# Go Big or Buy a Home:

## The Impact of Student Debt on Career and Housing Choices*

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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 heterogeneous wealth 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.

*Keywords:* Wealth Heterogeneity, Human Capital, Housing, Education.

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# 1. Introduction

Education, career, and housing choices are intertwined, and young workers pick different bundles depending on the conditions under which they enter the labor market. We leverage an experiment involving the role of student loans in the United States to study the role of initial wealth levels in shaping education, career, and housing choices. Student debt has become a relevant factor for the financial decisions of young workers after college. 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 **Figure 1**. In that time, the median cumulative amount borrowed rose from $\$14,329$ to $\$29115$ (in 2020 US dollars).[1]

We provide evidence on the effect of student loans on labor market outcomes and two of the most critical post-graduation choices: career and housing. We look at how student debt affects graduates' employment, earnings, post-bachelor enrollment, and first-time home ownership at different time horizons. Using supply-side shifts in institution-level grant availability as an instrumental variable, we find that graduating with more debt causes a significant and persistent under-investment in human capital and education, lower earnings growth, but no significant delay in first-time home ownership. A 10 p.p. increase in student debt balances at graduation leads to a decrease of about 1 p.p. in the likelihood of holding a post-bachelor degree and a 5.3 p.p. decrease in annual earnings after ten years.

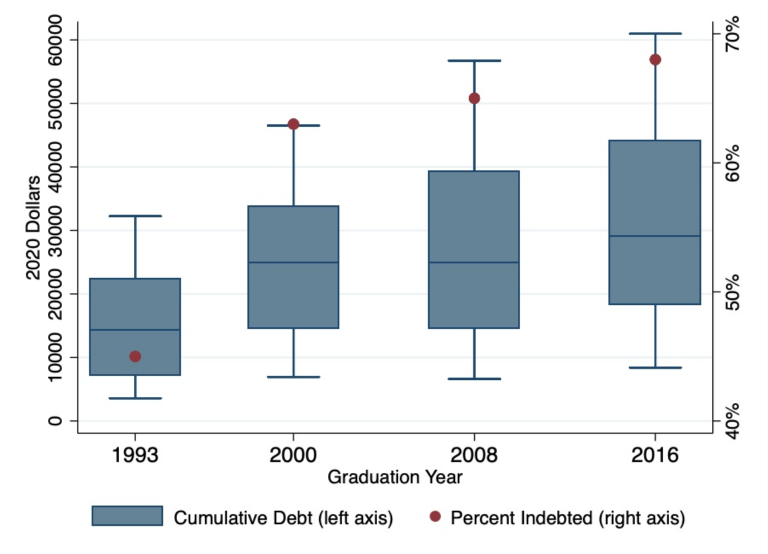
A reasonable strategy to interpret our reduced form estimates is to build and estimate a life cycle model that captures variation in the data as closely as possible. Thus, we introduce a Roy Model (Borjas, 1987) with housing and education choices and endogenous human capital accumulation in the spirit of Ben-Porath (1967). While student loans were introduced to increase university enrollment, our objective is to exploit their role as shifters in the net asset position in young graduates to understand the forces at play in early career decisions. We, therefore, abstract from college enrollment decisions and focus on the post-graduation outcomes of college graduates.[2]

The estimated model shows that while individuals deal with housing primarily as a long-term asset with monetary returns, educational investments beyond college are partly motivated by non-monetary considerations. We find a post-bachelor degree to be worth an

[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.

[2] Moreover, Ebrahimian (2022) shows that frictionless access to student loans would substantially increase consumption during college but only marginally affect the investment gap in college education. A relevant issue is the interaction of college dropouts with models of education financing, which we leave for future research.

**Figure 1:** Evolution of Student Debt (bachelor's degree graduates)




**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).

extra $\$3,929$ beyond its monetary return, with such valuation varying substantially across the income distribution. This finding is consistent with the emerging literature on compensating differentials (see Sorkin 2018, Taber and Vejlin 2020). Because of large and heterogeneous non-monetary returns, decisions on further education are more sensitive than housing decisions to initial wealth levels. Indebted students are thus more likely to give up on post-bachelor degrees.

Monetary returns of post-bachelor degrees are nonetheless relevant because they give access to careers that deliver higher pay. Controlling for ability and human capital, our model provides a wage premium of approximately $30\%$ for jobs accessible only through a post-bachelor degree. This way, distortions in career and education choices due to rising levels of student debt can amplify inequality and reduce social mobility.

The education decision helps in understanding the role of student debt on housing. Two groups of graduates are affected by high debt balances. The first group responds by giving up post-bachelor degrees and thus increasing early participation in labor markets. This group tends to enter home ownership relatively early. A second group that would have chosen not to pursue further education even without student debt is subject only to a negative wealth effect and thus demands less housing. The empirical result obtains from the two forces counterbalancing each other. Finally, we notice that part of returns from human capital investment depends on access to a long-term asset with good returns; absent housing, or when housing is more expensive, investment in human capital decreases.

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 pre-determined period. This design induces a high repayment burden right after graduation, especially for borrowers with lower earnings. We show that income-based repayment plans provide effective insurance but do not increase human capital accumulation, as adverse sorting and labor supply disincentives balance the reduced burden from debt repayment. .

# 2. Related Literature

This article contributes 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 variation in lifetime utility, the majority 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 career choices that rationalizes the significant impact of borrowing constraints on long-term labor market outcomes.

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) find that tuition subsidies increase college enrollment more than borrowing limits. Analyses of 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. In a related study, de Silva (2023) shows that the Australian income-based repayment system induces graduates to strategically reduce labor supply in order to save on repayments - despite its insurance value, which increases welfare, a contingent repayment scheme might depress output. We contribute to this literature by examining the effects of student loan repayment plans on graduate school enrollment, earnings, and home-ownership choices for college graduates.

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 in 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 don't 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.

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. (2020) 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 choice through graduate school attendance.

Cooper and Wang (2014), Gicheva and Thompson (2015), and Houle and Berger (2015) show that student debt reduces the likelihood of home ownership for young households. 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. Using a similar approach, 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 left school between 1997 and 2005. Differently from these analyses, we focus on the impact of student debt only for bachelor's degree recipients.[4]

[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 had no college degree.

# 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 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.

[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.

[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.

## 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. Mainly, this 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 imposing the above sample restrictions, the sample contains 9,000 and 8,000 graduates for the B&B:08/18 and B&B:16/17 surveys, respectively. Student characteristics and their distribution across colleges remain similar in both cohorts. However, the distribution of student debt shifted to the right: 72% (66%) of college graduates were indebted, with an average amount of student debt of $23,640 ($28,843) in 2008 and 2016, respectively.

For those that graduated in 2008 without any debt, their average annual earnings were $59,197 ten years after graduation. However, indebted graduates experienced about 15% lower earnings ten years after graduation. Graduate school attainment and home ownership increased substantially over the first ten years after college graduation, reaching 47% and 65% for non-indebted graduates, respectively. Indebted graduates were less likely to have a graduate degree ten years after graduation, but there were no significant differences in home ownership. 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

[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.

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 $\tau$ years after graduating from college j, $\alpha_j$ 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 ($\alpha_j$) 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 sector and the region where the institution is located[11].

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 financial aid eligibility where students put all their information. We include graduates' dependency status,[12] whether they enrolled in college in their state of residence, their financial need[13] 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).

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 $\beta$ is likely to be biased.

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

[12] 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.

[13] 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.

**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<br>[17,759] | | $ 28,843<br>[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<br>[8,470] | $ 8,432<br>[6,383] | $ 15,030<br>[15,499] | $ 11,081<br>[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<br>[10,717] | $ 15,966<br>[12,704] | $ 19,266<br>[18,998] | $ 20,814<br>[18,178] |
| Avg. GPA at graduation | 3.4<br>[0.5] | 3.3<br>[0.4] | 3.5<br>[0.4] | 3.3<br>[0.5] |
| **Post-college Outcomes** | | | | |
| Avg. Earnings (t+1) | $ 25,435<br>[22,887] | $ 25,389<br>[20,892] | $ 28,464<br>[23,915] | $ 27,863<br>[20,866] |
| Avg. Earnings (t+4) | $ 40,798<br>[31,011] | $ 39,006<br>[25,614] | | |
| Avg. Earnings (t+10) | $ 59,197<br>[69,918] | $ 51,060<br>[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 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).

### 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) 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, $Z_{j,t}$):[14]

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

One may still be concerned that $Z_{j,t}$ correlates with unobserved student characteristics, and these characteristics directly impact students' post-baccalaureate 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.[15] For this reason, we use as an instrument changes in grant-to-aid rather than its level.[16] 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:

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

**Figure A.2** shows how grant-to-aid captures the substitution between institutional grants

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

[15] 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.

[16] 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.

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. **Figure A.3** shows substantial variability in grant-to-aid from enrollment to graduation year for students that graduated in 2008.

We model the level of cumulative debt at graduation as an outcome of individual demand for debt and these supply-side changes in grants:

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

**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 | | | ✓ | | | ✓ |

*p<0.1;**p<0.05;***p<0.01

Note: 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.

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 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 for the instrument, which is at the institution level, to be contaminated by individual characteristics for institutions with too few observations. The cutoff at 6 students removes between $5\%$ and $10\%$ of observations, and results are not sensitive to changes around that threshold. We will then adopt the restricted sample specification as our preferred one. For 2008 graduates, on average, a ten percentage points increase in grant to aid while enrolled correlates with a corresponding $22.4\%$ decrease in cumulative student debt at graduation. Alternatively, an increase of 10 percentage points in grant-to-aid while enrolled in college implies a $1.8\%$ increase in the probability of holding any student debt.

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 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. Consistent with previous empirical studies, our results show that increasing student debt at graduation increases annual earnings in the first years after graduation. However, the positive effect on earnings disappears four years after graduation and reverts to negative ten years later. On average, an increase in student debt by $10\%$ at graduation in 2008 led to a decrease in annual earnings of $5,34\%$ in 2018.

**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 |

*p<0.1;**p<0.05;***p<0.01

Balanced repeated replication Delta-method standard errors in brackets.

Note: 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.

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. Most notably, 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 after obtaining the bachelor's degree. Career decisions, which have 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 determine them via endogenous investments in human capital.

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 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.

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.7 displays the effect on home value conditional on entering home ownership, which is also not significantly different from zero. 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 career choices or investment in education are in some significant part non-monetary, then choices can be more sensitive to initial levels of wealth (see Boar and Lashkari 2021). A complementary hypothesis is that, if some individuals

**Table 4:** Graduate School versus Home-ownership

| **Home-ownership** | Graduate School | | |
|---|---|---|---|
| 2018 | Enrolled 2012 | Completed 2012 | Completed 2018 |
| Yes | 60.6% | 62.5% | 59.0% |
| No | 65.2% | 63.4% | 66.6% |
| N | 7,700 | 8,200 | 8,200 |

| **Enrollment** | Home-ownership | |
|---|---|---|
| 2018 | Mortgage in 2012 | Home-owner in 2018 |
| Yes | 23.0% | 20.3% |
| No | 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-ba program at the moment of the survey, while "Completed 2012" indicates that the individual has earned their degree by the moment of the survey.

that give up graduate school because of student debt, they might be induced to enter home-ownership relatively earlier, due to a combination of lower debt balances and higher savings induced by working instead of being in school. For this to be the case, we postulate the existence of sub-populations whose choice to go to graduate school is more affected by wealth. To the extent that graduate school attendance is in part motivated by idiosyncratic and unobservable preferences, we consider the hypothesis that individuals with lower learning ability might be less likely to consider graduate school attendance whatever their personal situation is, and thus potentially less impacted by their wealth levels when choosing 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 include all the students who graduated within 4 years in the high ability group, and populate the low ability group with students who graduated in five years or more.[17] **Table 5** presents the results. 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

[17] 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) | (4) | (5) | (6) |
| **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 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

*p<0.1;**p<0.05;***p<0.01

Note: Probit and IVProbit regressions report the parameter estimates, together with average marginal effects in the line below. Ability groups are defined in the following ways. 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.

the same time, the housing response changes 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.

# 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 (c) and housing services (s):

$$u(c,s) = \frac{c^{1-\sigma}}{1-\sigma} + \frac{s^{1-\sigma}}{1-\sigma} \quad , \qquad c \geq 0 \tag{1}$$

**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:

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

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 $\gamma$, and workers pay tuition ($p_g$). Their human capital in graduate school thus grows by:

$$h_{t+1} = ae^{z_{t+1}}(1+\gamma)h_t, \quad z_{t+1} \sim N(\mu_z, \sigma_z^2) \tag{3}$$

While enrolled, individuals consume using a combination of their liquid savings (k) and graduate student loans ($d_g$). Attending graduate school yields utility $\xi$. In expectation, students with higher ability $a$ accumulate more human capital during a post-bachelor degree: this captures also the fact that individuals with better abilities might be able to access better programs. Heterogeneity in the on-the-job learning ability $a$ is useful not only to match the data. Sorting matters because it determines a different distributional impact on private life choices and, more generally, because the higher returns associated with an investment in higher education have obvious benefits for the rest of the economy - see Goldin and Katz (2009).

While graduates can switch careers at any point, they would lose part of their human capital, reverting to their human capital stock at labor market entry if they do. 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.[18]

**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 ($R_j$):

$$w_{j,t}(l_t, h_t) = R_j l_t h_t \; , \tag{4}$$

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 experience career-specific unemployment risk: they separate from their job with probability $p_j$; 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. The above formulation implies that switching to the career path that follows graduate school has three contrasting effects on human capital investment decisions. First, investments are riskier since earnings in the steeper career path load more on human capital. Second, the higher marginal product of the existing stock of human capital gives weaker incentives for a graduate school-educated worker to invest in human capital because of a simple wealth effect. Third, $R_G > R_B$ induces a strong substitution effect in that every unit of consumption today that is foregone to invest in human capital generates higher returns in the future. Structural estimates of the human capital premium $v_G = R_G/R_B - 1$ will inform on whether differences in earnings across career paths are amplified or dampened by endogenous human capital investment.

[18] 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

**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 ($\phi$) that depends on their current income. 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:

$$P_d = \frac{d_0}{\frac{(1+r_d)^{10}-1}{r_d(1+r_d)^{10}}}, \tag{5}$$

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 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:

$$P(H) = p_0 H^{-\kappa} \tag{6}$$

The parameter $\kappa$ 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 (6) 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 a function of the average price of a housing unit, $\bar{P}_0$, and matches a given price-to-rent ratio. Individuals can ask for a 30-year fixed mortgage to pay the house price ($P_o$).

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

$$P_m(H) = \frac{(1-\lambda)P_0(H)}{\frac{(1+r_m)^{30}-1}{r_d(1+r_m)^{30}}} \tag{7}$$

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, $\tau$, 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:

$$\begin{aligned} &V_{r,t}(a, w, k) = \max_{k'} u(c, s) + \beta V_{r,t+1}(a, w, k') \\ &c + k' + P_r = (1 + r) \cdot k + pw \\ &m_T = 0, k_T = 0,\ k' \geq \phi(pw),\ c \geq 0, \end{aligned} \tag{8}$$

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

$$\begin{aligned} V_{H,t}(a, w, k, m) &= \max_{k'} u(c, s) + \beta V_{H,t+1}(a, w, k', m') \\ c + k' + P_m(H) &= (1 + r) \cdot k + pw \\ m' &= (1 + r_d)m - P_m(H) \geq 0 \\ k_T &= 0,\ k' \geq \phi(pw),\ c \geq 0 \end{aligned} \tag{9}$$

### 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 ($\mathcal{H} = \{r, H\}$). 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, unemployment, and preference shocks in $e = \{z, u, \epsilon\}$, 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:

$$
\begin{aligned}
V^B_{r,t}(x,e) = \max_{k',l} & \left\{ u(c,s) + \sigma\epsilon_{B,r} + \beta \mathbb{E}[\tilde{V}^B_{r,t+1}(x',e')] \right\} \\
& c + k' + (P_r + P_d) = (1+r)\cdot k + w_B(l,h) \\
& h' = e^{z'}(h + a((1-l)h)^{\alpha}) \\
& d' = (1+r_d)d - P_d \geq 0 \\
& k' \geq \phi,\ c \geq 0 \text{ , where:}
\end{aligned}
\tag{10}
$$

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

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:

$$
\begin{aligned}
V^B_{H,t}(x,e) = & \max_{k',l} \left\{ u(c,s) + \beta \mathbb{E}[\tilde{V}^B_{H,t+1}(x',e')] \right\} \\
c + k' + & (P_m(H) + P_d) = (1+r)\cdot k + w_B(l,h) \\
h' = & e^{z'}(h + a((1-l)h)^{\alpha}) \\
d' = & (1+r_d)d - P_d \geq 0 \\
m'(H) = & (1+r_m)\, m(H) - P_m(H) \\
k' \geq & \phi, \text{ and } c \geq 0, \text{ , where:}
\end{aligned}
\tag{11}
$$

$$
P_m(H) = \begin{cases} \lambda P_0(H), & \text{at origination} \\ \frac{r_d(1+r_m)^{30}(1-\lambda)P_h(H)}{(1+r_m)^{30}-1} & \text{after origination} \end{cases}
$$

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

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 (7). 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:

$$
\begin{aligned}
V^G_{r,t}(x, e, g) = & \max_{k'} \left\{ u(c, s) + \xi + \beta \mathbb{E}[V^G_{r,t+1}(x', e', g')] \right\} \\
c + k' + & P_r + p_g = (1 + r) \cdot k + d_g \\
h' = & (1 + g) \cdot h \\
d' = & (1 + r_d) \cdot d + d_g \cdot \mathbf{1}_{s=1} \\
k' \geq & 0, \ c \geq 0
\end{aligned}
\tag{12}
$$

We assume that, during graduate school, the borrowing constraint with liquid assets is tighter - since the individual is not working she has to keep her liquid assets positive. After graduating, the recursive problem is identical to Equation (10) 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 $1 - p_G$.

## 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 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 (when student loan payments must not be made). 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. The yearly discount factor equals $0.96$. We set the constant relative risk aversion in the utility function to $2$. 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 is set to $5.5\%$ and $4.5\%$ for post-bachelor degree holders, matching the average number of employment to unemployment transition of the two groups (see Menzio et al. 2016). 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.

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. 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. We set the rental rate to a yearly rate of $5\%$ of the house price. The parameters that determine the loan-to-value (LTV) and DTI are chosen to match institutional features of the US mortgage market. For the LTV parameter, we fix a downpayment ratio of $0.2$, impliying 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)[19], with an average transfer of $\$16,344$ ($\mu_k$) and a standard deviation of $\$17,455$ ($\sigma_k$).

**Table 6:** External Parameters

| | Parameter | Value | Description | Source |
|---|---|---|---|---|
| **Preferences** | | | | |
| | T | 126 | Periods | - |
| | R | 88 | Working Periods | - |
| | $\beta$ | 0.985 | Discount Factor (Yearly) | - |
| | $\sigma$ | 2 | Risk Aversion | - |
| **Career** | | | | |
| | $p_g$ | \$ 50,000 | Cost of Graduate School | IPEDS |
| | $S$ | 4 | Graduate School Periods | NCES |
| | $p$ | 0.83 | Income in retirement (Replacement Rate) | Biggs and Springstead (2008) |
| | $p$ | $\{5.5\%, 4.5\%\}$ | Separation Probability | Menzio et al. (2016) |
| | b | \$991 | Home Production | Federal poverty threshold (2008) |
| **Financial Markets** | | | | |
| | $\phi$ | $-$\$ 5,000 | Credit Card Limit | 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** | | | | |
| | $\lambda$ | 0.2 | Downpayment | Greenwald (2018) |
| | $P_r/\bar{P}_0$ | 0.05 | Price-to-rent | Case-Shiller index (2008-2012) |
| | $\tau$ | $10\%$ | Housing Transaction Cost | Global Property Guide |
| | $\gamma$ | $2^{-1}$ | Housing Supply Elasticity | Saiz (2010) (average, big+small) |
| **Policy** | | | | |
| | $r_{ibr}$ | $10\%$ | Repayment Rate for IBR | Consumer Financial Protection Bureau |

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 $\$23,640$ ($\mu_d$) and a standard deviation of $17,759$ ($\sigma_d$). We then calibrate the initial human capital to match the initial post-graduation earnings of bachelor degree holders.

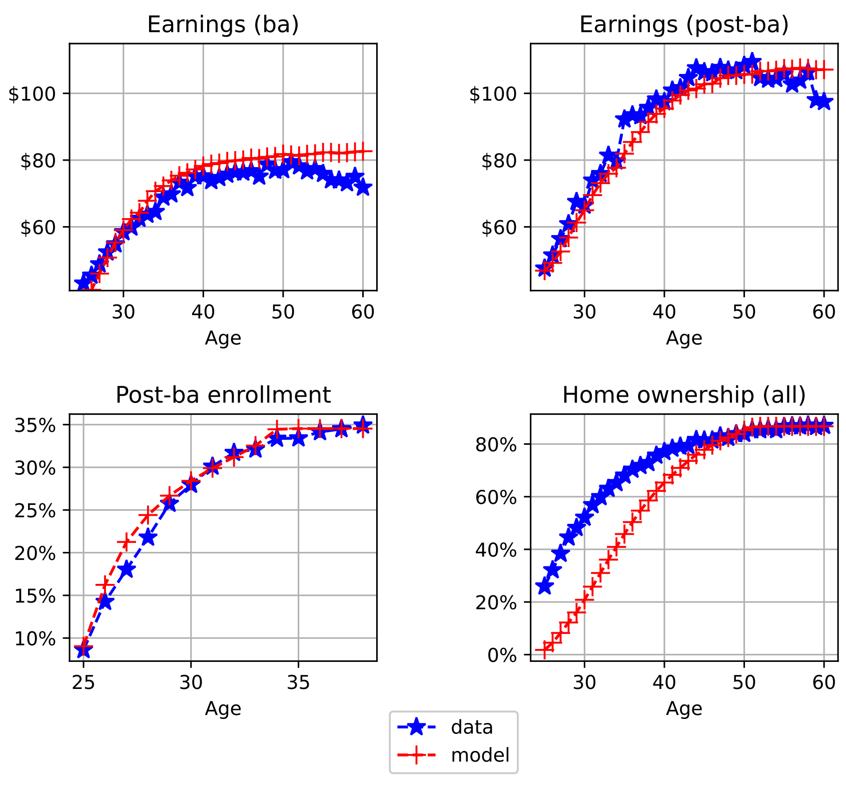
[19] The EFC is calculated according to a formula established by law that considers the student's family's income, assets, and benefits (such as unemployment or Social Security).

Finally, we must determine the correlation between ability and student debt ($\rho_{k,d}$), and between ability and initial assets ($\rho_{k,a}$). These parameter 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.

#### 4.3.4. **Model Fit and Discussion**

**Figure 2** compares the model-generated life cycle profiles for earnings, enrollment in post-ba 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.

**Figure 2:** Life Cycle Model (model and data).




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

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 that 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 $\$14,944$, 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 value of housing service $s$, 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 $\nu_G$. 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 $\alpha$ are crucial drivers of its production technology. In particular $\alpha$ 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-ba holders earnings over the life cycle relative to ba-holders.[20] In addition, the skewness of earnings helps discipline the riskiness of the human capital accumulation process, $\sigma_z$: as it grows, more workers are stuck in a low-accumulation state, skewing the earnings distribution.

**Table 7:** Target Moments

| Moments | Source | |
|---|---|---|
| | Data | Model |
| A. Earnings | | |
| Earnings Profiles, ba holders | $[1.0, 1.323, 1.416, 1.383]$ | $[1.0, 1.373, 1.462, 1.488]$ |
| Earnings Profiles, post-ba 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-ba 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-ba enrollment rates are reported for ages 25, 30, and 35.

The amenity value of post-bachelor degrees is primarily identified by age-specific

[20] Our calibration of $\alpha$ 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 modelled in the context of multiple sources of leverage affecting the marginal cost of such investment.

enrollment levels, with the early enrollment numbers driven by the human capital boost from attending a post-bachelor degree, $\gamma$: a higher value decreases the penalty from attending late, keeping everything else constant, because it allows graduates to recover part of the human capital level lost in the career switch.

**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** | | |
| $\xi$ | Lifetime amenity value, post-ba | 8.795 | $\$3,929^{*}$ |
| $\gamma$ | Human Capital from post-ba | 1.335 | $38\%$ increase in $h$ |
| $\nu_G$ | Skill Premium | 0.299 | $R_G = 1.299 \cdot R_B$ |
| | **Housing Parameters** | | |
| $s$ | Housing Service | 4.666 | $\$1,155^{*}$ |
| $P_0$ | House Price | 8.902 | $\$1,021$ monthly rent |
| | **Ben Porath Parameters** | | |
| $\alpha$ | Production Elasticity | 0.278 | - |
| $a$ | Ability | 0.347 | - |
| $\sigma_a$ | Ability Dispersion | 0.040 | - |
| $\sigma_z$ | 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.

## 4.4. The Impact of Student Debt: Model and Data

Empirical evidence in **Section 3.5** highlighted the impact of student debt on earnings and career choices, 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 $90\%$ confidence interval of empirical estimates.

Quantitatively, results on discrete choices are 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

**Table 9:** The Impact of Student Debt

| Moments | Data | Model |
|---|---|---|
| **Earnings** | | |
| $\partial y_{t+1}/\partial d_t$ | $0.348$ | $0.226$ |
| | $[0.149, 0.547]$ | |
| $\partial y_{t+4}/\partial d_t$ | $0.358$ | $0.075$ |
| | $[0.09, 0.626]$ | |
| $\partial y_{t+10}/\partial d_t$ | $-0.534$ | $-0.111$ |
| | $[-0.144, -0.923]$ | |
| **Graduate School Enrollment** | | |
| $\partial P(G)_{t+1}/\partial d_t$ | $-0.18$ | $-0.151$ |
| | $[-0.114, -0.246]$ | |
| $\partial P(G)_{t+4}/\partial d_t$ | $-0.169$ | $-0.497$ |
| | $[-0.096, -0.241]$ | |
| **Home Ownership** | | |
| $\partial P(H)_{t+4}/\partial d_t$ | $0.044$ | $-0.007$ |
| | $[-0.106, 0.194]$ | |
| $\partial P(H)_{t+10}/\partial d_t$ | $-0.06$ | $-0.281$ |
| | $[-0.21, 0.083]$ | |

Note: Empirical results are from **Table 3** from Section 2. For enrollment and home ownership, we report the Probit coefficient. The $90\%$ confidence interval is reported between square brackets. The model regression controls for ability, liquid wealth, and human capital.

choice more sensitive to disposable income. Even assuming severe financial frictions, it can be surprising that net wealth can play such a dramatic role in shaping career decisions. However, part of what drives career 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, $\xi$. A prominent role of $\xi$ 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 initial career 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.

The second consideration regarding career choice 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 $\sigma_z$ 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.

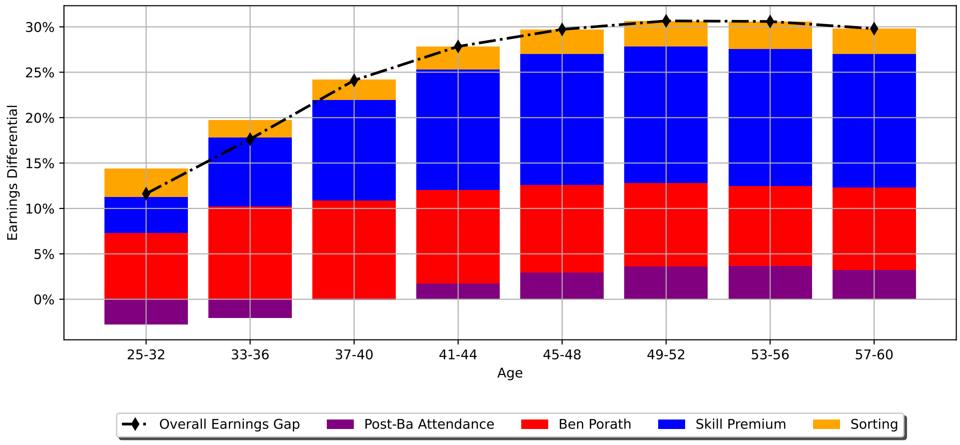
## 4.5. The Value of Post-Bachelor Degrees

The model allows us to disentangle the components of the observed wage differential between workers with and without a post-bachelor degree. The parameter $\gamma$ 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 $\nu_G$ represents the premium on the market price of those newly acquired skills, and it links to equation 4 by $\nu_G = R_G/R_B - 1$. 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 $\sigma_a$, 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.

**Figure 3** 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.

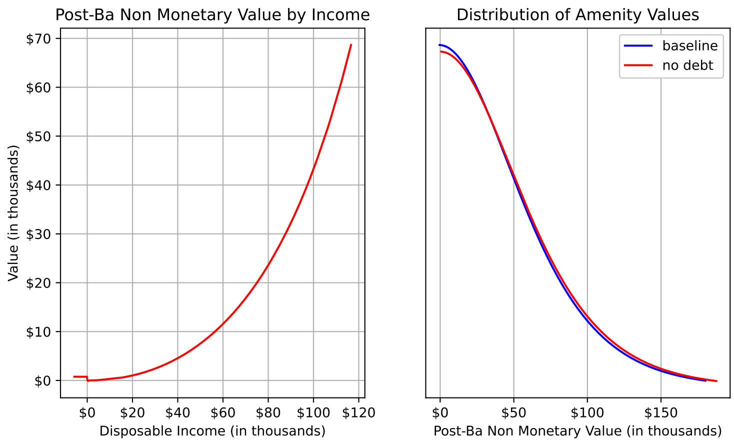
**Figure 3:** Decomposition of Earnings Differential.




**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.

Despite the value of $\gamma$ 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.

**Figure 4:** Non Monetary Value of Post Ba Enrollment.




**Note:** Monetary equivalent value for $\xi$ across renters of age 25. Source: Model estimates.

The left panel in **Figure 4** shows the heterogeneity in graduate school attendance valuations, an exercise in the spirit of Athreya et al. (2019).[21] Differences in the consumption–equivalent amount of $\xi$ 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 in the right panel of **Figure 4** will consider the switch in career choice 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. 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. Our model shows that non-monetary returns and the present value of monetary returns are positively correlated. As they give up graduate school, indebted

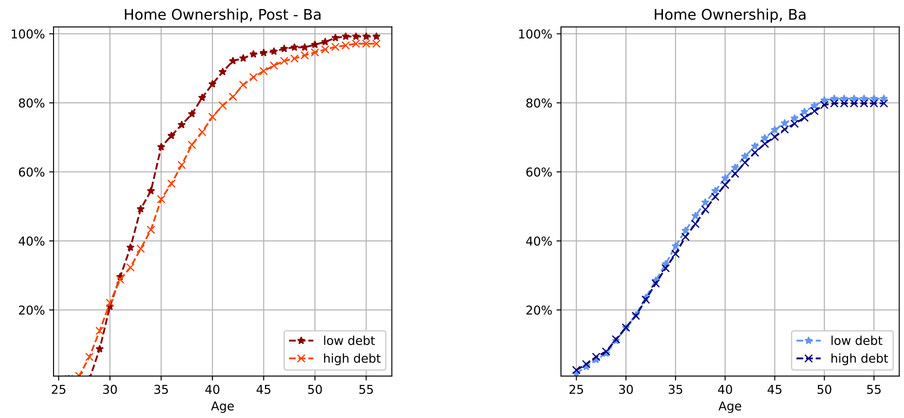
[21] To compute the amenity value of graduate school in dollar terms, we use $\xi$ and then calculate the amount of consumption increase that would yield equivalent flow utility to grad school attendance and the value of the human capital-intensive career graduate school gives access to. Similarly, we compute the value of housing service 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.

graduates are financially worse off in present value terms while front-loading their earnings profile.

## 4.6. The Role of Housing

While the earnings and career outcomes seem intuitive in isolation, understanding why entry into home ownership is barely affected by student debt in the early post-graduation years can require more structured reasoning. A pronounced wealth effect is at work, *ceteris paribus* lowering the ability of young graduates to meet the downpayment constraint. **Figure 5** helps clarify the forces at play. As the two panels show, more indebted graduates postpone home ownership, conditional on education choices. However, post-ba degree holders enter later into home ownership, highlighting the second channel; skill investment postpones home ownership - and since student debt primarily depresses investment in human capital, this channel increases demand for housing.[22]

**Figure 5:** Home ownership Profiles by Education.



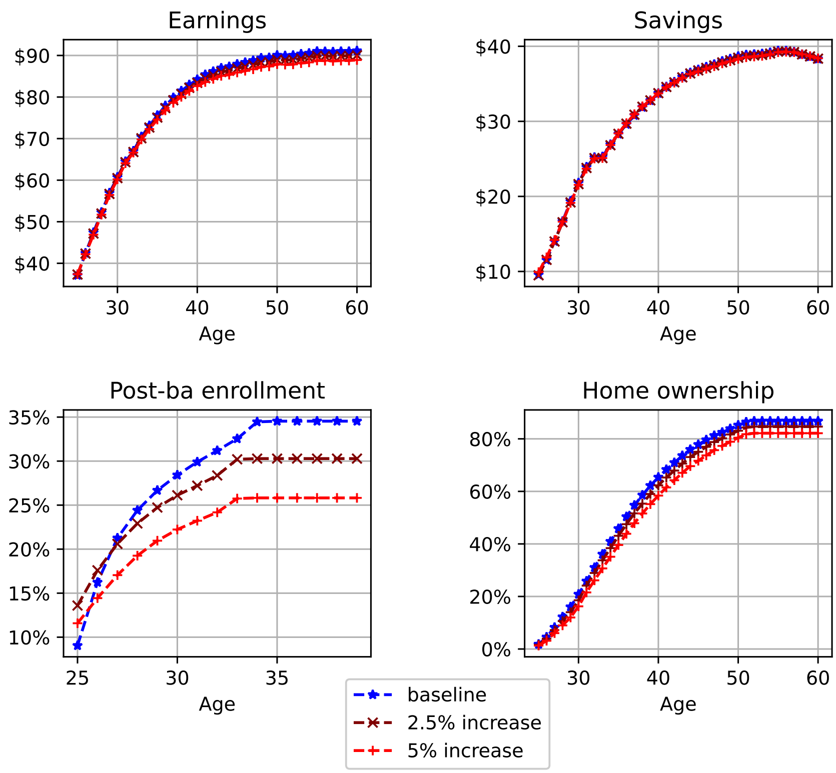

**Note:** The Low (High) Debt group includes graduates with balances below (above) the median level.

Having established that career choices can shape the life cycle profile of home ownership, we now study the role of housing in shaping graduates' income and enrollment profiles. **Figure 6** 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

[22] The second channel is less prominent in the analysis of Mezza et al. (2020), who consider not only undergraduate loans but take total loan amounts. By lumping together bachelor and post-ba borrowing, they account for the wealth effects for two different pools of workers: those who enrolled in post-bachelor degrees and those who have not (yet). In our empirical analysis and according to our model, the two effects cancel out, at least in the medium horizon.

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.

**Figure 6:** Impact of Increased House Prices




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

As highlighted from the discussion of **Figure 3**, 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.

These exercises represent a strong case for viewing career and wealth decisions jointly. Absent a long term asset to invest additional income in, returns to further education would be biased downwards. At the same time, fluctuations in home prices drive wealth effect that affect many investment margins at the household level, not last the choice of education. On the other hand, career choices interact with entry into home ownership, determining its timing and hence its expected returns.

## 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.[23] 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 $\tau$ 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:

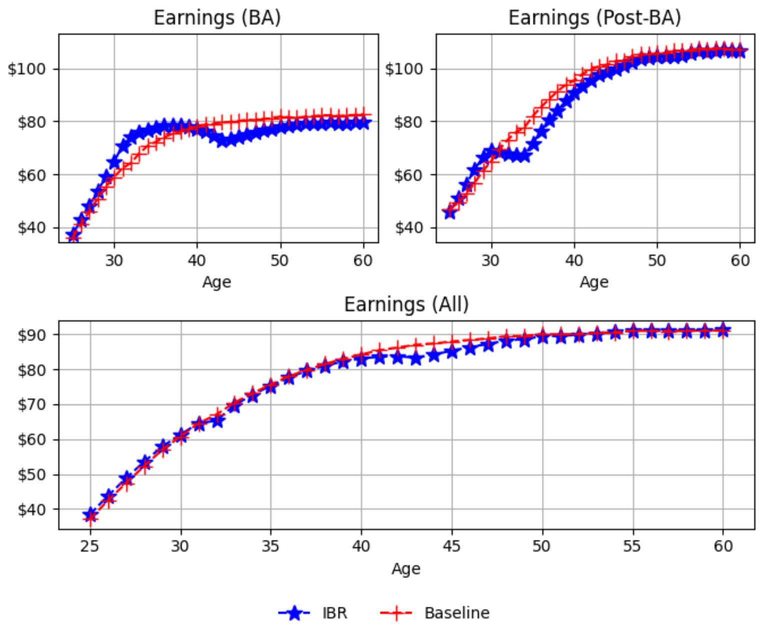
$$P_d^{PAYE} = \min\{\tau_{IBR} * (w(l,h) - \underline{y}), P_d) \tag{13}$$

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.

[23] 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)

**Figure 7** and **Table 10** 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 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. At the same time, overall earnings do not grow much, in part because of lower human capital accumulation via the Ben-Porath channel, consistently with the labor supply disincentives of proportional repayment schemes discussed by de Silva (2023). Notice, however, that the impact on welfare is still largely positive, given the existence of non-monetary returns from both home ownership and post-bachelor enrollment.

**Figure 7:** Baseline vs. IBR Repayment.




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

**Table 11** expands the analysis of graduate school enrollment under the income-based repayment plan (IBR). We find that enrollment under IBR rises and is less affected by debt balances – at the same time, IBR dampens sorting because low-ability individuals who are more likely to benefit from the built-in forgiveness provision enroll in post-ba more than proportionally in the new scenario. This is particularly true for graduates with higher debt balances from undergraduate, who are adversely sorted under IBR. This contributes to the

**Table 10:** 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.

moderate increase in labor earnings shown in **Figure 7**, as now the graduates of post-bachelor programs are even more likely to be of lower ability.

**Table 11:** Sorting into Post-Bachelor Degrees

| Enrollment | Ability | | |
|---|---|---|---|
| | Low | Medium | High |
| Post - Ba Degree Enrollment, Baseline | | | |
| Low Debt | 55.8% | 55.9% | 53.4% |
| High Debt | 4.2% | 7.3% | 7.9% |
| Post - Ba Degree Enrollment, IBR | | | |
| Low Debt | 48.6% | 40.4% | 55.8% |
| High Debt | 49.8% | 43.3% | 36.4% |

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

Even if the program did not achieve full participation of graduates, the growth in IBR enrollment can be credited with moderating the impact of the significant increase in undergraduate debt balances that occurred between 2008 and 2016. However, it contributed to the aggregate statistics showing an acceleration of the growth in debt balances. Our model allows only for a partial equilibrium analysis of the proposed policies, and most missing channels would reduce their effectiveness or include elements in the analysis suffering welfare losses. The program is not guaranteed to be budget neutral, and might in fact end up subsidizing lower earners, with the impact on career choices highlighted in **Table 11**. Considerations on the fiscal implications of different repayment plans, however, go beyond the scope of the present paper.

# 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 polarisation across multiple dimensions: economic returns, amenities, and taking location considerations.

APPENDIX

# 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:

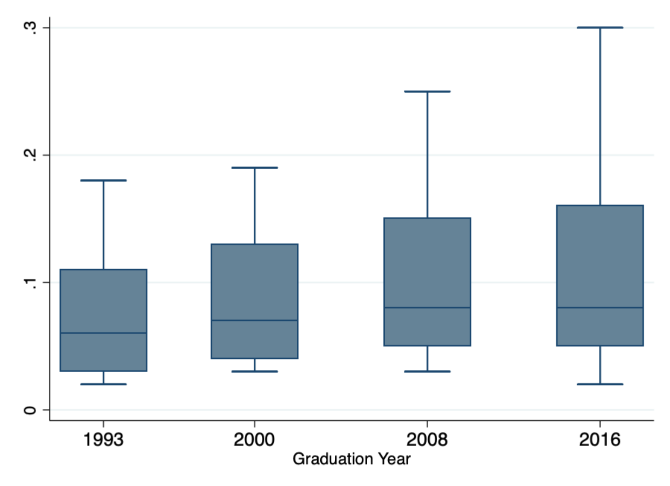
We drop colleges with any missing values. We construct $Z_{j,t}$ as follows:

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

$$Z_{j,t} = \frac{pgrant_{j,t} \cdot grant_{j,t}}{aid_{j,t}}$$

## A.2. **Additional Figures and Tables**

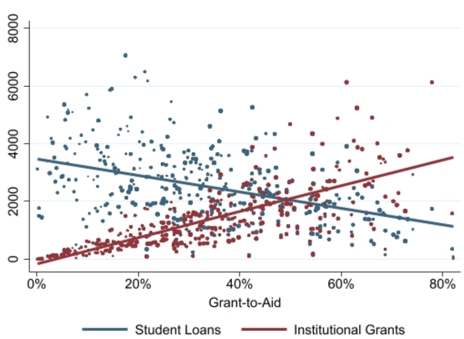
**Figure A.1:** Monthly Student Debt Repayment



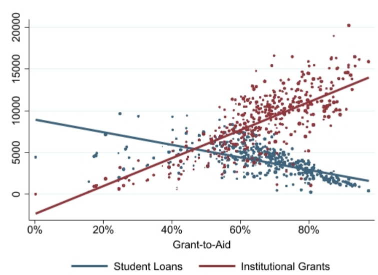

Source: Baccalaureate and Beyond Longitudinal Study (B&B:93/94, B&B:2000/01, B&B:2007/08, B&B:2015/16).

**Figure A.2:** Institutional Grants and Student Loans (2007/08)

**(a)** Public Colleges



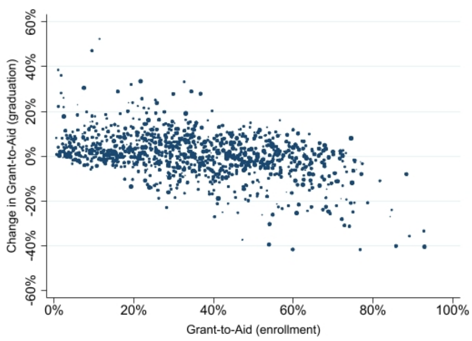

**(b)** Private non-profit Colleges



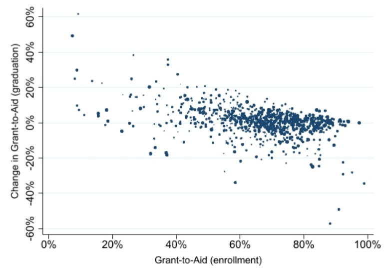

Source: Integrated Postsecondary Education Data System (IPEDS 2007/08) and Baccalaureate and Beyond Longitudinal Study (B&B:2008/18). Blue dots are average student loan balances, red dots are average institutional grant amounts, both at the college level.

**Figure A.3:** Change in Grant-to-aid

**(a)** Public Colleges




**(b)** Private non-profit Colleges




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.

**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 |

*p<0.1;**p<0.05;***p<0.01

Balanced repeated replication Delta-method standard errors in brackets.

Note: 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 | | ✓ |

*p<0.1;**p<0.05;***p<0.01

Balanced repeated replication Delta-method standard errors in brackets.

Note: 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). Sample is constituted 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 | | | ✓ | | | ✓ |

*p<0.1;**p<0.05;***p<0.01

Note: 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 | | | ✓ | | | ✓ |

*p<0.1;**p<0.05;***p<0.01

Note: 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 | | | ✓ | | | ✓ |

*p<0.1;**p<0.05;***p<0.01

Note: 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 | | ✓ | | ✓ |

*p<0.1;**p<0.05;***p<0.01

Note: 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:** 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 | | | ✓ | | | ✓ |

*p<0.1;**p<0.05;***p<0.01

Note: 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.

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