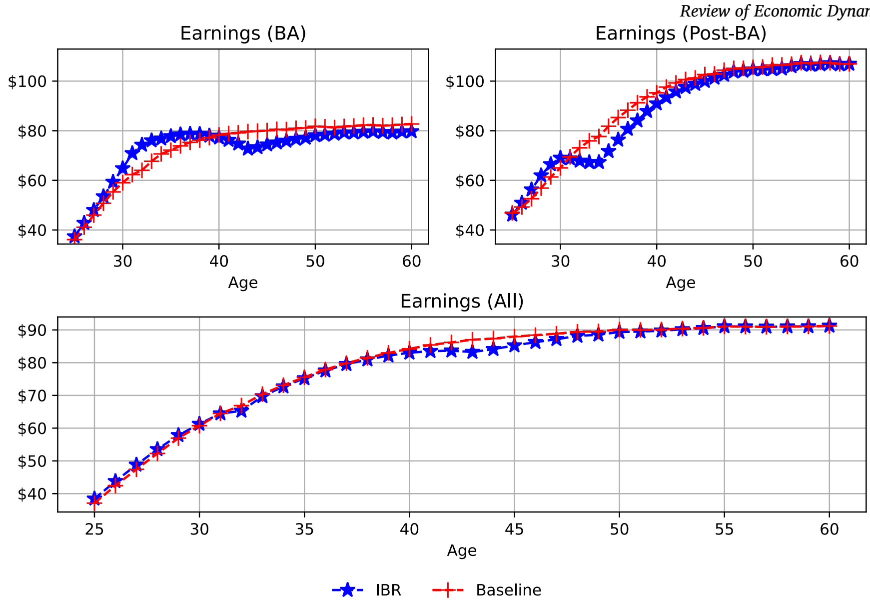
Table A.14 expands the analysis of graduate school enrollment under the income-based repayment (IBR) plan. We find that enrollment rates rise under IBR and become less sensitive to debt balances. All groups increase their enrollment in post-bachelor programs, except for individuals who completed undergraduate studies without student debt. For this group, enrollment falls from above 60% to around 40%, with the decline particularly pronounced among those in the highest ability tercile. Overall, total enrollment increases from 35% in the baseline to 42.4% under IBR.

IBR alters human capital investment decisions through the classic Ben-Porath channel, consistent with the labor-supply distortions inherent in proportional repayment schemes discussed by de Silva (2025) and Fu et al. (2025). The repayment cap, by limiting the

[34] This is consistent with the measured Average Sales Price of Houses Sold for the United States for the years 2008-2020 computed by the U.S. Department of Housing and Urban Development, and deflated by the CPI, and amounts to a 20% increase in average house prices in the model over the same period.

[35] Plans that link repayment to income are today a popular solution to broadening access to higher education, as countries like Australia and Great Britain made them their baseline program for student finance (see Chapman 2016).

[36] We assume that any forgiven loan amount is taxed at a marginal federal income tax rate of 24%, corresponding to the bracket for individuals with taxable income between $100,000 and $191,950. This effective wealth transfer—larger for individuals with higher cumulative debt at graduation—can significantly distort incentives to accumulate additional debt, particularly for graduate school. Consequently, any increase in the assumed tax rate, or any modeling adjustment that reduces the size of the implied transfer, has a first-order impact on both enrollment and housing choices.



Note: Comparison between a counterfactual based on PAYE repayment vs our baseline model simulation. All values are in thousands of US dollars.

Fig. 6. Baseline vs. IBR Repayment.

amount due each period, leads to slower amortization and higher total outstanding balances, ultimately increasing the present value of repayments. Because individuals effectively face a higher marginal tax rate on post-education income, the monetary return to graduate education declines. Consequently, the policy not only dampens incentives for high human capital investment but also affects the composition of enrollees, shifting participation toward lower expected earners. These mechanisms help explain the moderate increase in aggregate labor earnings observed in Fig. 6, as post-bachelor graduates become increasingly concentrated among lower-ability individuals.

At the same time, enrollment among indebted students rises sharply. In particular, participation among individuals in the most indebted tercile increases to roughly 42%, compared to about 3.5% in the baseline. This response reflects two forces. First, the IBR scheme provides substantial insurance through income-contingent repayments, reducing the downside risk associated with additional borrowing. Second, pursuing further education under IBR effectively dilutes existing balances: repayment obligations grow more slowly than under a fixed-schedule regime, and debt forgiveness offers protection in the event of poor labor market outcomes.

Our results highlight two main benefits of the IBR scheme. The first is its direct effect on payment smoothing, which mitigates consumption drops against adverse shocks, consistent with welfare gains in Matsuda and Mazur (2022). The second, which is distinctive to our analysis, is the higher enrollment in post-graduate education and a reallocation of assets from liquid to housing wealth. Both channels enhance welfare through their non-monetary components. Overall, while our findings align with the mechanisms emphasized in the literature on moral hazard and insurance, we expand the discussion to selection into education and home ownership. In particular, we show that the expanded access to post-graduate education under IBR occurs at the cost of lower average student quality, whereas the increase in home ownership arises almost entirely from a compositional shift from liquid to housing wealth.

A final consideration is that our framework provides a partial equilibrium assessment of the proposed policies. As such, it abstracts from general equilibrium adjustments, including changes in relative wages, returns to education, or aggregate demand spillovers that may arise as borrowers' disposable income and wealth positions evolve. Within this setting, however, the fiscal implications of IBR can be measured directly, since they stem mechanically from the forgiveness clause that cancels remaining balances after 10 or 20 years of repayment.

In our simulation, roughly 4% of all individuals (or 6% of all borrowers) experience debt forgiveness, with an average amount of about $55,000 per debtor. After accounting for the 24% tax levied on forgiven balances, the net fiscal transfer corresponds to approximately $42,000 per beneficiary, or $1,700 when averaged across the entire cohort. To express this in per-period fiscal incidence terms, we assume equally sized cohorts and restrict the tax base to working-age individuals. Dividing the aggregate transfer by the 88 half-year periods that constitute the working life in our model yields a lump-sum equivalent tax of approximately $20 per period. Given the small magnitude of this tax, behavioral responses are negligible. Thus, we can safely abstract from wealth or income effects arising from fiscal feedbacks outside the modeled economy for the IBR experiment, without compromising the internal consistency of the partial equilibrium results.

5. Conclusions

We leverage an experiment involving student loans to study the role of initial wealth levels in shaping education, career, and housing choices. Lower net wealth leads to a significant and persistent under-investment in human capital and education, lower earnings growth, but no significant delay in first-time home ownership. Additionally, we find that decisions on further education are more sensitive than housing decisions to initial wealth levels due to large and heterogeneous non-monetary returns. Overall, this study provides valuable insights into the complex interplay between student debt, education, career, and housing choices, with important implications for policymakers and young workers. We argue that, when considering the importance of wealth inequality and its role in social mobility, wealth accumulation and career choices will be deeply intertwined, with the timing of each affecting the returns of the other. Income-based plans are an effective policy to reduce career and human capital accumulation distortions induced by student borrowing. However, they contribute to adversely sorting workers into post-bachelor degrees because of the implicit subsidy provided to borrowers. Future research is needed to understand better the design of student finance and its interactions with wealth accumulation in the context of job polarization across multiple dimensions: economic returns, amenities, and taking location considerations.

Appendix A

A.1. IPEDS data

Using harmonized college identifiers, we merge the B&B student-level data with college-level data from the Institutional Post-Secondary Database (IPEDS). We use the following variables from the IPEDS data center to construct grant-to-aid:

Student Debt:

Average amount of student loans awarded to full-time first-time undergraduates (loan): Any monies that must be repaid to the lending institution for which the student is the designated borrower. Includes all Title IV subsidized and unsubsidized loans and all institutionally- and privately-sponsored loans. Does not include PLUS and other loans made directly to parents.

Percent of full-time first-time undergraduates awarded student loans (ploan): Percentage of full-time, first-time degree/certificate-seeking undergraduate students who were awarded student loans.

Institutional Grants:

Average amount of institutional grant aid awarded to full-time first-time undergraduates (grant): Scholarships and fellowships granted and funded by the institution and/or individual departments within the institution, (i.e., instruction, research, public service) that may contribute indirectly to the enhancement of these programs.

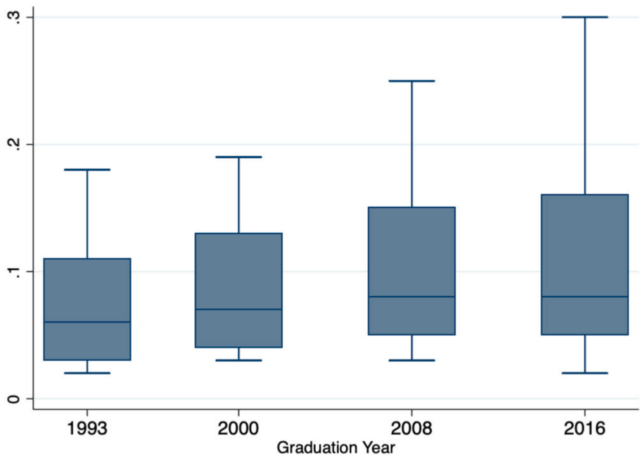
Percent of full-time first-time undergraduates awarded institutional grant aid (pgrant): Percentage of full-time, first-time degree/certificate-seeking undergraduate students who were awarded institutional grants (scholarships/fellowships).

Grant-to-Aid:

We drop colleges with any missing values. We construct $Z_{j,t}$ as follows:

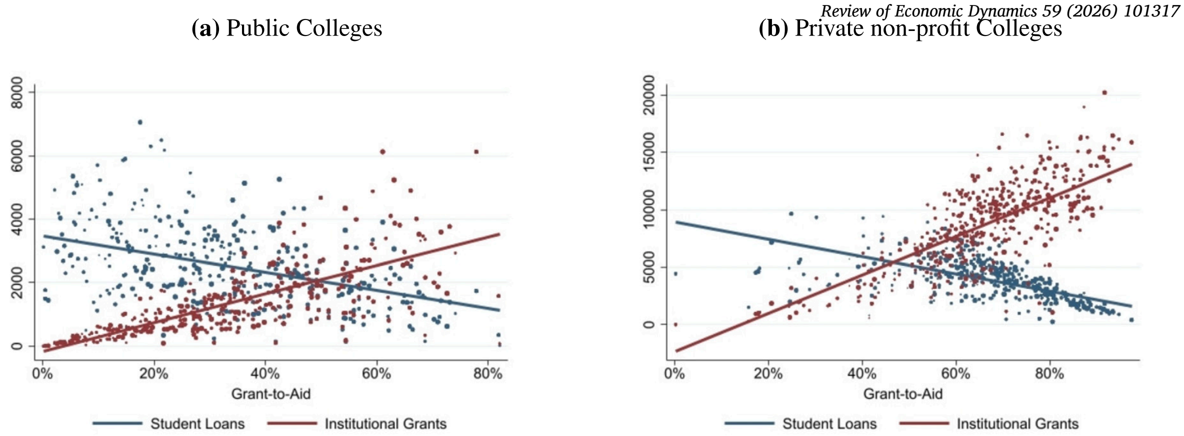
$$\begin{aligned} aid_{j,t} &= \left(\frac{TotalDebt_{j,t}}{Indebted_{j,t}}\right) \cdot \left(\frac{Indebted_{j,t}}{Students_{j,t}}\right) + \left(\frac{Grant_{j,t}}{Recipient_{j,t}}\right) \cdot \left(\frac{Recipient_{j,t}}{Students_{j,t}}\right) \\ &= ploan_{j,t} \cdot loan_{j,t} + pgrant_{j,t} \cdot grant_{j,t} \\ Z_{j,t} &= \frac{pgrant_{j,t} \cdot grant_{j,t}}{aid_{j,t}} \end{aligned}$$

A.2. Additional figures and tables



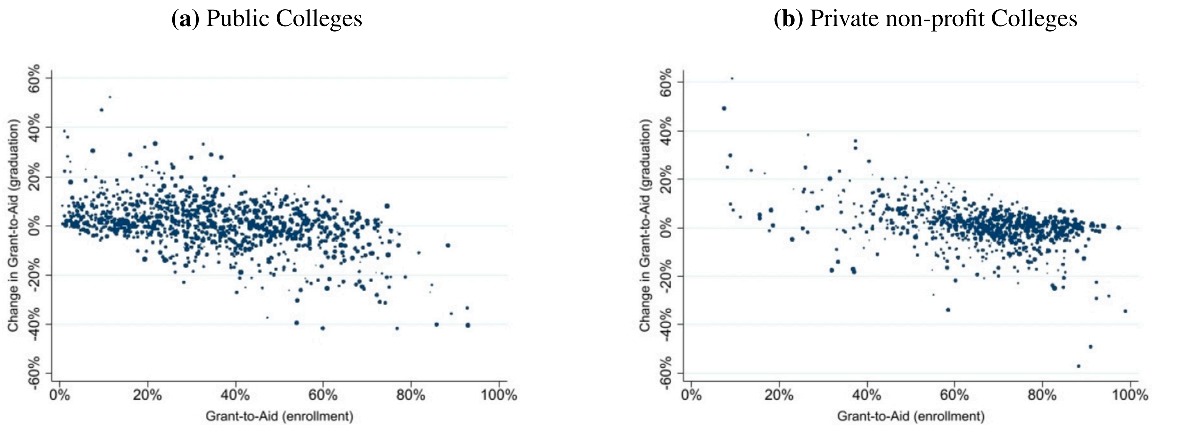
Source: Baccalaureate and Beyond Longitudinal Study (B&B:93/94, B&B:2000/01, B&B:2007/08, B&B:2015/16).

Fig. A.1. Monthly Student Debt Repayment.



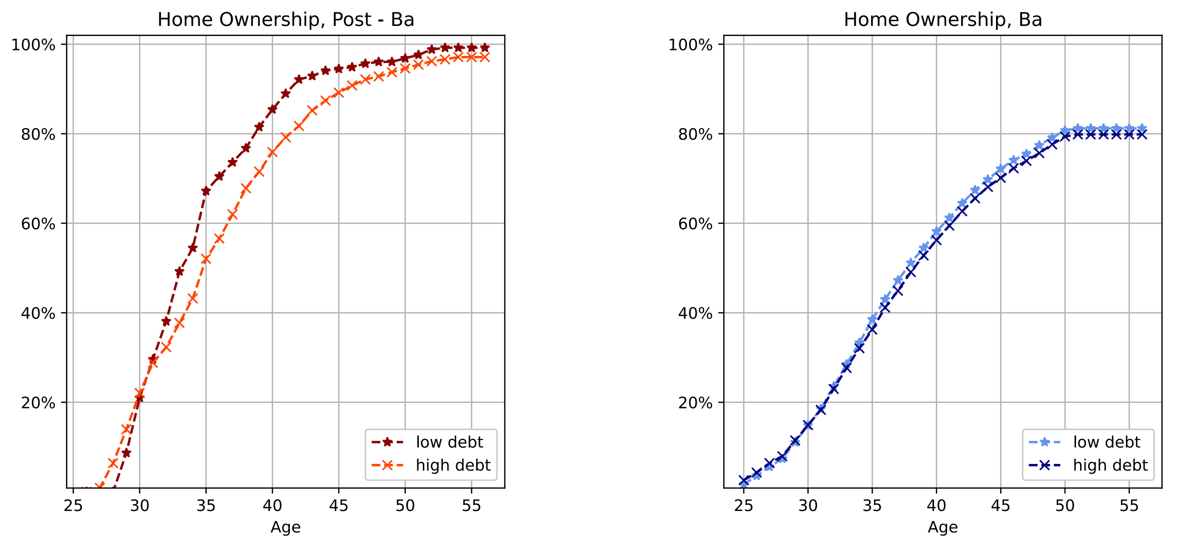
Source:: Integrated Postsecondary Education Data System (IPEDS 2007/08) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Blue dots are average student loan balances, red dots are average institutional grant amounts, both at the college level.

Fig. A.2. Institutional Grants and Student Loans (2007/08). (For interpretation of the colors in the figure(s), the reader is referred to the web version of this article.)



Source: Integrated Postsecondary Education Data System (IPEDS 2007/08) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Estimates are survey weighted. Each dot represents a college-specific level of grant-to-aid ratio, Z_j, and how it changes from the first year of enrollment.

Fig. A.3. Change in Grant-to-aid.



Note: The Low (High) Debt group includes graduates with balances below (above) the median level.

Fig. A.4. Home ownership Profiles by Education.

Table A.1
Impact of Student Debt on Selected Outcomes (B&B:2008/18), Binary Variable.

	2009	2012	2018
	(1)	(2)	(3)
Earnings:			
OLS	0.20	0.19**	-0.3**
	[0.13]	[0.076]	[0.069]
2SLS	1.335**	1.334**	-2.392**
	[0.503]	[0.499]	[0.947]
Graduate school enrollment:			
Probit	-0.126***	-0.069*	0.013
	[0.036]	[0.036]	[0.037]
	-0.041***	-0.025*	0.004
	[0.012]	[0.013]	[0.037]
IV BiProbit	-0.768***	-0.87***	0.103
	[0.229]	[0.26]	[0.470]
	-0.246***	-0.297***	0.031
	[0.069]	[0.081]	[0.144]
Home ownership:			
Probit	-	-0.041	-0.054
	-	[0.037]	[0.035]
	-	-0.012	-0.019
	-	[0.011]	[0.012]
IV BiProbit	-	0.627	-0.224
	-	[0.341]	[0.461]
	-	0.193*	-0.079
	-	[0.106]	[0.162]
University Controls	✓	✓	✓
Student Controls	✓	✓	✓
Restricted Sample	✓	✓	✓
Observations	7,600	7,600	7,600

Note: *p<0.1; **p<0.05; ***p<0.01. The number of observations is rounded to comply with privacy requirements. Binary Variable constructed as indicating whether the bachelor recipient has left school with positive student debt balances. Probit and IV BiProbit regressions report the parameter estimates, together with average marginal effects in the line below. The restricted sample includes only individuals graduated from universities from which at least 6 other students are observed at graduation. *Earnings* represents the (logarithm of) annualized salary for primary job in the given year. *Graduate school enrollment* indicates the individual is enrolled in either a Master's Degrees, Post-Master's Certificates, First-Professional Degree or Doctoral Degree at the given date. Sample: graduated between age 21 and age 25. *Home-ownership* covers both mortgage holders and individuals that owned a home outright at the moment of survey. The number of observations is rounded to comply with privacy requirements. Data comes from Integrated Postsecondary Education Data System (IPEDS) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Standard errors are clustered. The number of observation is rounded to comply with privacy requirements.

Table A.2
Balancing Test.

	(1)	(2)
Dependency	-0.026	-0.026
	[0.035]	[0.035]
Fin. Need	0.025**	0.023**
	[0.011]	[0.012]
High School GPA:		
1.0-1.4	0.456	0.393
	[0.515]	[0.515]
1.5-1.9	0.608	0.726
	[0.475]	[0.468]
2.0-2.4	0.761	0.758
	[0.49]	[0.482]
2.5-2.9	0.748	0.456
	[0.48]	[0.476]
3.0-3.4	0.758	0.456
	[0.48]	[0.48]
3.5-4.0	0.772	0.456
	[0.48]	[0.48]
In State	-0.02	-0.02
	[0.031]	[0.003]
Male	-0.001	0.004
	[0.02]	[0.02]
White	-0.104	-0.087
	[0.084]	[0.091]
F-Stat p-value (all individual covars = 0)	0.30	0.49
Observations	8,100	7,600
University Controls	✓	✓
Restricted Sample		✓

Note: *p<0.1; **p<0.05; ***p<0.01. The number of observations is rounded to comply with privacy requirements. All covariates are based on the sample of the graduating cohort of 2008, with characteristics that are pre-determined at the moment of enrollment into the bachelor degree. The dependent variable is the cumulated change in the grant-to-aid ratio between the year of enrollment and the academic year 2007-2008, as defined in (2). University controls include location, institution type, and selectivity. Sample of students graduated between age 21 and age 25. Data comes from Integrated Postsecondary Education Data System (IPEDS) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Standard errors are clustered at the institution level. The number of observation is rounded to comply with privacy requirements.

Table A.3
Impact of Student Debt on Enrollment and Completion (B&B:2008/18).

	Probit			IVProbit		
	(1)	(2)	(3)	(4)	(5)	(6)
Grad School Enrollment						
2009	-0.013***	-0.012***	-0.013***	-0.214***	-0.19***	-0.18***
	[0.003]	[0.003]	[0.004]	[0.016]	[0.033]	[0.04]
	-0.005***	-0.004***	-0.004***	-0.186**	-0.094**	-0.085**
	[0.001]	[0.001]	[0.001]	[0.084]	[0.042]	[0.039]
2012	-0.009***	-0.007*	-0.007*	-0.207***	-0.173***	-0.169***
	[0.003]	[0.04]	[0.004]	[0.02]	[0.044]	[0.044]
	-0.003***	-0.002*	-0.002*	-0.174**	-0.087*	-0.083**
	[0.001]	[0.001]	[0.001]	[0.09]	[0.044]	[0.043]
2018	0.000	0.002	0.002	-0.20***	-0.173***	-0.164***
	[0.003]	[0.04]	[0.004]	[0.024]	[0.041]	[0.046]
	0.000	0.000	0.000	-0.13**	-0.077**	-0.07*
	[0.001]	[0.001]	[0.001]	[0.067]	[0.038]	[0.036]
Grad School Completion						
2012	-0.010***	-0.010***	-0.009***	-0.179***	-0.155***	-0.136**
	[0.004]	[0.004]	[0.004]	[0.046]	[0.056]	[0.065]
	-0.003***	-0.003***	-0.003***	-0.08	-0.056*	-0.046
	[0.001]	[0.001]	[0.001]	[0.049]	[0.033]	[0.031]
2018	-0.006*	-0.006*	-0.006*	-0.209***	-0.193***	-0.177***
	[0.003]	[0.003]	[0.004]	[0.02]	[0.03]	[0.04]
	-0.002*	-0.002*	-0.002*	-0.183**	-0.114**	-0.093**
	[0.001]	[0.001]	[0.001]	[0.086]	[0.048]	[0.043]
Observations	8,100	8,100	7,600	8,100	8,100	7,600
University Controls	✓	✓	✓	✓	✓	✓
Student Controls		✓	✓		✓	✓
Restricted Sample			✓			✓

Note: *p<0.1; **p<0.05; ***p<0.01. The number of observations is rounded to comply with privacy requirements. Probit and IVProbit regressions report the parameter estimates, together with average marginal effects in the line below. The restricted sample includes only individuals graduated from universities from which at least 6 other students are observed at graduation. Sample: graduated between age 21 and age 25. Data comes from Integrated Postsecondary Education Data System (IPEDS) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Standard errors are clustered at the institution level. The number of observation is rounded to comply with privacy requirements.

Table A.4
Impact of Student Debt on Home-ownership (B&B:2008/18).

	Probit			IVProbit		
	(1)	(2)	(3)	(4)	(5)	(6)
Home-ownership						
2012	-0.006	-0.004	-0.005	0.098	0.021	0.044
	[0.003]	[0.004]	[0.004]	[0.003]	[0.098]	[0.093]
	-0.002	-0.001	-0.001	0.036	0.007	0.014
	[0.001]	[0.001]	[0.001]	[0.001]	[0.031]	[0.031]
2018	-0.006*	-0.006*	-0.006*	-0.046	-0.077	-0.060
	[0.003]	[0.003]	[0.004]	[0.115]	[0.084]	[0.087]
	-0.002*	-0.002*	-0.002*	-0.017	-0.029	-0.022
	[0.001]	[0.001]	[0.001]	[0.044]	[0.034]	[0.033]
Observations	8,100	8,100	7,600	8,100	8,100	7,600
University Controls	✓	✓	✓	✓	✓	✓
Student Controls		✓	✓		✓	✓
Restricted Sample			✓			✓

Note: *p<0.1; **p<0.05; ***p<0.01. The number of observations is rounded to comply with privacy requirements. Probit and IVProbit regressions report the parameter estimates, together with average marginal effects in the line below. The restricted sample includes only individuals graduated from universities from which at least 6 other students are observed at graduation. Sample: graduated between age 21 and age 25. Data comes from Integrated Postsecondary Education Data System (IPEDS) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Standard errors are clustered at the institution level. The number of observation is rounded to comply with privacy requirements.

Table A.5
Impact of Student Debt on Employment and Earnings (B&B:2008/18).

	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Employment						
2009	0.002**	0.002***	0.002**	0.049	0.013	0.026
	[0.001]	[0.001]	[0.001]	[0.045]	[0.019]	[0.020]
2012	0.003***	0.003***	0.003***	0.10*	0.043**	0.048***
	[0.001]	[0.001]	[0.001]	[0.055]	[0.018]	[0.014]
Earnings						
2009	0.023**	0.022	0.023	0.729*	0.198	0.348***
	[0.01]	[0.012]	[0.013]	[0.417]	[0.127]	[0.121]
2012	0.012	0.018**	0.020**	0.556	0.258	0.358**
	[0.008]	[0.007]	[0.008]	[0.397]	[0.185]	[0.163]
2018	-0.040***	-0.031***	-0.031***	-0.754***	-0.527**	-0.534**
	[0.007]	[0.001]	[0.001]	[0.314]	[0.234]	[0.237]
Observations	8,100	8,100	7,600	7,200	7,200	6,800
University Controls	✓	✓	✓	✓	✓	✓
Student Controls		✓	✓		✓	✓
Restricted Sample			✓			✓

Note: *p<0.1; **p<0.05; ***p<0.01. The number of observations is rounded to comply with privacy requirements. Employment indicates the percentage of time (expressed in months) the individual has been employment in the time period between bachelor's degree graduation and the given year. Earnings indicates the (logarithm of) annualized salary for primary job in the given year. The restricted sample includes only individuals graduated from universities from which at least 6 other students are observed at graduation. Sample: graduated between age 21 and age 25. Data comes from Integrated Postsecondary Education Data System (IPEDS) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Standard errors are clustered at the regional level. The number of observation is rounded to comply with privacy requirements.

Table A.6
Impact of Student Debt on Completion if Enrolled.

	Completion 2012 if Enrolled 2009		Completion 2018 if Enrolled 2012	
	(2)	(3)	(5)	(6)
$\widehat{\text{Debt}_{j,t}}$	0.169	0.218	-0.136	-0.11
	[0.079]	[0.43]	[0.135]	[0.169]
	0.093	0.229	-0.048	-0.037
	[0.512]	[1.164]	[0.068]	[0.07]
Observations	2,600	2,500	3,500	3,300
University Controls	✓	✓	✓	✓
Student Controls	✓	✓	✓	✓
Restricted Sample		✓		✓

Note: *p<0.1; **p<0.05; ***p<0.01. The number of observations is rounded to comply with privacy requirements. The dependent variable is the indicator for having completed a graduate degree in 2012 (columns 1 to 2) or in 2018 (columns 3 to 4). (2). Sample is constituted of students graduated between age 21 and age 25, that have been enrolled in a graduate program in 2009 (columns 1 to 2) or in 2012 (columns 3 to 4). Data comes from Integrated Postsecondary Education Data System (IPEDS) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Standard errors are clustered at the institution level. The number of observation is rounded to comply with privacy requirements.

Table A.7
Labor Market Outcomes for Stayers.

	2009	2018
Earnings		
2SLS	0.486***	-0.424***
	[0.137]	[0.141]
Enrollment		
IV Probit	-0.192***	-0.145***
	[0.035]	[0.053]
	-0.1***	-0.056*
	[0.047]	[0.032]
Home-ownership		
IV Probit	-	-0.019
	-	[0.092]
	-	-0.006
	-	[0.031]
University Controls	✓	✓
Student Controls	✓	✓
Restricted Sample	✓	✓
Observations	5,950	4,700

Note: *p<0.1; **p<0.05; ***p<0.01. The number of observations is rounded to comply with privacy requirements. Sample is restricted to individuals who reported no change in the state of residence between the last year of undergraduate enrollment and, respectively, 2009 and 2018.

Table A.8
Enrollment into Post-Bachelor Degrees Across Institutions of Origin.

		(1)			(2)		
		2009	2012	2018	2009	2012	2018
Non-Research Institutions							
	IV Probit	-0.15**	-0.118*	-0.126*	-0.18***	-0.15***	-0.141**
		[0.058]	[0.069]	[0.067]	[0.041]	[0.052]	[0.057]
		-0.058*	-0.048	-0.044	-0.081**	-0.07*	-0.054*
		[0.034]	[0.036]	[0.032]	[0.037]	[0.039]	[0.032]
	Observations	3,760	3,560	3,860	3,760	3,560	3,860
Research Institutions							
	IV Probit	-0.151***	-0.163***	-0.17***	-0.171***	-0.181***	-0.177***
		[0.078]	[0.074]	[0.056]	[0.052]	[0.047]	[0.042]
		-0.063	-0.076	-0.079	-0.081*	-0.098*	-0.088*
		[0.053]	[0.063]	[0.056]	[0.049]	[0.059]	[0.051]
University Controls		✓	✓	✓			
Student Controls		✓	✓	✓			
University Controls (small)					✓	✓	✓
Student Controls (small)					✓	✓	✓
Restricted Sample		✓	✓	✓	✓	✓	✓

Note: *p<0.1; **p<0.05; ***p<0.01. The number of observations is rounded to comply with privacy requirements. Standard errors in brackets. Classification based on Carnegie Code (2000) for 2007-2008 institution of enrollment. *Research Institutions* include Doctoral / Research Universities (R1, R2, and D/PU universities). All others are categorized under *Non-Research Institutions*. The *small* set of controls excludes institution selectivity, and undergraduate major. Controls common to both specifications include: sector (public vs private, non-profit vs for-profit, 4-year vs 2-year), region, financial need, high school and undergaduate grade-point average, in-state attendance, gender and race dummies, and whether the student had financial independence.

Table A.9
Impact of Student Debt on House Values (B&B:2008/18).

	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Home Value						
2012	0.010***	0.007***	-0.007***	0.445	0.095	0.085
	[0.002]	[0.003]	[0.002]	[4.63]	[0.284]	[0.200]
2018	-0.01***	-0.006**	-0.006**	-0.234	-0.181	-0.172
	[0.002]	[0.002]	[0.002]	[0.231]	[0.149]	[0.131]
Observations						
2012	2,300	2,300	2,100	2,300	2,300	2,200
2018	8,100	8,100	7,600	7,200	4,400	4,100
University Controls	✓	✓	✓	✓	✓	✓
Student Controls		✓	✓		✓	✓
Restricted Sample			✓			✓

Note: *p<0.1; **p<0.05; ***p<0.01. The number of observations is rounded to comply with privacy requirements. House Value indicates the (logarithm of) reported current value of the house owned, conditional on being an owner. The restricted sample includes only individuals graduated from universities from which at least 6 other students are observed at graduation. Sample: graduated between age 21 and age 25. Data comes from Integrated Postsecondary Education Data System (IPEDS) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Standard errors are clustered at the institution level. The number of observation is rounded to comply with privacy requirements.

Table A.10
The Education–Housing Tradeoff.

Panel A	Subsamples	
	No Post-Ba in t+10	Post-Ba in t+10
Home-owner in t+5	0.038	-0.013
Home-owner in t+10	0.009	-0.042
Panel B	**Subsamples**	
	Renter in t+10	Home-owner in t+10
Post-Ba in t+5	-0.495	-0.760
Post-Ba in t+10	-0.568	-0.727

Note: Panel A: all individuals who had not enrolled in a post-bachelor degree in the first 10 years after graduation from bachelor in the first column, vs. those who enrolled in a post-bachelor degree during the same period. Panel B: all individuals who have not entered home ownership in the first 10 years after graduation from bachelor in the first column, vs. those who did at any point before the tenth year.

Table A.11
Impact of Student Loans on Post-Bachelor Enrollment in $t+4$.

		ξ				
		−10%	−5%	baseline	+5%	+10%
	−10%	-0.275	-0.293	-0.333	-0.424	-0.468
	−5%	-0.283	-0.306	-0.332	-0.427	-0.467
$\bar{s}$	baseline	-0.289	-0.308	-0.370	-0.456	-0.469
	+5%	-0.294	-0.316	-0.373	-0.464	-0.470
	+10%	-0.291	-0.320	-0.426	-0.466	-0.471

Note: We report the Probit coefficient from the same regressions as in Table 9 in the paper. All regressions control for ability, initial liquid wealth and human capital.

Table A.12
Impact of Student Loans on Home ownership in $t+4$.

		ξ				
		−10%	−5%	baseline	+5%	+10%
	−10%	-0.013	-0.013	-0.015	-0.015	-0.016
	−5%	-0.015	-0.017	-0.016	-0.015	-0.021
$\bar{s}$	baseline	-0.017	-0.018	-0.017	-0.019	-0.021
	+5%	-0.018	-0.019	-0.020	-0.021	-0.022
	+10%	-0.021	-0.022	-0.025	-0.023	-0.026

Note: We report the Probit coefficient from the same regressions as in Table 9 in the paper. All regressions control for ability, initial liquid wealth and human capital.

Table A.13
Baseline Moments vs. Alternative Amenity Value ξ.

Moments	Source	
	Baseline	Alternative ξ
A. Earnings		
Earnings Profiles, ba holders	$[1.0, 1.373, 1.462, 1.488]$	$[1.0, 1.377, 1.467, 1.493]$
Earnings Profiles, post-ba holders	$[1.108, 1.634, 1.882, 1.941]$	$[1.221, 1.732, 1.908, 1.949]$
Standard Deviation of log-earnings	0.608	0.600
Skewness of log-earnings	−1.121	−1.165
B. Housing and Enrollment Profiles		
Home Ownership	$[49.5\%, 77.1\%, 86.5\%]$	$[49.6\%, 76.0\%, 85.5\%]$
Post-ba Enrollment	$[9\%, 28.4\%, 34.5\%]$	$[26.5\%, 28.1\%, 29.2\%]$
Average Home Price	\$245,079	\$245,108
Home Price Dispersion	\$124,671	\$124,758

Note: We divide life-cycle profiles into four age blocks: 22-32, 33-43, 44-54, and 55-64. Then the earnings profiles report the average of each block divided by the average of the 22-32 block for ba holders. The home ownership profiles report ownership rates for age blocks 33-43, 44-54, and 55-64. Post-ba enrollment rates are reported for ages 25, 30, and 35.

Table A.14
Sorting into Post-Bachelor Degrees.

Enrollment	Ability		
	Low	Medium	High
Post - Ba Degree Enrollment, Baseline			
No Debt	67.9%	62.8%	62.9%
Low Debt	19.2%	15.0%	18.5%
High Debt	3.0%	3.5%	4.2%
Post - Ba Degree Enrollment, Alternative Amenity Value			
No Debt	54.6%	52.4%	53.8%
Low Debt	13.4%	15.8%	16.2%
High Debt	4.0%	3.9%	4.6%
Post - Ba Degree Enrollment, IBR			
No Debt	48.0%	40.6%	35.7%
Low Debt	50.2%	43.4%	37.8%
High Debt	49.8%	42.3%	35.6%

Note: The Low (High) Debt group includes graduates with balances below (Above) the median level, conditional on positive debt balances.

Table A.15
The Impact of Student Debt.

Moments	Baseline	Counterfactual
Earnings		
$\partial y_{t+1}/\partial d_t$	0.226	0.229
$\partial y_{t+4}/\partial d_t$	0.075	−0.033
$\partial y_{t+10}/\partial d_t$	−0.111	−0.083
Graduate School Enrollment		
$\partial P(G)_{t+1}/\partial d_t$	−0.151	−0.230
$\partial P(G)_{t+4}/\partial d_t$	−0.497	−0.308
Home Ownership		
$\partial P(H)_{t+4}/\partial d_t$	−0.007	−0.005
$\partial P(H)_{t+10}/\partial d_t$	−0.281	−0.180

Note: Counterfactual model assumes every enrollee in post-bachelor program receives a transfer equivalent to the average monetary equivalent of ξ while in graduate school.

Table A.16
Homeownership and Enrollment Rates by Student Debt Level.

	No Debt	Low Debt	High Debt
Baseline			
Home Ownership	92.17%	82.81%	81.82%
Post-Ba Enrollment	64.64%	17.38%	3.65%
House Price Trend			
Home Ownership	84.23%	70.64%	67.77%
Post-Ba Enrollment	61.15%	15.98%	3.13%

Note: Enrollment rates represent cumulative enrollment by age 35; home ownership rates are measured at age 60. The "*low debt*" and "*high debt*" groups correspond to bachelor's graduates with positive debt balances below and above the median, respectively.

Table A.17
The Impact of Student Debt with/without a Housing Price Trend.

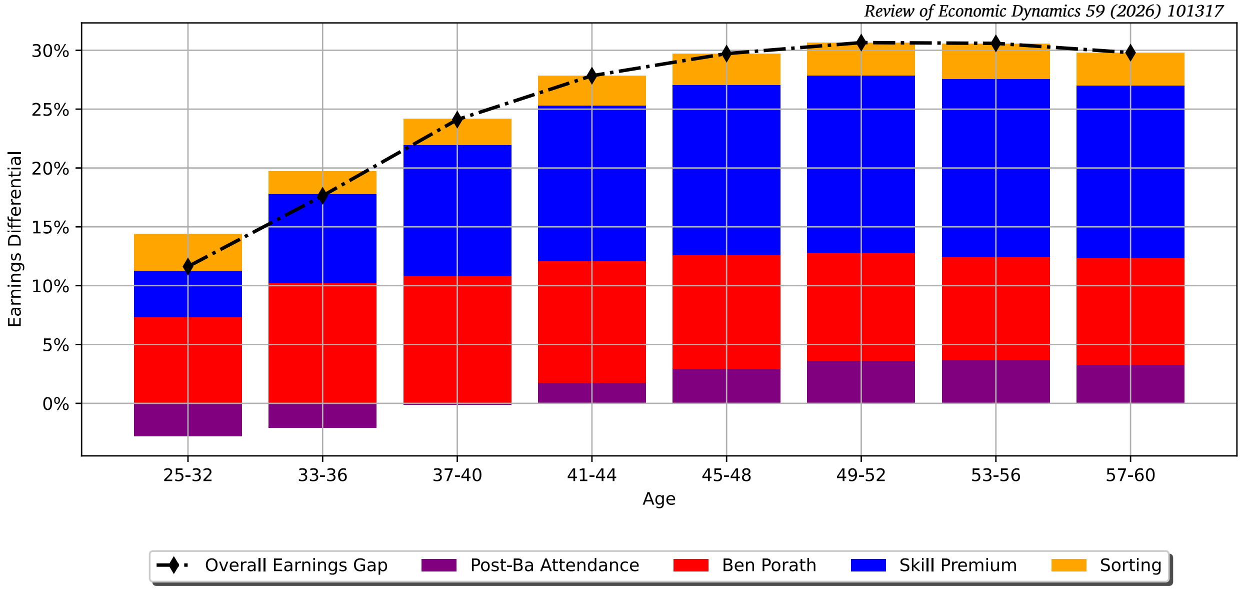
Moments	Baseline	Housing Price Trend
Earnings		
$\partial y_{t+1}/\partial d_t$	0.226	0.168
$\partial y_{t+4}/\partial d_t$	0.075	0.074
$\partial y_{t+10}/\partial d_t$	−0.111	−0.097
Graduate School Enrollment		
$\partial P(G)_{t+1}/\partial d_t$	−0.151	−0.333
$\partial P(G)_{t+4}/\partial d_t$	−0.497	−0.639
Home Ownership		
$\partial P(H)_{t+4}/\partial d_t$	−0.007	−0.014
$\partial P(H)_{t+10}/\partial d_t$	−0.281	−0.223

Note: For enrollment and home ownership, we report the Probit coefficient. The model regression controls for ability, liquid wealth, and human capital.

Table A.18
Baseline vs. IBR Repayment.

Moments	Source	
	IBR	Baseline
Home Ownership	[85.2%, 93.8%, 97.8%]	[49.5%, 77.1%, 86.5%]
Post-ba Enrollment	[14.4%, 28.2%, 42.4%]	[9%, 28.4%, 34.5%]
Average Wealth at Retirement	\$256,978	\$248,808

Note: The home ownership profiles report ownership rates for age blocks 33-43, 44-54, and 55-64. Post-ba enrollment rates are reported for ages 25, 30, and 35. Average wealth is the sum of home values (for home owners) and liquid asset holdings.



Note: The Post-Ba attendance share corresponds to the contribution of human capital accumulated via graduate school minus the losses due to career switching. The Ben-Porath share accounts for the differential patterns of learning for graduates with and without a post-ba degree. The skill premium share reports the influence of the wage premium v_G, and the sorting share is accounted by the different distribution of high-versus-low ability across ba and post-ba holders. Source: Model estimates.

Fig. A.5. Decomposition of Earnings Differential.

A.3. Decomposition of earnings gap

The model allows us to disentangle the components of the observed wage differential between workers with and without a post-bachelor degree. The parameter γ captures the human capital accumulation through post-bachelor degree attendance and proxies the acquisition of skills that occurs during the time spent in school; the parameter v_G represents the premium on the market price of those newly acquired skills, and it links to equation (3) by $v_G = R_G/R_B - 1$. The increase in human capital caused by graduate school attendance would increase average earnings at graduation by 38% on average, with heterogeneous returns depending on learning ability. Together with the ability parameters a and σ_a, and taking into account the sorting into post-bachelor degrees, we can decompose the overall wage differentials into the sorting, skill premium, and human capital components.

Fig. A.5 shows the decomposition of the graduate-bachelor gap, the wage differential between workers with only a bachelor's degree and workers with further education. In the decomposition, the skill premium is the most significant component of the earnings gap at all ages. One interpretation of such a hefty skill premium points to a relative scarcity of specialized workers in sectors where a graduate degree is a necessary condition to apply for jobs. In our model, the existence of front-loaded costs to career switch and financial frictions acts as an effective barrier against the equalization of the remuneration of human capital in the two segments of the labor market.

Because debt depresses enrollment in post-ba degrees, a positive value of $\rho_{a,d}$ reduces the degree of sorting in explaining the overall gap. The parameter $\rho_{a,d}$ is essential in linking our empirical results to the model. Since $\rho_{a,d} > 0$, we have a clear indication of the direction of the bias in OLS results: positive sorting (in ability or opportunities in the workplace other than continuing towards graduate studies) is biasing our OLS estimates in the empirical section.

Despite the value of γ implying a strong accumulation in human capital while enrolled, switching careers implies a destruction in current human capital stock that it takes some time to recover. Thus, post-ba attendance in itself accounts for a 5% difference in earnings on average between the two education groups even as they age. Because of heterogeneity in learning ability and age of entry, this value is the most variable component of the earnings gap. Finally, we show that the endogenous human capital accumulation component contributes significantly to the earnings gap. Several channels are at play. First, because of the skill premium, the Ben Porath trade-off between current income versus future human capital becomes steeper. When the substitution effect dominates the income effect, as in this case, the accumulation will be stronger. Second, attending a post-bachelor degree means the worker's net asset position will worsen, resulting in a slower desired rate of human capital accumulation via a classic wealth effect. However, individuals with stronger net asset position are significantly more likely to be post-ba degree holders, pushing the effect in the same direction. Third, workers with a post-bachelor degree enter home ownership later. The need to meet the down-payment constraint requires building a savings buffer that, in turn, calls for lower human capital accumulation after graduation. The total impact of these channels results in differential patterns of human capital accumulation explaining a little more than 15% of income differential.

Data availability

The data that has been used is confidential.

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