Student Debt and Entrepreneurship in the US[*]

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Abstract

This paper studies the interplay of education and entrepreneurial outcomes, and its implication for business dynamism, capital allocation and aggregate productivity in the US. Using micro-level data, I document that having a student loan is associated with a lower likelihood of opening a firm and obtaining funding, and it is linked to lower firm size but higher profit margins. To rationalize my findings, I build a heterogeneous agents model enriched with education and entrepreneurial decisions, where student debt slows down the accumulation of wealth and reduces the collateral entrepreneurs can pledge to rent capital on financial markets. Calibrated to US data, my framework matches between 30 and 80% of the gaps in entrepreneurial margins across agents with and without college, and with or without loans. I also show that the increase in university prices and student debt since the late 1980s accounts for a third of the decline in the entrepreneurial rate of college graduates with loans over time. Finally, I use the model as a laboratory to study the effect of policy reforms, such as expanding grants and college borrowing limits, switching to income-driven repayment plans and loan forgiveness.

Keywords: Student Debt, Education, Entrepreneurship, Financial Constraints, Productivity.

JEL Classification: E21, E23, I2, L26

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1 Introduction

As of today, 60% of all college graduates and nearly 1 in 4 labor force participants in the US have borrowed to finance their degrees. Student loans have become the second largest debt market in the country – valued at 1.6 trillion dollars and worth 6% of the GDP – and are currently at the center of a vivid public debate. In particular, while college borrowing represents the main pathway to university for many US students, the cost of higher education has been rising faster than inflation and faster than the college premium over the past years. Such a steady increase in university prices has been accompanied by an unprecedented surge in the level of student debt per person. With the median borrower piling up more than 35K dollars of education loans, recent studies have documented far-reaching implications of rising student debt for individuals' life choices, including their job search strategies, marital decisions and home-ownership rates.[1]

An aspect that has received less attention by the literature is whether and how student loans interact with entrepreneurial dynamics. In several countries – including the US – entrepreneurs play a pivotal role in enhancing job creation and innovation, and analyses of micro-level data reveal that firms started by college graduates tend to be bigger and exhibit higher returns and life-cycle growth (see Michelacci and Schivardi (2020) and Queiró (2021)).[2] Yet, while college loans allow a large fraction of US students to pursue a university education, evidence from studies of household finance suggests that they can also lead to debt overhang (Di Maggio et al. (2019)). Since owners typically need funds to run their businesses, a natural question that follows is whether college borrowing may interact with the entrepreneurial decisions of indebted graduates. And if so, could this also have repercussions for US firm dynamism and macroeconomic aggregates?[3]

This paper intends to study the effect of student loans on entrepreneurial margins in three key steps. I begin by providing novel empirical evidence on the link between education loans and entrepreneurial outcomes. I then build a quantitative model that features several interactions between college borrowing and entrepreneurial choices over the life-cycle of individuals, and I calibrate it on US data to investigate the implications of student loans for firm creation, capital allocation and output. Finally, I use my framework as a laboratory to analyse potential reforms to university financing, such as expanding need- and merit-based grants, raising college borrowing limits, adopting income-driven repayment plans and cancelling off outstanding education loans.

The first contribution of my work is to empirically document a negative relationship between

[1] See for example Alon et al. (2021), Luo and Mongey (2019), Folch and Mazzone (2020) and Abbott et al. (2019).

[2] Queiró (2021) uses the universe of firms and workers from Portugal to document that education affects firm size and growth, and that educated entrepreneurs seem to be specifically better at innovation and technology adoption. With data from the US, Michelacci and Schivardi (2020) further show that a high degree of complementarity between education and experience determines higher returns to entrepreneurship for graduate and post-graduate individuals.

[3] A recent survey by the US Chamber of Commerce found that 30% of small business owners think student loans have impacted their ability to grow their business. Moreover, the concern that student debt may constitute a barrier to entrepreneurship has long been a topic of political debate. For example, on June 30th, 2021, Republican Nydia Velazquez, who is the chair of the House Small Business Committee, proposed a bill to establish a student loan debt forgiveness and deferment program for entrepreneurs (i.e: The 2021 Supporting America's Young Entrepreneurs Act).

college loans and the *extensive* and *intensive* margins of entrepreneurship. To this end, I leverage micro-level data from the Fed Survey of Consumer Finances (SCF) and focus on the 1989-2019 period. In the cross-section, higher levels of education are associated with better business outcomes for entrepreneurs, as shown in Michelacci and Schivardi (2020). Yet, individuals who took out student loans or carry higher outstanding balances at the time of the survey are less likely to become business owners and obtain funding compared to agents without a degree and to college graduates without student debt. Their firms are also relatively younger, tend to employ fewer workers and generate lower revenues and profits in absolute terms. Importantly, robustness analyses point towards the fact that these correlations are not systematically driven by negative selection into having student debt, both in terms of financial and individual productivity characteristics.

Several mechanisms could explain these findings: for the most part, education loans are settled through fixed repayment plans, carry a relatively high interest rate and cannot be discharged in bankruptcy, which may discourage or delay agents' entrepreneurial careers. Since outstanding liabilities can increase the chances of debt overhang, college borrowing could also tighten entrepreneurial financial constraints. Both factors may represent barriers to firm ownership, and, consistent with this observation, I show that indebted college graduates run businesses with higher profitability (relative to their size), which suggests they undergo a stricter selection at entry.

To rationalize my results, I develop a heterogeneous agents life-cycle framework, where individuals differ by wealth, productivity, age, education, and student debt. Since I want to analyse the interplay of education and entrepreneurial outcomes, I build on the occupational models by Cagetti and De Nardi (2006) and Buera et al. (2011), but also allow agents to endogenously choose whether to obtain a degree and take out student debt. In particular, individuals either enroll in college or immediately enter the labor market during their youth. University has a tuition – net of grants – and students choose how much to take out in college debt, which is repaid after graduation. A unique feature of student loans is that they are *unsecured* credit granted by the Federal Government, without requiring collateral and with the goal of reducing barriers to higher education. However, they are neither dischargeable nor collateralized by physical assets one can borrow upon, which motivates my choice of modeling college borrowing and personal wealth separately.

In the model, education gives agents an income premium through a higher deterministic productivity growth over their life-cycle, which is an incentive to enroll in college. Then, during adulthood, individuals make occupational choices and decide whether to open a firm or become workers. They save out of their income and consume a final good, which is produced by entrepreneurs combining their idiosyncratic and deterministic productivity, capital and labor. In retirement, agents consume their pension and savings, and leave bequests. Importantly, entrepreneurs face an intra-temporal borrowing constraint that limits the amount of capital they can rent to a multiplier of their pledgeable assets. Finally, there is a government that collects income taxes, holds student debt and distributes grants and pensions. Equilibrium outcomes include the wage, the interest rate and the tax rate, and the general equilibrium (GE) setting of my framework allows

me to study counterfactuals and policy reforms accounting for the full response of the economy.

The key contribution of the model is to link the dynamics of student debt and entrepreneurial choices through two main channels. First, the repayment of loans after graduation reduces the amount of resources individuals can save, slowing down wealth accumulation. Since personal assets are the collateral against which entrepreneurs borrow to finance capital acquisition, this mechanism has a negative effect on the entrepreneurial outcomes of graduates with loans, particularly at the beginning of their career. Second, outstanding student debt is discounted from the amount of resources entrepreneurs can pledge to rent capital. Since one component of agents' productivity is stochastic and not pre-determined at the time of college enrollment, some productive but constrained graduates may be prevented from acquiring capital due to student debt. By tightening their borrowing constraint, education loans ex-ante reduce entry into entrepreneurship and make it more selective, and ex-post limit the expansion of the firms run by indebted entrepreneurs.

Calibrated to US data, my quantitative framework replicates as untargeted moments several cross-sectional differences between entrepreneurs with and without education, and with or without student debt. I fit closely the share of student borrowers, the business ownership rates of non-college and college graduates, and the composition of the entrepreneurial sample. Moreover, I can replicate between 30 and 80% of the empirically estimated heterogeneity in firm profits, sales and size across owners with and without student debt. Importantly, the model infers sizeable distortions generated by the discounting of education loans from the amount of resources that firm owners can pledge to rent capital. In fact, equalizing access to business credit across individuals with and without student debt would decrease capital misallocation by 4.96%, increase college graduates' entrepreneurial production by 5.39% and result in a 2.11% rise in aggregate output.

The second quantitative contribution of the paper is to use the calibrated framework to analyse the recent rise in student debt and the decline in entrepreneurship for US college graduates. A vast literature has focused on the drop in business dynamism and its potential causes, while few contributions document a steeper decrease in firm ownership rates for college graduates (see Salgado (2020)). I use SCF data to show that a large share of the decline in entrepreneurship for college-educated individuals since the 1980s is driven by graduates with loans. Next, I interpret this finding through the lens of my theory, and, in particular, through the effect of outstanding student loans on entrepreneurial financial constraints. Quantitatively, I compare two different steady states of the model, by varying the return and the price of higher education to match the changes in the college premium and attainment rate between the late 1980s and today. This channel brings about a consistent increase in student debt and in the share of borrowers, and explains a third of the decline in the entrepreneurial rate of US college graduates with loans over the same period.

As an additional exercise, I leverage the exogeneity of the 1998 reform to student debt bankruptcy to estimate the elasticity of firm ownership to outstanding college loans, which I then use to quantitatively validate the model. In particular, before 1998, college borrowers could discharge their loans after 7 years into repayment, which enables me to exploit the discontinuity in the

availability of bankruptcy by repayment year when the reform hit. Employing a regression discontinuity design (RDD) on SCF data, I estimate an elasticity of firm ownership to education loans between 6 and 9%.[4] Then, I use my model to simulate a counterfactual scenario in which some graduates are allowed to discharge their loans after 7 years into repayment, following the legal terms in order before the reform. After matching the share of bankrupt households in the 1990s, I show that introducing student debt discharge would increase the entrepreneurial rate of graduates with loans by 8%, a partial equilibrium elasticity that closely replicates its empirical counterpart.

To conclude, I use the model as a laboratory to study the implications of expanding college grants and borrowing limits, switching to income-based repayment plans and canceling off outstanding education loans. Note that, while Luo and Mongey (2019) and Abbott et al. (2019) have analysed the effect of changes to college financing on wages, there is a lack of understanding with respect to whether and how such policies may also impact entrepreneurship and affect firm dynamism, aggregate welfare and production. Importantly, within the specifics of my model environment, agents are born with uninsurable heterogeneous wealth and productivity, and student loans foster college enrollment. However, while education ensures higher income growth over the life-cycle, outstanding debt can distort both extensive and intensive entrepreneurial margins.

All policy exercises are carried out as neutral to the budget constraint of the government, and allow for GE responses. I find that higher university subsidies and loans limits, or the possibility of tying debt repayments to one's income, all raise college enrollment in my counterfactuals. Moreover, income-driven plans provide relief to indebted graduates when hit by adverse shocks, while merit-based grants can successfully decrease debt overhang for productive students. Yet, changes in the composition of the pool of borrowers and in the amount borrowed do not lead to higher entrepreneurial rates and output across all experiments, and do not necessarily improve capital allocation. Finally, a preliminary assessment of loan forgiveness plans reveals that, through the lens of my model, the small gains in entrepreneurial margins following the partial cancellation of outstanding college loans could be offset by welfare losses from a higher tax and interest rate.

Related Literature. This project contributes to a rich macroeconomic literature on financial frictions and entrepreneurship, which studies the effects of firm borrowing constraints for capital allocation, entrepreneurial decisions and aggregate output (see Cagetti and De Nardi (2006), Buera et al. (2011) and Midrigan and Xu (2014), among many others). From a theoretical and quantitative point of view, the novel focus of my work is to combine education and entrepreneurial choices together in a heterogeneous agents life-cycle model, which is characterized by the interplay of student debt and its repayment structure with the financial frictions faced by entrepreneurs.

[4]The change to the availability of college loans bankruptcy is also analysed in Yannelis (2016) to link outstanding student debt and strategic default on other types of credit, using SCF data. Following Krishnan and Wang (2019), I instead study the effect of the 1998 reform to student debt bankruptcy on the likelihood of becoming an entrepreneur. Two are the key differences with respect to my work: first, I adopt a different regression strategy, which exploits the discontinuity in the availability of bankruptcy based on the repayment year agents were in by 1998. Secondly, I use the results to quantitatively validate the model-implied elasticities of entrepreneurial rates to outstanding college loans.

Second, my work relates to a recent body of applied research on student debt and individuals' outcomes. For example, Looney and Yannelis (2015a), Yannelis (2016) and Mueller and Yannelis (2019) investigate the drivers of default among college borrowers. Parallel to that, Mezza et al. (2020) study the impact of student debt on the likelihood and timing of buying a house, and Di Maggio et al. (2019) show that education loans can cause debt overhang, affecting borrowers' geographic mobility and the probability of changing jobs. Catherine and Yannelis (2020) also suggest an effect of college borrowing on family formation. As in Ambrose et al. (2015) and Krishnan and Wang (2019), I focus on firm ownership, but also use micro-level data to document a relationship between education loans and several entrepreneurial outcomes beyond business creation.

In combining empirical analyses and a quantitative framework to examine the macroeconomic consequences of student debt, I am similar in spirit to Alon et al. (2021), Ji (2021), Folch and Mazzone (2020), and Luo and Mongey (2019). Differently from these papers, I do not focus on human capital accumulation, job search strategies or home-ownership choices, but rather on the consequences of education loans for entrepreneurial outcomes. In this respect, my research relates to Kerdelhué (2021), who explores whether college financial aid can shape inequality by analysing its impact on entrepreneurial careers as well. A key distinction of my study is to model endogenously the choice of taking student debt, and investigate how the interplay between education loans and entrepreneurship affects capital misallocation and output. Moreover, I quantify the contribution of the rise in college debt for the decline in US entrepreneurial rates over the last decades, and assess the welfare implications of different policy reforms to the college financial aid system.

Finally, this paper connects to a growing literature on the macroeconomic effects of higher education policies in the US. For instance, Colas et al. (2021) study the optimal design of college aid as a function of parental income, while Matsuda (2020) shows that back-loaded subsidies may increase the supply of college-educated labor. Other works have examined the welfare implications of income-contingent plans, lower uncertainty over the generosity of financial aid, and loan forgiveness for college dropouts (see Matsuda and Mazur (2022), Vardishvili (2020) and Chatterjee and Ionescu (2012)). Parallel to that, research by Daruich (2018), Abbott et al. (2019) and Blandin and Herrington (2020) compares interventions affecting children as opposed to college students, stressing the importance of pre-college investments for university completion and lifetime earnings. With respect to these studies, I investigate how expanding university grants and loans, or switching to income-driven repayment plans, affect entrepreneurial outcomes and aggregate productivity, on top of welfare and college enrollment. My work is also one of the first quantitative assessments of President Biden's recent proposal to cancel off part of outstanding student loans.

The paper is organized as follows: Section 2 provides suggestive evidence on the link between student debt and entrepreneurial outcomes. In Section 3, I develop a life-cycle model of education and occupational choices that is calibrated to US data in Section 4, where I also assess its quantitative fit with respect to my empirical evidence. In Section 5, I exploit SCF data to study the effect of student debt discharge on entrepreneurial entry, and use the regression results to validate the

model-implied elasticities of entrepreneurship to outstanding college loans. Section 6 performs instead a series of counterfactuals to assess the aggregate implications of policy changes to the provision of college financial aid and student debt repayment plans. Finally, Section 7 concludes.

2 Empirical Analysis

In what follows, I present suggestive evidence on the relationship between student debt and entrepreneurial margins in the US. I first focus on the extensive margin and show that education loans are associated with a lower likelihood of opening a firm. Then, turning to standard intensive margins, I document that student debt correlates negatively with firm profits, size and revenues, and with the probability of obtaining firm credit. Finally, I discuss whether different mechanisms of selection into student debt and into entrepreneurship find plausible support in the data.

2.1 Student Debt and Business Ownership

For my empirical exploration, I rely on the SCF, an extensive triennial and cross-sectional survey of US families conducted by the Federal Reserve Board, which provides information on household's demographic characteristics and balance sheet variables, including income, assets and debt.[5] When applicable, it also reports information on respondents' spouses. In this paper, I use the 1989-2019 sample and focus on agents in the labor force and between 25 and 65 years old, which leaves me with approximately 170,300 observations.[6] Furthermore, I apply survey weights in regressions and comparative analyses to always ensure the representativeness of the sample.

Self-employed individuals constitute more than 20% of the respondents in the SCF, which makes this dataset suitable to study several aspects of US entrepreneurship (see Michelacci and Schivardi (2020) and Cagetti and De Nardi (2006)). In particular, the section related to the firms owned by the households contains data on their size, revenues, profits and equity, and information on the 1-digit industry code, the legal status and the funding date of the firms. It also reports how the business was started, the ownership share of the respondents and their working hours. Throughout the main analysis, I classify as entrepreneurs those that actively manage an enterprise in which they are majority shareholders, and who report employing at least one salaried worker.[7]

Moreover, the SCF asks respondents information regarding their student debt, for example whether they have education loans, the initial amount taken and the amount still to be paid at the

[5] Table A1, Table A2 and Table A3 in the Appendix report a list of all the variables used in my regressions, including demographic, business and student debt-related ones, along with a brief explanation and their unit of measure. In Table A4 and Table A5, I instead list several distributional moments and patterns regarding student debt take-up and repayment, comparing the estimates I compute from the SCF to those reported in other available surveys and papers.

[6] In the SCF, the information is stored in five separate imputation replicates (which are denominated as "implicates"). For example, for the 5,783 families interviewed during the 2019 survey, there are 28,915 records in the final dataset.

[7] The analysis is robust to also considering self-employed households as entrepreneurs. Moreover, while SCF does not contain information on the reason why entrepreneurs started or operate their business, existing evidence from the Global Entrepreneurship Monitor shows that less than 15% of business owners in the US opens a firm out of necessity.

time of the interview, the year in which the loan was issued and started to be repaid, the interest rate charged and the type of repayment plan agents are enrolled into. In the sample period I consider, 20.3% of all respondents reports a student loan to repay,[8] and the average debt taken is around 30,800$, which is in line with estimates from the National Center of Education Statistics.[9]

Table 1: Entrepreneurial Rates: 1989-2019

Education Level	*Average*	*Without Student Debt*	*With Student Debt*
College	14.23%	15.56%	10.27%
Non College	10.42%	-	-

As summarized in Table 1, entrepreneurial rates of households with college are higher than those of non-college graduates.[10] Yet, firm ownership rates of college graduates with student loans are substantially lower compared to their non-indebted counterpart, and closer to the ones of non-college graduates. Note that Table 1 shows averages for the 1989–2019 period: however, over the recent decades, business ownership rates have decreased and the average amount of student debt per person has increased, as reported in Figure A.1. The first trend speaks to the steady decline in US entrepreneurial rates extensively documented by Decker et al. (2014), while the second one has been argued to reflect changes in the returns to college and in the educational system, for instance regarding tuition costs, loan limits and funding schemes. In Section 4, I will analyse the evolution of business rates and student loans over time. Here, I instead assess the interplay of education loans and firm ownership in the full cross-section, and estimate the likelihood of becoming an entrepreneur for agents in my sample by running a set of probit regressions of the following form:

$$Pr(BusOwner_{it} = 1) = F\left(\beta_0 + \beta_1 Student\ Loan_{it} + \boldsymbol{\delta}'\boldsymbol{\Gamma}_i + \boldsymbol{\gamma}'\boldsymbol{\Phi}_{it} + \alpha_t + \epsilon_{it}\right) \tag{1}$$

where *BusOwner* is a binary variable that is equal to 1 if individuals are entrepreneurs at t, and to 0 if they are not. Focusing on the right-hand side of the equation, I first use as main regressor the amount of student debt taken out by individuals, which does not depend on the survey year.

[8] Before 2016, the SCF did not ask specifically whose education the loan was taken for. For this reason, I first check that results hold whenever focusing only on the last 2 surveys (2016 and 2019), for which I can identify the correspondence between the person interviewed and the actual underwriter of the student loan reported. Secondly, when pooling together all the survey years, I check that my results hold true whenever focusing on a restricted subsample of the population, namely on those between 25 and 40 years old, which should exclude cases of parents taking or having to repay loans in the name of their children. See Hershbein and Hollenbeck (2015) for several discussions on this issue.

[9] Over the last decade in particular, roughly 35% of the US population aged 25 and older is reported to have earned a college degree. Among college graduates, on average 65% have to borrow to finance college. Hence, 23% of the US population above 25 years old is estimated to have negative student loan balances to repay after graduation. Moreover, borrowers on average take out between 30K and 50K $ in student loans, as documented by Looney and Yannelis (2015b).

[10] An extensive literature has established that university education correlates positively with entrepreneurial rates, see for example Poschke (2013). College can enhance human capital accumulation and facilitate inter-personal connections or networks that can improve entrepreneurial outcomes. Moreover, starting a firm in particular sectors often requires specialized field education because of the nature of certain industries (e.e: civil engineers and biologists, etc).

Second, I construct a dummy variable that signals whether households have pending college loans to repay, and finally exploit the amount still to be paid at t. Note that 80% of college borrowers has only one recorded loan, while a smaller fraction of the sample reports two to three loans.[11] Hence, unless specified, I consider the total amount of student debt hold or taken out by the households.

Table 2: Business Ownership

	(1)	(2)	(3)	(4)
log(Student Debt Taken)	-0.0034***	-0.0024***		
	(0.0002)	(0.0002)		
Dummy(Have Student Loan)			-0.0241***	
			(0.0024)	
log(Student Debt Still Owed)				-0.0025***
				(0.0003)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	Y	Y
Survey Year FE	N	Y	Y	Y
Observations	170,302	170,302	170,302	170,302
Pseudo-R^2	0.0373	0.0493	0.0521	0.0520

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner. Pre-College controls refer to agent's gender and ethnicity (Table A8 includes parental education, only available in 2016/2019). General controls are agents' education, age, marital and home-ownership status and income. Robust to including spousal income, households' leverage or assets, and to using either an income or wealth category by age and educational level instead of their personal income. Table A9 provides regression results for the cases in which business ownership is defined without any restriction on the extent of the ownership share of respondents. Finally, Table A10 conducts the analysis focusing only on the first education loan reported by respondents.

The regressions include a set of controls $\mathbf{\Gamma}_i$, which capture factors that were pre-determined to the choice of getting a student loan and could affect entry into entrepreneurship (e.g. year of birth, gender, ethnicity and parental education). Then, I sequentially introduce several control variables recorded at the time of the survey that were not pre-determined to the moment in which individuals contracted college borrowing, such as their overall education, marital and home-ownership status, income or wealth.[12] These latter regressions also allow for survey year fixed effects (FE).

Table 2 shows that student debt correlates negatively with business ownership. In Column (1), where only pre-determined controls are included, an increase of 1% in college borrowing is associated with a 0.34% lower likelihood of becoming an entrepreneur. To interpret this result, note that the average entrepreneurial rate in the sample is 12%, while the average student debt is $31,000. Hence, a $3,100 higher loan at graduation is associated with a roughly 0.5 percentage points (p.p.) difference in the likelihood of becoming an entrepreneur relative to the mean. As reported in Columns (2)-(4), the amount of debt initially taken and any outstanding balances at the time of the survey have a negative correlation with firm ownership also when including controls.[13,14]

[11] This is the case of loans separately undertaken to finance undergraduate and graduate studies, for example.

[12] Due to the high degree of endogeneity of both income and wealth, I can alternatively use the average income or assets of agents within the same age and/or education category (robust to do it by age and/or education and year too).

[13] Robust to interacting controls with student debt to check results are not driven by one demographic group only.

[14] Results are in line with recent studies on the relevance of available credit and entrepreneurial personal balance

Table 3: Business Ownership, College Graduates Only

	(1)	(2)	(3)	(4)
log(Student Debt Taken)	-0.0058***	-0.0025***		
	(0.0004)	(0.0004)		
Dummy(Have Student Loan)			-0.0294***	
			(0.0039)	
log(Student Debt Still Owed)				-0.0027***
				(0.0004)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	Y	Y
Survey Year FE	N	Y	Y	Y
Observations	80,157	80,157	80,157	80,157
Pseudo-R^2	0.0202	0.0452	0.0455	0.0453

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner. Pre-College controls refer to agent's gender and ethnicity (robust to including parental education, only available in 2016/2019). General controls are agents' education, age, marital and home-ownership status and income. Robust to including spousal income, households' leverage or assets, to using either an income or wealth category by age and educational level instead of agents' personal income, and to considering owners with any given equity share.

As a robustness check, Table 3 estimates again Equation 1 excluding non-college graduates. The presence and extent of student debt correlate negatively with business ownership also among individuals with at least a bachelor degree. Moreover, the magnitude of the coefficients is bigger than in Table 2: this suggests that the estimated gap in firm creation by student debt is wider among college graduates, in line with the comparison of unconditional entrepreneurial rates in Table 1. Interestingly, the negative correlation between education loans and entrepreneurship is much stronger over the last 15 years (i.e: 2005-2019 vs 1989-2004), which is when student debt has become a more widespread financial instrument, and when its amount has significantly risen.

Next, in Table 4, I investigate whether the link between student debt and entrepreneurship varies along the income distribution. For agents with information on personal earnings, I run a set of regressions similar to Equation 1, including the amount of education loans individuals graduated with as an additional control and isolating the effect of their outstanding balances. Column (1) reports results without conditioning on income: a 1% increase in outstanding student debt is associated with a 0.9% lower likelihood of being an entrepreneur. Yet, the coefficient is larger for respondents in the bottom half of the earnings distribution, for whom a 1% higher balance on college loans is associated with a 2.6% lower likelihood of owning a firm. Table A11 also shows that the coefficient attached to outstanding student debt decreases with age, suggesting a stronger correlation between college loans and entrepreneurship early on in agents' life-cycle.

When I turn to the likelihood of owning a relatively bigger enterprise (i.e: 20+ employees), the association between student debt and entrepreneurship becomes stronger. Overall, Column

sheets for firm ownership and financing (see Herkenhoff et al. (2021) and Robb and Robinson (2014)). It is important to mention that, in a previous contribution, Hurst and Lusardi (2004) found little role for household's net worth in determining entrepreneurship. However, Hurst and Lusardi (2004) focused on self-employment (as opposed to firm ownership) and could not observe instances of financial constraints, as opposed to more recent analyses on the matter.

Table 4: Business Ownership and Outstanding Student Balances by Income

	Business Ownership			Firms with 20+ Employees		
	Full Sample	Earnings<p50	Earnings>=p50	Full Sample	Earnings<p50	Earnings>=p50
SLoans Owed	-0.0094***	-0.0257***	-0.0071***	-0.0161***	-0.0112***	-0.0507***
	(0.0031)	(0.0059)	(0.0022)	(0.0044)	(0.0028)	(0.0186)
Controls	Y	Y	Y	Y	Y	Y
Survey Year FE	Y	Y	Y	Y	Y	Y
Observations	170,302	83,229	84,287	37,051	23,749	10,521
Pseudo-R^2	0.0381	0.1060	0.0177	0.0263	0.0346	0.0312

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. In Columns (1)-(3), the dependent variable is a binary indicator = 1 if the individual is a business owner, and = 0 if not. In Columns (4)-(6), the dependent variable is a binary indicator = 1 if the business owned by the respondent has 20+ employees, and = 0 if it has less than 20 employees. Controls refer to agent's gender and ethnicity, age, student loan size at graduation, educational level, marital and home-ownership status.

(4) in Table 4 shows that a 1% increase in outstanding student loans is associated with a 1.6% lower likelihood of running a big firm. Yet, the effect is larger for individuals in the top half of the earnings distribution (see Column (5)-(6)). Taken together, these results suggest that student debt correlates negatively with entrepreneurship by more for low-income earners, but seems to have a stronger influence on business size for top earners.[15] This may be indicative of heterogeneities in the barriers to the creation of firms and big firms along the income distribution, and it is consistent with Hurst and Lusardi (2004) and Herkenhoff et al. (2021), who document a non-linear relation between wealth and self-employment, and between credit access and firm ownership. Results are robust to doing the analysis by agents' position in the asset – instead of income – distribution.[16]

Focusing more closely on firm owners and the enterprises they run, I find that individuals that took out bigger education loans show on average a higher probability of having their family's or their personal wealth collateralized for business reasons, as reported in Table A6. Moreover, Figure A.2 analyses the business legal status of enterprises run by individuals with and without education loans. Indebted owners are less likely to open corporations or limited liability companies, as opposed to those without student loans to repay.[17] Figure A.2 also shows that university graduates without debt tend to start enterprises earlier on in life.[18] In particular, conditional on the same educational attainment, firms of indebted entrepreneurs are 5 years younger, which in-

[15] When repeating regressions in Columns (3) and (6) for individuals above the 90th percentile of the income distribution, I no longer find a significant negative association between entrepreneurship and outstanding student debt, which is instead still correlated with big firms ownership (the coefficient is -0.0312, significant at the 10% confidence level).

[16] Table A7 reports a robustness check for regressions in Table 2, in which I analyze the correlation between entrepreneurship and education loans controlling for agents' net worth (excluding student debt). This stresses the relevance of student loans for entrepreneurial decisions beyond the effect of individual wealth and additional indebtedness.

[17] The business legal status reported at the time of the interview is likely to be the one with which the business originally started. Changing the legal status of an enterprise is very infrequent in the US, and bureaucratically complex.

[18] For this comparison, I focus on entrepreneurs that funded their own business, as opposed to inheriting or joining it. In the period considered, 75% of the business owners report funding their own business, 18% buying it, 4% inheriting it, and 3% joining it as a partner. Moreover, more than 95% of entrepreneurs hold a >50% share in their business.

dicates that households with student debt may delay undertaking their entrepreneurial careers.

As pointed out by Alon et al. (2021), the repayment of student loans can incentivize individuals to trade-off higher earnings upon graduation with careers of better long-run prospects. In a similar way, Luo and Mongey (2019) show that agents with student debt generally choose to work for high paying jobs with worse amenities early on in their life-cycle, while they are still repaying their loan balances. Consistent with their mechanisms, I argue that college borrowing could similarly discourage or delay business ownership, as opening a firm can lead to potentially higher earnings but also involves taking higher risk. I will further explore this trade-off in the quantitative section.

2.2 Student Debt and Business Outcomes

After having investigated the link between education loans and the extensive margin of entrepreneurship, I now focus on analysing a set of intensive-margins outcomes across entrepreneurs with different student debt balances. In terms of the intensive entrepreneurial margins considered, I first examine firm financing, and then turn to firm size, sales, profits and profitability measures.

2.2.1 Business Financing

Enterprises generally need funds to run their operations, and one way to secure finances is through business borrowing.[19] The SCF records information on whether the respondent applied for and obtained a business loan up to 12 months before the interview. First, in Table A12, I report estimates for the likelihood of applying for a business loan. Neither the initial amount of student debt taken nor the outstanding balances as of the survey year t correlate with the probability of asking for business funding, suggesting little to no role for any heterogeneity in the demand for credit across indebted and non-indebted entrepreneurs. Second, I estimate the likelihood of being turned down in a business loan application via a probit regression of the following form:

$$Pr(LoanApproved_{it} = 1) = F\left(\beta_0 + \beta_1 Student\ Loan_{it} + \boldsymbol{\delta}'\boldsymbol{\Gamma}_i + \boldsymbol{\gamma}'\boldsymbol{\Phi}_{it} + \alpha_t + \epsilon_{it}\right) \tag{2}$$

where $LoanApproved$ is a binary variable that takes a value of 1 if the loan request was approved, and 0 if it was rejected. I exploit individual-level controls and FEs as in Equation 1, as well as a set of firm-level controls that include business size, age, legal structure and 1-digit industry code.[20]

As reported in Table 5, student debt shows a negative correlation with firm credit approval. In Column (1), I only control for demographic characteristics that were pre-determined at the time the student loan was taken, such as gender, ethnicity and parental education: an increase of 1% in student debt is associated with a 1.2% lower likelihood of getting business funding. In all the other specifications, I control for variables recorded at the time of the interview that may also influence

[19] Using a sample of US startups from the Kauffman Firm Survey, Morazzoni and Sy (2021) show that business borrowing from financial institutions tend to represent the most important source of funding for entrepreneurs.

[20] Results are robust to excluding firms offering accounting and legal services, and are available upon request.

Table 5: Business Loan Approval

	(1)	(2)	(3)	(4)
log(Student Debt Taken)	-0.0120***	-0.0118***		
	(0.0028)	(0.0025)		
Dummy(Have Student Loan)			-0.1308***	
			(0.0262)	
log(Student Debt Still Owed)				-0.0125***
				(0.0026)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	Y	Y
Firm Controls	N	Y	Y	Y
Survey Year FE	N	Y	Y	Y
Industry FE	N	Y	Y	Y
Observations	5,196	5,075	5,075	5,075
Pseudo-R^2	0.0365	0.2174	0.2188	0.2178

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the owner had a business loan application approved within the 12 previous months. Pre-College controls refer to gender and ethnicity (Table A8 includes parental education, only available in 2016/2019). General controls are education, age, marital and home-ownership status and income. Firm controls include size, age, legal type and owner's working hours. Robust to including spousal income and households' leverage or assets, to using either an income or wealth category by age and educational level instead of agents' personal income, and to considering owners with any given equity share.

business credit approvals. Column (2) shows that the amount of student debt taken out has a 1.3% negative correlation with business loan approval. In Column (3), I use as main regressor a dummy variable equal to 1 if the respondent is still in repayment, and to 0 otherwise. Consistent with previous results, having a student loan is associated with a 13% lower likelihood of receiving business credit. Finally, for the regression in Column (4), I exploit the amount of college borrowing still owed at the time of the survey, and find a similar coefficient to the one in Column (2).[21]

2.2.2 Business Size, Sales, Net Worth and Profits

An impaired access to business financing is likely to influence the operations of firms run by indebted entrepreneurs. For this reason, I next examine whether the amount of student debt taken for college relates to the size, sales, net worth and profits of enterprises in the SCF sample. For instance, due to difficulties in accessing business credit, entrepreneurs that took out larger education loans – or still have to repay substantial balances at t – might run smaller firms (measured in numbers of employees). Parallel to that, if external credit is used to finance capital acquisition and business operations, firms owned by indebted entrepreneurs may generate lower revenues and profits, even within the same size category. To test for this, I run the following set of regressions:

$$y_{it} = \beta_0 + \beta_1 Student\ Loan_{it} + \delta' \mathbf{\Gamma}_i + \gamma' \mathbf{\Phi}_{it} + \alpha_t + \epsilon_{it} \tag{3}$$

[21] I can further restrict the focus only to entrepreneurs that are college graduates. Similar to what observed for entrepreneurial rates in the previous section, this choice reduces noticeably the sample size and gives (statistically significant) stronger effects across the different regression specifications in Table 5. All results are available upon request.

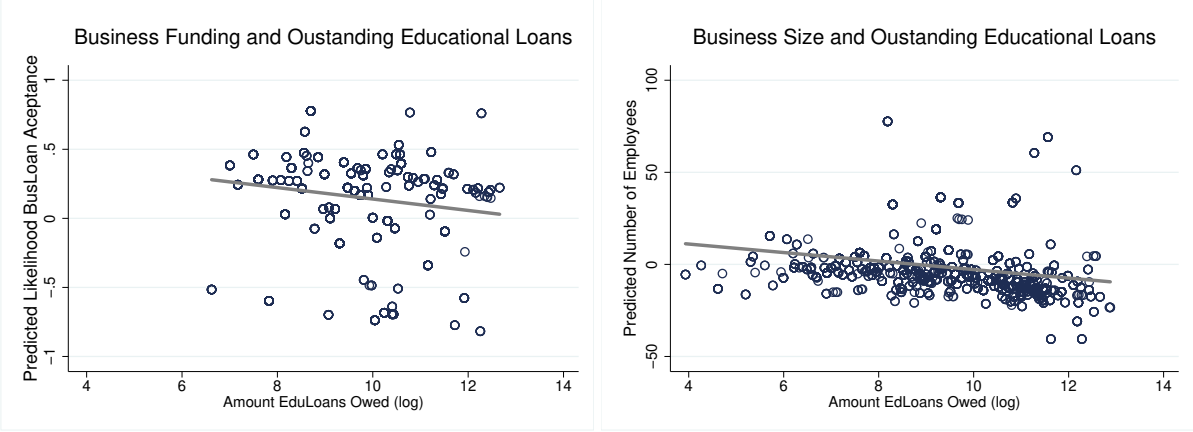
where $y = \{employees\ ;\ sales\ ;\ profits\ ;\ net\ worth\}$ is a vector containing the number of employees, (log) gross sales, (log) profits and (log) business net worth at t.[22] I allow for firm and individuals' controls, as previously explained, and include survey year FE (α_t). Results for size and sales are in Table 6, while those concerning profits and net worth are reported in Table A14 and Table A15.

Table 6: Business Outcomes: Size and Gross Sales

	Employees	Employees	Sales	Sales
log(Student Debt Taken)	-1.9828***	-1.9919***	-0.0648***	-0.0423***
	(0.1656)	(0.1890)	(0.0055)	(0.0048)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	N	Y
Firm Controls	N	Y	N	Y
Survey Year FE	Y	Y	Y	Y
Industry FE	N	Y	N	Y
Observations	40,145	39,461	37,540	36,855
R^2	0.0026	0.0339	0.0780	0.4054

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variables are number of employees and the log(*Sales*). Pre-College controls are gender and ethnicity (robust to include parental education, only available in 2016/2019). General controls are education, age, marital and home-ownership status and income. Firm controls include age, legal type and entrepreneurs' working hours (and business size in Columns (3)-(4)). Robust to including spousal income, households' leverage/assets, using income/wealth by age and education instead of personal income, and considering owners with any equity share.

Figure 1: Business Outcomes by Student Debt Outstanding Balances



Notes: Residuals from OLS and Linear Probability regressions. Survey weights are used. The dependent variables are the number of employees and a dummy for whether a business loan application was accepted in the 12 months before the survey date (in the panel on the left, the upper limit is set at the p95 of the distribution of residuals for illustration purposes). Control variables are as in the baseline regressions, namely as in Equation 2 and Equation 3.

The estimation of Equation 3 reveals that the amount of student debt taken by entrepreneurs to finance education is linked to lower business size,[23] and an increase of 1000$ in college borrowing is associated to hiring 12 employees less. Moreover, across businesses of comparable profile and

[22] The net worth of a firm is the value at which the business could have been sold in the year of the survey interview.

[23] Table A13 reports robustness checks using a dummy for whether the entrepreneur has a student loan to repay at the time of the interview, as well as the actual amount still to be repaid. Results are in line with the baseline specification.

entrepreneurs of similar demographic and financial characteristics, a 1% increase in the amount of student debt held at graduation correlates with 4-6% lower sales, 2-4% lower profits, and 5-7% lower business net worth. Results are stable to the sequential introduction of controls, suggesting that the magnitude and statistical significance of the coefficients of interest are not driven by the choice of the regressors. Also, the coefficient β_1 is 3 times larger when considering only firms that are active in Manufacturing and Wholesale Trade industries, where larger finances are needed to operate.[24] Finally, Figure 1 further confirms that, conditional on having taken out loans to finance a degree, the amount still owed at the time of the interview has a negative impact both on the likelihood of having a business funding application accepted and on the size of the business.

2.3 Selection Effects

2.3.1 Selection into Entrepreneurship

So far, I have shown that the amount of debt contracted to finance college education, as well as the amount still to be repaid at a given time throughout individuals' life-cycle, correlate with a lower likelihood of being an entrepreneur and obtaining funding, and are associated with opening firms of smaller size, profits and sales. To rationalize these results, this paper advances the hypothesis that the financial burden implied by education loans may act as a barrier to entrepreneurship.[25]

On the one hand, repaying a loan for 10 to 25 years after graduation can have a negative income effect on households and slow down wealth accumulation. Note that the current average monthly student debt repayment college graduates have to make is around $450, nearly 10% of an average monthly salary.[26] Loan repayments may therefore reduce savings and discourage or delay firm ownership, as personal assets are crucial for running businesses (see Quadrini (2009) for a review of the literature and Robb and Robinson (2014) for recent empirical evidence). Consistent with this, Table 4 shows that the negative correlation between outstanding education loans balances and business ownership is stronger for individuals below the median in the income distribution.

On the other hand, lending institutions typically take into consideration outstanding debt when individuals apply for other loans, and the negative effect of student debt on the access to credit is estimated to be more severe in tightly underwritten markets (see Mezza et al. (2021)). Similarly, there is evidence that student loans are associated not only with a higher likelihood of being credit constrained, (see Folch and Mazzone (2020) and Mezza et al. (2020) on the effect on home-ownership rates) but also with a higher likelihood of declaring consumer credit bankruptcy (Gicheva and Thompson (2015)). At the same time, Brown et al. (2015) have shown that student debt borrowers have lower average credit scores nowadays as opposed to the beginning of the

[24] Results are available upon request.

[25] The concern that student debt could prevent entrepreneurship has long been debated. Recently, the magazine Forbes has reported the insights of its Business Council on how student debt can affect an entrepreneur's journey.

[26] See `https://educationdata.org/average-student-loan-payment` and Avery and Turner (2012). Importantly, for agents that also take out loans for post-graduate studies, monthly payments are on average between $700 and $1500.

century, when their risk profiles were comparable to non-borrowers.[27] Therefore, education loans could also decrease the likelihood of getting funds (or the amount one can get) for running or starting a business,[28] which is in line with the evidence from the SCF data I presented in Table 5.

Impaired access to external credit also implies that barriers to business ownership may be more pronounced for individuals with larger initial or outstanding college loans, resulting in a stronger selection into the entrepreneurial sample. In turn, one should expect individuals who took out or carry large amounts of student debt to be marginally more productive as entrepreneurs. To check for instances of selection into entrepreneurship, I compute profitability indicators such as profits per dollar revenues, or profits per dollar of collateralized debt, and check if they correlate with student loans for the entrepreneurs in my sample by running the following set of regressions:

$$y_{it} = \beta_0 + \beta_1 Student\ Loan_i \times Business\ Size_{it} + \boldsymbol{\delta}'\boldsymbol{\Gamma}_i + \boldsymbol{\gamma}'\boldsymbol{\Phi}_{it} + \alpha_t + \epsilon_{it} \tag{4}$$

Table 7: Business Outcomes: Profitability

	$\log\left(\frac{\text{Profits}}{Revenues}\right)$	$\log\left(\frac{\text{Profits}}{Revenues}\right)$	$\log\left(\frac{\text{Profits}}{CollDebt}\right)$	$\log\left(\frac{\text{Profits}}{CollDebt}\right)$
log(Student Debt Taken)	0.0204***	0.0122***	0.0052**	0.0058**
	(0.0026)	(0.1890)	(0.0019)	(0.0017)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	N	Y
Firm Controls	N	Y	N	Y
Survey Year FE	Y	Y	Y	Y
Industry FE	N	Y	N	Y
Observations	40,150	39,461	40,150	39,461
R^2	0.0230	0.1411	0.0083	0.0575

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. Pre-College controls refer to agent's gender and ethnicity (robust to include parental education, only available in 2016/2019). General controls are agents' education, age, marital and home-ownership status and income. Firm controls include business age, legal type and owner's working hours. Robust to including spousal income, households' leverage or assets, to using either an income or wealth category by age and educational level instead of personal income, and to considering all owners without restrictions on their equity share.

where $y = \{\log\left(\frac{Profits}{Revenues}\right); \log\left(\frac{Profits}{CollDebt}\right)\}$. I regress both variables against the (log) amount of student loans took by the respondents, the size of their business and an interaction term to ensure that results are not driven by bigger (or smaller) firms only. Control variables and survey year FE are as in Equation 3, and results are displayed in Table 7. Moreover, Table A16 collects robustness analyses that use as main regressors either the (log) amount of college debt still owed, or a dummy equal to 1 if the respondent reports pending student loans on their balance sheets at time t.

[27] Brown et al. (2015) show that the relation between student loans and other debt, such as mortgages, credit cards and auto loans used to be positive before the 2000's. This suggests that student debt was potentially an indicator of borrowers having a higher level of education and projected income, a signal of financial prosperity that might have changed recently. Hua (2021) also documents an increase in the fraction of college graduates with negative net worth.

[28] Credit from financial institutions – as opposed to loans by family members or friends – tend to be the main funding source for US entrepreneurs, as documented in Morazzoni and Sy (2021) using data from the Kauffman Firm Survey

Column (1) and (3) show regression outcomes for the simplest specifications, which include the initial amount of education loans (without the interaction term *Student Loan* $\times$ *Business Size*) and controls that were pre-determined at the time the student loan was taken. Columns (2) and (4) consider instead the full set of controls and the interaction term in Equation 4, and show that the coefficient on *Student Loan* is significant and positive, above and beyond confounding effects coming from the size and characteristics of the businesses run by the entrepreneurs. Larger initial amounts of education loans correlate with higher firm profitability per dollar revenues or per dollar of collateralized debt. In particular, a 1% increase in the original amount of college borrowing is associated with 4 to 9% higher business profit margins, which suggests that owners with larger balances of student loans may have also undergone a stricter selection into entrepreneurship.

2.3.2 Selection into Student Loans

An important question to ask is who are the individuals that borrow for college. If agents selected into student debt on characteristics that are linked to a lower likelihood of becoming entrepreneurs and running productive firms, the above results would say little about the financial or income effects of education loans on entrepreneurial outcomes. I tackle this issue in two steps: here, I discuss why results do not seem to be mainly driven by selection into college borrowing. Then, in Section 5, I exploit an exogenous change in the repayment policy of student debt to strengthen the correlation between education loans and entrepreneurship, beyond confounding selection effects.

What does it take to open and run a firm? Data and theories point at wealth and entrepreneurial ability as crucial factors behind many business cases (see Cagetti and De Nardi (2006) and Buera et al. (2011) for example). Moreover, regarding the wealth dimension, one could further consider and distinguish between family and personal finances. Hence, it seems important to assess whether student borrowers significantly differ from non-borrowers along these key dimensions.

Parents' finances are an important determinant of college attendance, but have become a weaker predictor of the likelihood to borrow to finance education (Lochner and Monge-Naranjo (2016)). According to the National Center for Education Statistics, student loans growth at the extensive and intensive margins (% borrowing and amount per borrower) was more pronounced for the highest family income quartile between 1989 and 2004 (Berkner (2000) and Wei and Berkner (2008)). Moreover, among graduates from the 2012 cohort, half the students from high-income families borrowed for college, twice the share compared to the 1992-93 cohort.[29] Along these lines, Looney and Yannelis (2015b) have shown that rich US households are now more likely to use loans for tuition and boarding costs, especially at highly-ranked or Ivy League universities.[30]

Such steady increase in the share of borrowers from the highest family income quartiles might reflect the introduction of unsubsidized federal loans, which are not based on financial needs,[31]

[29] See: `https://www.pewresearch.org/social-trends/2014/10/07/`.
[30] See: `www.brookings.edu/opinions/students-at-elite-schools/`
[31] Unsubsidized Federal loans were first introduced with the 1992 Higher Education Act.

and the fact that aid schemes such as Pell Grants only target qualifiable low and middle-income students.[32] Although I have no data on family wealth or income for SCF respondents, I have controlled for parental education in baseline regressions, and interacted it with college debt. In addition, individuals with student loans are those who acquired higher education and hence will likely have better career prospects and earnings profiles.[33] Consistently, I have interacted individuals' student debt balances with their wealth or income deciles, without observing changes to my main results. Hence, this preliminary exploration does not suggest that the link between student loans and entrepreneurship is due to the fact that borrowers only pertain to the bottom of the income or wealth distributions, considering either their family's or their personal finances.

Moreover, it is difficult to argue that student loan borrowers have lower entrepreneurial skills than non-borrowers. Entrepreneurial skills are complex to measure but are typically proxied by educational attainment (Poschke (2013)). Only students that pursue university degrees get a student loan, and higher education has often been found to positively impact entrepreneurship (Guo et al. (2016) and Michelacci and Schivardi (2020)). Comparing individuals with and without student debt, one should in fact expect the latter to be more likely to open and run a successful firm.

Another plausible confounding mechanism is that students with higher talent get access to grants and may not borrow for their degrees. Yet, merit-based aid covers at most 20% of the average financial needs of roughly 15% of all students, leaving the rest to be covered either by family contributions or through borrowing. To strengthen my argument, I exploit data from the National Longitudinal Survey of Youth (NLSY97), which contains results to cognitive and attitudinal tests administered to all survey respondents, irrespective of their education. Table A17 shows that cognitive abilities are indeed a strong predictor of both receiving grants and taking out college debt.

Moreover, if students were to negatively select into having education loans according to their idiosyncratic skills, it should reflect in their entrepreneurial outcomes. Yet, Table 7 shows that – conditional on opening a firm – profitability is higher (not lower) for college borrowers. In a similar spirit, Luo and Mongey (2019) and Alon et al. (2021) have documented that education loans have a positive effect on wages upon graduation. Using NLSY97, in Table A18 I also regress self-employment rates on the interaction between individuals' education loans and cognitive abilities to show that student debt per sé is still significantly and negatively associated with entrepreneurial outcomes. Hence, individuals with student loans should not necessarily be the least productive ones among college graduates, otherwise it should likely be reflected in their earnings as well.

Finally, I check for any heterogeneity in the correlation between college borrowing and firm ownership by student debt balances. Specifically, I estimate the elasticity of business ownership to outstanding college loans – analogous to β_1 in Equation 1 – for individuals in different quartiles of the student debt distribution. As shown in Figure A.4, conditional on having taken out college debt, the negative correlation between outstanding balances and firm ownership is stronger for

[32] See: `www.brookings.edu/research/the-economic-case-for-doubling-the-pell-grant/`

[33] See also `www.peoplespolicyproject.org/2020/11/16/what-is-the-current-student-debt-situation/`.

agents below the 75^{th} percentile in the student debt distribution. This confirms that results do not depend on respondents with large education loans, and suggests that having large education loans does not necessarily mean being selected on characteristics that predict worse entrepreneurial outcomes. In fact, individuals with large education loans might have attended more prestigious universities and be positively selected into having student debt either on wealth, talent or both.

In conclusion, SCF data has still several limitations, and causal claims regarding the effect of college loans on entrepreneurship cannot be made without clearly accounting for individuals' idiosyncratic types or their family's income (among other factors). Since student debt and occupation choices are endogenous outcomes that reflect agents' selection along these key characteristics, I next build a model that can carefully account for both decision margins and their interaction.

3 Model

This section presents a general equilibrium life-cycle framework that nests together education and occupation choices. Households are born with heterogeneous wealth and idiosyncratic productivity, which accumulate and change over time. During youth, they decide whether to attend college and how much to take out in student loans, which are repaid after graduation. Households are endowed with one unit of time they either supply inelastically, if they choose to be workers, or use to run a firm, if they choose to be entrepreneurs. They save out of their income and consume a final good produced by the entrepreneurial sector. Output is obtained combining productivity, capital and labor, and entrepreneurs face a limited-pledgeability constraint to rent capital.

In the model, student debt and entrepreneurship are interconnected due to two key channels: first, repaying education loans slows down the accumulation of wealth. Since personal assets are the collateral entrepreneurs use to finance capital acquisition, this has a negative effect on the entrepreneurial rates and outcomes of college graduates with student loans, particularly at the beginning of their career. Second, borrowers' outstanding balances are discounted from the amount of resources that can be pledged to rent capital. By tightening their collateral constraint, student loans ex-ante reduce entry into entrepreneurship, and ex-post limit the expansion of firms run by indebted college graduates. The model can hence account for the interplay of student debt with both the extensive and intensive margins of entrepreneurship, as documented in Section 2.

3.1 Primitives and General Settings

Preferences: Agents have a strictly increasing and concave utility function over consumption, which satisfies standard Inada conditions, and whose coefficient of risk aversion is denoted by γ:

$$u(c) = \frac{c^{1-\gamma} - 1}{1 - \gamma}$$

Moreover, individuals discount their utility over future consumption at rate β.

Timing: Households are born as if they were out of high-school. In the first stage of their lives, T_{edu}, they decide whether to attend college or to enter directly the labor force. In the years between $T_{edu}+1$ and T_{work}, all agents work, consume and save. Between $T_{work}+1$ and T_{end} they retire and live off their savings and pensions until death. Survival probabilities vary by age and are denoted by θ_{age}. To ease the exposition, I suppress time subscripts whenever they are not strictly necessary.

Productivity: Individuals are characterized by heterogeneous idiosyncratic entrepreneurial productivities z, which evolve stochastically over time according to a standard AR(1) process:

$$z' = \rho z + \epsilon \quad \text{with} \quad \epsilon \sim \mathcal{N}(0, \sigma_\epsilon^2)$$

Such process is defined by a conditional distribution $d\Xi(z'|z)$, where I indicate by ρ_z the persistence of individuals' productivity and by ϵ its idiosyncratic risk component. Both terms do not vary by college attainment. Also, note that my theoretical framework features idiosyncratic shocks to productivity but no source of aggregate uncertainty. As in models à la Buera et al. (2011), I assume that z evolves constantly in the background of individuals and over their life-cycle, regardless of their occupational choices. However, the idiosyncratic productivity component is used only in entrepreneurial production, and does not scale the wage of workers. This is why z can be thought as agents' comparative advantage of pursuing entrepreneurship as opposed to paid work.

Parallel to that, all households – including workers and entrepreneurs – are also characterized by a tenure or efficiency profile, denoted by ℓ^i_{age}, which differs by educational attainment i and evolves exogenously and deterministically over the life-cycle according to the following process:

$$\ell^i_{age} = \zeta^i_1 \times age - \zeta^i_2 \times age^2 \quad \text{with} \quad i \in \{college, nocollege\}$$

Note that the parameters ζ^i_1 and ζ^i_2 govern the slope and curvature of the deterministic efficiency profile of individuals, and will reflect heterogeneities in the income growth of households across educational attainments and over their life-cycle. In this modeling choice, I hence embed the college premium that determines the incentives of young adults to acquire a university degree.

It is important to stress that total entrepreneurial productivity comprises both a deterministic and a stochastic or idiosyncratic component, given by the expressions for ℓ^i_{age} and z previously discussed.[34] Total entrepreneurial productivity is then given by their combination according to:

$$e^{\xi^i_{age}} = e^{\ell^i_{age}} \times e^z \quad \text{with} \quad i \in \{college, nocollege\}$$

Firm's Technology: Output is produced through a standard production function that combines

[34] As argued by Michelacci and Schivardi (2020), entrepreneurs with graduate degrees have higher returns to their business ventures, and increasingly so by previous experience. This rationalizes including the deterministic life-cycle efficiency component – and the college premium embedded into it – within overall entrepreneurial productivities.

total entrepreneurial productivity ξ^i_{age}, capital k and labor l. The production function is increasing in its arguments, strictly concave in capital and labor, and has decreasing returns to scale, allowing for a non-degenerate distribution of the enterprise size. In particular, $f(\xi^i_{age}, k, l)$ is given by:

$$f(\xi^i_{age}, k, l) = e^{\xi^i_{age}}(k^\alpha l^{1-\alpha})^{1-\nu}, \quad \text{with} \qquad 0 < 1-\nu < 1, \quad \text{and} \quad i \in \{college, nocollege\}$$

where α is the capital share in production and $1-\nu$ is the span of control as in Lucas (1978). Both capital and labor are static inputs and rented on their respective markets at each point in time.[35]

Financial Markets: There is a perfectly competitive intermediary sector that receives deposits from savers and lends funds to firms, without intermediation costs. The rental rate of capital is given by r, the deposit rate which is determined in general equilibrium. Financial markets are incomplete, and entrepreneurs can borrow intra-temporally up to a fraction of their assets a, net of any education loan d they might carry at a given time t. Capital constraints are hence given by:

$$k \leq \lambda(a - \eta d); \qquad a \geq 0$$

where $a \geq 0$ (i.e.: there is no intertemporal borrowing) and λ measures the degree of the constraint, as micro-founded in Buera et al. (2011). If $\lambda = 1$, agents operate in a zero credit environment, as opposed to the case in which $\lambda = \infty$ and individuals borrow according to their productivity, regardless of their financial wealth. Importantly, education loans limit the collateral college graduates can pledge to rent capital on financial markets at any given time t during the repayment period. Moreover, the parameter η governs precisely the extent to which college loans reduce the amount of wealth entrepreneurs can use to rent capital.[36] Note that $d = 0 \; \forall t$ for entrepreneurs without college education and for those with college education that did not take out student debt. Finally, d becomes 0 when indebted college graduates finish repaying their loans.

[35] In the Appendix, I also consider a version of the model augmented with an unconstrained productive sector.

[36] This formulation for the collateral constraint faced by entrepreneurs builds on the way financial frictions are modeled in Buera and Shin (2013), and can be related to the microfoundations of collateral pledgeability limits by Kiyotaki and Moore (1997). In particular, I assume that the amount of debt entrepreneurs can take intra-temporally to finance their operations cannot exceed the returns on capital (which I call ϕk), and that creditors discount student loans from the business debt they grant to owners. Note that the model does not allow for assets to be negative, and creditors are concerned about the amount of liabilities that have to be served in a given period. Since student loans cannot be discharged in bankruptcy (i.e: they are a senior form of debt) , I assume that creditors do not discount from the amount of pledgeable assets all outstanding student debt, but rather a fraction ηd. This latter term reflects the sum of per-period principal payments and interest rates that may be due intra-temporally. Denoting firm liabilities by b one can write:

$$b + \eta * d \leq \phi k$$

Since the net wealth entrepreneurs carry on to the next period is $a = k - b$, I rewrite the above borrowing constraint as:

$$k \leq \frac{1}{1-\phi}(a - \eta d) \quad \rightarrow \quad k \leq \lambda(a - \eta d)$$

where I denote by λ the borrowing multiplier given by $\frac{1}{1-\phi}$. For example, let us focus on the zero-credit-environment case in which $\lambda = 1$: what I am assuming is that, due to the risky nature of running a business, college-indebted entrepreneurs are required to keep a buffer to face the periodic repayment on student debt they owe to federal authorities.

Profit Maximization: Entrepreneurs' profit maximization problem in a given t reads as follows:

$$\pi^* = \max_{l,k} \left\{ e^{\xi^i_{age}} (k^\alpha l^{1-\alpha})^{1-\nu} - wl - (r+\delta)k, \quad \text{s.t.} \quad k \leq \lambda(a - \eta d) \right\} \tag{5}$$

where the price of output is normalized to 1. All entrepreneurs pay capital rental costs $(r+\delta)k$ and salaries wl as variable input costs, where I denote by δ the depreciation rate of capital. Moreover, in this baseline version, I abstract from any other type of production costs, including fixed ones.[37] Importantly, the differences in the profit maximization problem of individuals with and without college education are given by the different processes that characterize their idiosyncratic total entrepreneurial productivity ξ^i_{age}, and by the capital constraint, which varies according to the presence of student loans in the balance sheet of the households. There is no further source of heterogeneity by education in the production technology or in the input prices paid by entrepreneurs.

Occupation Choice: In each year during their working life and until retirement, agents decide their occupation o based on their wealth a, idiosyncratic comparative advantage as entrepreneurs z, and on the amount of outstanding student debt d. Households choose to be either entrepreneurs ($entr$) or workers ($work$).[38] Entrepreneurs own a firm and earn business profits $\pi(a, z, d, age; r, w)$, while workers inelastically supply one unit of labor and receive a salary $\tilde{w}_{age}$ in efficiency units, given by the general equilibrium wage w and scaled according to the their age-dependent efficiency profile so that: $\tilde{w}_{age} = e^{\ell^i_{age}} * w$. Recall that, in this baseline version of the model, I assume wages to be fully deterministic, while entrepreneurial profits have a stochastic component.[39]

3.2 Education Period

Agents start their life with heterogeneous wealth a and heterogeneous idiosyncratic productivity z. The distribution of initial assets and productivity in the economy is stationary and denoted by $F(a, z)$. Moreover, I assume that initial assets – interpreted as parental wealth – and productivity are correlated at birth, to reflect well-documented evidence on the inter-generational persistence of wealth and labor market outcomes in the US. As such, even though the model does not feature overlapping generations with altruism and/or paternalism, the relation of a and z at birth will be

[37] Including a deterministic fixed cost would strengthen selection into entrepreneurship, by making a given technology feasible only above a minimum scale. Moreover, stochastic fixed costs that are realized at the end of any period t would increase the risk of opening a firm. This would in turn affect entry patterns and amplify misallocation, without changing the implications of the effect of student loans on entrepreneurial margins. I hence consider the baseline version of my model to be a lower bound for the potential distortions created by student debt on business outcomes.

[38] I abstract from the inter-generational transmission of firms because inheritances make up for only 4% of existing enterprises in the SCF. This compares well to other surveys: Kaplan and Rauh (2013) find that more than 80% of Forbes 400 businesses in 2011 were first-generation. Moreover, Hurst and Lusardi (2004) reports that 6.5% of owners in the 1993 National Survey of Small Business Finances inherited their firm, while the analysis of the 1992 US Census survey on the Characteristics of Business Owners by Fairlie and Robb (2009) reveals that roughly 2% of owners inherit a firm.

[39] In this respect, I follow Buera et al. (2011) and Midrigan and Xu (2014), who assume stochastic idiosyncratic productivity to matter only for entrepreneurs, and focus on the relative risk of opening a firm as opposed to be a worker. To stress the plausibility of this assumption, I use SCF data and further show in Figure A.3 that, while the average wage and profit of individuals tend to diverge over their life-cycle, measures of relative volatilities stay the same.

calibrated to deliver the correlation in earnings across generations reported in Chetty et al. (2014).

Young households have to make an education choice and decide whether to attend university or not. College entails a tuition χ, net of subsidies s funded by the government, which are both proportional to individuals' idiosyncratic productivity (i.e: *merit based*) and inversely related to individuals' wealth (i.e: *means-tested*),[40] as it will be further explained in the calibration exercise. College tuition can be paid also by contracting student debt, denoted by d, which is administered by the government.[41] Since applying for financial aid in the US is free and done on-line through the Free Application for Federal Student Aid (FAFSA) form,[42] I do not model any cost to obtain grants or federal loans. However, note that young households are heterogeneous in initial financial resources, and there are no markets to insure against being unable to pay for university. Since college is costly, grants and student debt therefore facilitate enrollment into higher education.

To ease notation in the following steps, I refer to V^c and V^{nc} as agents' value functions during youth – based on their education decision – while W^c and W^{nc} will be the continuation values during their working stage. The maximization problem for agents that decide to go to college is:[43]

$$\begin{aligned} V^c(a,z,age) = \max_{a',d_{edu},c} & \left\{ u(c) + \beta\theta_{age} \int W^c(a',z',d',age')d\Xi(z'|z) \right\} \\ \text{s.t.} : & \; c + a' = (1+r)a - \chi + d_{edu} \\ \text{and} : & \; a' \geq 0, \quad c \geq 0, \quad 0 \leq d_{edu} \leq \underline{d} \end{aligned}$$

where $\underline{d}$ is the student debt borrowing limit.[44] Note that borrowing caps on US federal loans are such that students cannot borrow up to the entire tuition amount, which means that $\underline{d} < \chi$ and that the private cost of higher education exceeds its social cost, a departure from social efficiency.

Agents that do not go to college enter directly the labor market, make an occupational choice and decide whether to work for a salary or to become entrepreneurs and earn the net profits

[40] Nowadays, 80% of students with family income below 30K$ receive a Pell grant, and the award does not generally vary by college. Pell grants can fund enrollment at accredited institutions, including 2-years or part-time programs.

[41] In the US, 90% of college borrowers – worth 92.6% of the total value of student debt – receive loans from Federal Sources. The remaining 10% of the students who borrow for their degrees obtains credit from private lenders, which however have different borrowing conditions. For a perspective on this topic, see the study of Ionescu and Simpson (2016), who quantitatively assess the macro effects of the private market for student loans on college enrollment.

[42] After prospective students submit their FAFSA form, the US Department of Education computes the expected family contribution based on students' dependency status, family size and income. Then, the financial offices of universities put together aid packages for incoming students before the start of the term. Under the Federal Title IV Aid program established in 1965, financial aid is generally offered in the form of loans, grants and, sometimes, work-study plans.

[43] Since 4 years are spent in college, not just 1 as per this simplified notation, the Appendix reports the conversion.

[44] In the US, eligibility for federal student loans (except parent PLUS loans) is universal. Loan limits are more binding for undergraduate borrowers, while typically graduate students can borrow up to the entire cost of their program. More specifically, at the undergraduate level, loan limits vary across the first, the second and the third/fourth year in college, between two broad categories of family-dependency status and across types of loans (eg: direct subsidized vs direct unsubsidized loans). Since I abstract from dependency statuses or debt types and I model college as a one-period choice (i.e: no further graduate education is considered), I assume everyone face the same limit $\underline{d}$ on student loans.

generated by their firm.[45] Their value function during youth, denoted by V^{nc}, is given by:

$$V^{nc}(a,z,age) = \max\left\{V^{nc,work}(a,z,age), V^{nc,entr}(a,z,age)\right\} \tag{6}$$

More specifically, the maximization problem for workers can be expressed as follows:

$$\begin{aligned} V^{nc,work}(a,z,age) = \max_{a',c}\left\{u(c) + \beta\theta_{age}\int W^{nc}(a',z',age')d\Xi(z'|z)\right\} \\ \text{s.t.}: c + a' = (1+r)a + (1-\tau)\tilde{w}_{age} \\ \text{and}: a' \geq 0, \quad c \geq 0 \end{aligned}$$

where τ denotes the income tax levied by the government. The value function of agents that choose entrepreneurship as their occupation is instead summarized by the following expression:

$$\begin{aligned} V^{nc,entrep}(a,z,age) = \max_{a',c}\left\{u(c) + \beta\theta_{age}\int W^{nc}(a',z',age')d\Xi(z'|z)\right\} \\ \text{s.t.}: c + a' = (1+r)a + (1-\tau)\pi(a,z,age;r,w) \\ \text{and}: a' \geq 0, \quad c \geq 0, \quad k \leq \lambda a \end{aligned}$$

Finally, the education choice made by young households boils down to the following decision:

$$\max\{V^c; V^{nc}\}$$

namely to comparing the present and continuation value of getting or not a college degree. Note that I do not allow agents to drop out of college. While college dropouts are an important phenomenon to keep in mind for future extensions of the paper, Abbott et al. (2019) argue that dropout occurs more often during freshman years and among part-time students. Here, I focus on full-time students and college-completers, assuming full commitment to graduating from university.

3.3 Working Period

In each year t between $T_{edu}+1$ and T_{work}, all households make consumption and saving decisions and choose their occupation. For households that attended college, the value function V^c to maximize is defined over agents' assets, productivity, student debt and age, and it is given by:

$$W^c(a,z,d,age) = \max\left\{W^{c,work}(a,z,d,age), W^{c,entr}(a,z,d,age)\right\} \tag{7}$$

[45] I am ruling out the possibility for work-study combinations. Currently, 40% of full time students work during college, the vast majority for part-time jobs that total at most 20 hours per week. Full-time workers while in college tend to be relatively older, and represent just 8% of the total (see `https://nces.ed.gov/programs/coe/indicator/ssa`).

which accounts for the occupational choice made by college graduates. More specifically, the value function for college-educated working individuals can be written in the following form:

$$W^{c,work}(a,z,d,age) = \max_{a',c}\left\{u(c) + \beta\theta_{age}\int W^{c}(a',z',d',age')d\Xi(z'|z)\right\}$$
$$\text{s.t.}: c + a' = (1+r)a + (1-\tau)\tilde{w}_{age} - \mathcal{R}$$
$$\text{and}: a' \geq 0, \quad c \geq 0, \quad \mathcal{R} = \max\left\{\frac{d_{edu}}{T_{repay}} + r^{d}d, 0\right\}$$

where $\mathcal{R}$ is the (deterministic) repayment function of student debt. During the repayment period, households with education loans have to pay a fixed amount of the original balance d_{edu}, and the interest on the outstanding amount.[46] Importantly, r^d includes a wedge on top of the overall GE interest rate, and does not fluctuate over the span of the repayment, reflecting the fact that interest rates on federal debt have become fixed (as opposed to floating) since 2006.[47] I denote by T_{repay} the repayment length, which is assumed to be the same for all borrowers, independently of their initial or current balances.[48] The law of motion of outstanding student debt is hence given by:

$$d' = (1+r^{d})d - \mathcal{R}$$

The value function of college-graduates that choose entrepreneurship is instead characterized by:

$$W^{c,entrep}(a,z,d,age) = \max_{a',c}\left\{u(c) + \beta\theta_{age}\int W^{c}(a',z',d',age')d\Xi(z'|z)\right\}$$
$$\text{s.t.}: c + a' = (1+r)a + (1-\tau)\pi(a,z,d,age;r,w) - \mathcal{R}$$
$$\text{and}: a' \geq 0, \quad c \geq 0,$$
$$\text{and}: k \leq \lambda(a - \eta d), \quad \mathcal{R} = \max\left\{\frac{d_{edu}}{T_{repay}} + r^{d}d, 0\right\}$$

with college debt d' following the same law of motion outlined above.[49] Having defined the value functions of college graduates, one can clearly see the second important departure from social efficiency that is embedded in the model, namely that private returns to higher education are

[46] I will discuss the introduction of income-based repayment plans and the implications of education loans bankruptcy in the quantitative section of the paper. In the Appendix, I also consider a modified version of the model in which the repayment function $\mathcal{R}$ allows for periods of non-repayment through student debt forbearance.

[47] The interest rate is computed as a percentage of the unpaid principal amount, and it is set by Federal Laws based on the 10-year treasury note rate of a given year. For example, in 2021, subsidized and unsubsidized loans to undergraduate students carried roughly a 4% interest rate, unsubsidized loans to graduate students had a 5.5% interest rate and parent PLUS loans involved almost a 6.5% interest rate. Between 2006 and 2013, interest rates were much higher on average, oscillating between 5% for subsidized undergraduate loans and 8.5% for parent PLUS loans.

[48] To preserve tractability, an important simplifying assumption of my model is to rule out the possibility that agents make excess repayments on their loan to pay it off more quickly. However, looking at SCF data over the 1989-2019 period, roughly 25% of the student debt borrowers interviewed affirmed to be making payments ahead of schedule.

[49] Since agents choose the maximum value between becoming entrepreneurs or workers, the net salary $(1-\tau)\tilde{w}_{age}$ is to be considered as the minimum income they can dispose of with certainty in a given year. This feature of the model excludes the possibility of defaulting on the repayment of student debt, even when individuals have no savings.

lower than their social counterpart. This is due to three main factors: first, the economy features incomplete markets, which introduce an element of uncertainty in the returns to educational investments, specifically with respect to entrepreneurial careers. Second, there are firm financial frictions that also depend on the presence and extent of student loans. Finally, distortionary taxation reduces the gains from obtaining a higher efficiency profile through college education. These elements will be also key to understand the implications of the policy counterfactuals in Section 6.

As before, the value function of agents that do not go to college, W^{nc}, is instead given by:

$$W^{nc}(a,z,age) = \max\left\{W^{nc,work}(a,z,age), W^{nc,entr}(a,z,age)\right\} \tag{8}$$

which accounts for the occupational choice made by non-college graduates. More specifically, the value function for working individuals without a university degree has the following form:

$$\begin{aligned} W^{nc,work}(a,z,age) = \max_{a',c}\left\{u(c) + \beta\theta_{age}\int W^{nc}(a',z',age')d\Xi(z'|z)\right\} \\ \text{s.t.}: c + a' = (1+r)a + (1-\tau)\tilde{w}_{age} \\ \text{and}: a' \geq 0, \quad c \geq 0 \end{aligned}$$

The value function of non-college graduates that choose entrepreneurship is instead given by:

$$\begin{aligned} W^{nc,entrep}(a,z,age) = \max_{a',c}\left\{u(c) + \beta\theta_{age}\int W^{nc}(a',z',age')d\Xi(z'|z)\right\} \\ \text{s.t.}: c + a' = (1+r)a + (1-\tau)\pi(a,z,age;r,w) \\ \text{and}: a' \geq 0, \quad c \geq 0, \quad k \leq \lambda a \end{aligned}$$

At the end of their working life, households retire. In T_{work}, the continuation value that characterizes agents' problem is given by $U^c(a, z_{T_{work}}, age)$ and $U^{nc}(a, z_{T_{work}}, age)$, further explained below.

3.4 Retirement Period

Between $T_{work}+1$ and T_{end}, households make consumption and saving decisions as retirees. They receive a pension p^i for $i \in \{college, nocollege\}$, which is funded by the government and amounts to a given share of the income they earned in the last working period. Since agents differ in income according to education $i \in \{college, nocollege\}$ and entrepreneurial productivity z, pensions vary across individuals with and without a college degree, and are affected by the realization of z in $t = T_{work}$. Note that, both in the last year of their lives T_{end} and throughout their life-cycle, households leave any remaining assets upon death as bequests to the next cohort. This ensures that the wealth distribution of new generations remains stationary and can be pinned down quantitatively.

Therefore, for households that attended college, the value function U^c to maximize during

retirement is defined over their assets, last-working-period productivity, and age and given by:

$$U^c(a, z_{T_{work}}, age) = \max_{a',c}\{u(c) + \beta\theta_{age}U^c(a', z_{T_{work}}, age')\}$$
$$\text{s.t.} \quad a' = (1+r)a - c + p^c \quad \text{and} \quad a' \geq 0, \quad c \geq 0$$

For households that did not attend college, the value function U^{nc} to maximize is defined over agents' assets, last-working-period productivity and age, and is instead characterized as follows:

$$U^{nc}(a, z_{T_{work}}, age) = \max_{a',c}\{u(c) + \beta\theta_{age}U^{nc}(a', z_{T_{work}}, age')\}$$
$$\text{s.t.} \quad a' = (1+r)a - c + p^{nc} \quad \text{and} \quad a' \geq 0, \quad c \geq 0$$

3.5 Government

The role of the government in the model is twofold. On the fiscal side, the public sector collects income taxes (the tax rate has been denoted by τ throughout the exposition) and provides pensions to retired agents. On the education side, the government issues student loans and holds in place grants schemes to foster enrollment in college, especially for low-income households. While both the pension rate and the extent of the grant scheme are calibrated quantitatively to match their empirical counterparts, the tax rate τ is a general equilibrium outcome and has to clear the government budget constraint. In particular, fiscal revenues from tax collection are given by:

$$\sum_{t=T_{edu}}^{T_{work}} \int \tau * (\max\{\pi_t(a,z;r,w); \tilde{w}_t\} dH_t^{nc}(a,z)) + \sum_{t=T_{edu}+1}^{T_{work}} \int \tau * (\max\{\pi_t(a,z,d;r,w); \tilde{w}_t\} dH_t^{c}(a,z,d))$$

where $H_t^{nc}(a,z)$ and $H_t^c(a,z,d)$ denote the distribution of non-college and college households in each time t. Parallel to that, the items in government expenditure are given by pensions:

$$\sum_{t=T_{work}+1}^{T_{end}} \int p * \tilde{w}_{age T_{work}} dH_t^{nc}(a,z) + \sum_{t=T_{work}+1}^{T_{end}} \int p * \tilde{w}_{age T_{work}} dH_t^{c}(a,z)$$

and by college loans d_t and grant schemes $s_{T_{edu}}$ according to:

$$\sum_{t=T_{edu}}^{T_{repay}} \int d_t dH_t^c(a,z,d) + \int s_{T_{edu}} * dH_{T_{edu}}^c(a,z,d)$$

3.6 Equilibrium Conditions

At time $t = T_{edu}$, given the initial distribution $H_{T_{edu}}(a,z,d)$, the equilibrium of the economy is characterized by a sequence of allocations $\{edu_t, o_t, c_t, a_{t+1}, k_t, l_t\}_{t=T_{edu}}^{T_{end}}$, factor prices $\{w_t, r_t\}_{t=T_{edu}}^{T_{end}}$, a tax rate $\{\tau_t\}_{t=T_{edu}}^{T_{end}}$ and the distributions of college and non-college graduates $H_t^c(a,z,d)_{t=T_{edu}}^{T_{end}}$ and $H_t^{nc}(a,z)_{t=T_{edu}}^{T_{end}}$ such that:

1. $\{edu_t, o_t, c_t, a_{t+1}, k_t, l_t\}_{t=T_{edu}}^{T_{end}}$ solves the individuals' policy functions for given factor prices.

2. Capital, goods and labor markets clear according to:

$$\int_{o_t(a,z)=entr} k_t dH_t^{nc}(a,z) + \int_{o_t(a,z,d)=entr} k_t dH_t^{c}(a,z,d) = \int a_t dH_t^{nc}(a,z) + \int a_t dH_t^{c}(a,z,d)$$

$$\int c_t dH_t^{nc}(a,z) + \int c_t dH_t^{c}(a,z,d) + \delta k_t = Y_t$$

$$\int_{o_t(a,z)=entr} l_t dH_t^{nc}(a,z) + \int_{o_t(a,z,d)=entr} l_t dH_t^{c}(a,z,d) =$$

$$\int_{o_t(a,z)=work} dH_t^{nc}(a,z) + \int_{o_t(a,z,d)=work} dH_t^{c}(a,z,d)$$

   with total output Y_t given by:

$$\int_{o_t(a,z)=entr} \left[e^{\xi_t^{nc}} (k_t^{\alpha} l_t^{1-\alpha})^{1-\nu} \right] dH_t^{nc}(a,z) + \int_{o_t(a,z,d)=entr} \left[e^{\xi_t^{c}} (k_t^{\alpha} l_t^{1-\alpha})^{1-\nu} \right] dH_t^{c}(a,z,d)$$

3. The budget constraint of the government clears, as outlined in Section 3.5.

4. The sum of incidental bequests (by non-surviving individuals) and bequests by the oldest generation alive in T_{end} covers the sum of the assets of the new generation of young adults:

$$\int (1-\theta_t) a_t dH_t^{nc}(a,z) + \int (1-\theta_t) a_t dH_t^{c}(a,z,d) +$$

$$b * \int (a_{T_{end}} dH_{T_{end}}^{nc}(a,z) + a_{T_{end}} dH_{T_{end}}^{c}(a,z)) = \int a_{T_{edu}} dH_{T_{edu}}(a,z,d)$$

4 Quantitative Exercise

In what follows, I calibrate the model to available US data, and assess the extent to which the differences in entrepreneurial outcomes across individuals with and without university education can be explained by the presence of student debt. Moreover, I quantify the contribution of the rise in college loans to the decline in entrepreneurial rates for college graduates over the last 30 years.

4.1 Calibration

Of the 22 parameters I need to calibrate, 9 are fixed outside of the model and summarized in Table 8. The reference period in the model is a year: agents that attend college spend 4 years in university ($T_{edu} = 23$), then all individuals are active on the labor markets for 40 years and retire at 63 ($T_{work} = 63$), potentially living for 25 years in retirement ($T_{end} = 88$). I also set survival probabilities to reflect life-expectancy in the US.[50] As standard, I use as coefficient of risk aversion $\gamma = 2$, set the capital share to $\alpha = 0.36$ and the depreciation rate to $\delta = 0.1$.[51] Moreover, I calibrate

[50] I take estimates from: `https://benjaminmoll.com/wp-content/uploads/2021/04/STEG_course.pdf`

[51] Commonly used values for δ range from 0.06, as in Buera and Shin (2013), to 0.1, as in Clementi and Palazzo (2016).

the pension replacement rate p in the model economy to be on average 50% of households' income in their last working period,[52] which is close to the estimate reported by De Nardi et al. (2020).

Table 8: Externally Fixed Parameters

Fixed	Value	Description
γ	2	Risk aversion
α	0.36	Share of capital in production
δ	0.10	Capital depreciation rate
p	0.50	Pension replacement rate
T_{repay}	15	Student loan repayment term
r^d	0.05	Interest rate on student loans
$\underline{d}$	\$9,800	Borrowing limit on student loans
s	\$5,625	College grant(s)
θ	(see text)	Survival probabilities

Next, I set the student loan repayment term to $T_{repay} = 15$ because, before 2010, almost all college borrowers were enrolled in 10-years fixed repayment plans, which often extended to 20 years (see Abbott et al. (2019) and Daruich (2018) for a similar strategy). Plans that are tied to one's income have recently grown, but represent only 10-15% of the repayment plans subscribed in the last decade. This is why I leave for the next sections the exploration of the difference between fixed and income-based repayment plans and their implication for workers and entrepreneurs.

Moreover, as in Abbott et al. (2019), I allow the scholarship term s to have two components, denoted by s_1 and s_2. The former is need-based and depends on individuals' initial wealth according to: $s_1 = \phi_1 a^{-\psi_1}$. The latter is instead proportional to their talent and increases with initial productivity according to: $s_2 = \phi_2 z$. Overall, the parameters ϕ_1 and ϕ_2 are calibrated so that scholarships cover respectively 15% and 10% of the average financial need of incoming students (shares are computed taking into consideration the mean amount awarded per student and the average share of students receiving it).[53,54] Finally, to replicate the progressivity of need-based programs – governed by ψ_1 – I target the correlation between grants received and students' family income.[55]

Table 9 reports other internally fitted parameters. First, I pick $\beta = 0.98$ to match an average annual interest rate of 4%. I then set the wedge between r and the interest rate on student debt such that $r^d = 0.05$, in line with the average interest rate on education loans over the last decade.[56] The college tuition parameter χ is instead calibrated to replicate the share of the adult population with

[52] https://data.oecd.org/pension/net-pension-replacement-rates.htm

[53] https://www.urban.org/urban-wire/what-better-data-reveal-about-pell-grants-and-college-prices

[54] https://www.usnews.com/education/best-colleges/paying-for-college

[55] See the information reported for the 2015/2016 cohort at https://professionals.collegeboard.org/pdf/trends-spotlight-family-income-net-price.pdf. Abbott et al. (2019) adopt a similar strategy and target the progressivity in means-tested grants considering, however, data for the fiscal year 1999/2000.

[56] https://educationdata.org/average-student-loan-interest-rate

a college degree, which is roughly 35% over the last 10 years.[57,58] The estimated value $\chi = 1.25$ amounts to almost 30% of the median yearly income in the model (roughly \$25,000), consistent with recent US data on college costs and households' income. Accordingly, the lower bound on student loans $\underline{d}$ is set to over a third of the average yearly tuition for a 4-years college degree. Since I abstract from graduate studies, I compute an average of the maximum amount of education loans granted for undergraduate degrees across dependent and independent students, considering both subsidized and unsubsidized federal loans, which corresponds to almost \$10,000 per year.[59]

Table 9: Internally Fitted Parameters

Fitted	Value	Description	Moment	Model	Data
β	0.98	Discount factor	Interest rate	0.04	0.04
χ	1.25	College tuition	Educational rate	0.37	0.35
σ_a	3.50	Dispersion initial wealth	Top10 wealth share	0.69	0.70
ρ_{az}	0.25	Correlation initial (a, z)	Inter-generational earnings	0.31	0.28
ν	0.78	Span of control	Top10 income share	0.45	0.45
σ_ϵ	0.305	St deviation prod shocks	Top25 employment share	0.63	0.65
ρ_z	0.92	Persistence entrep prod	Serial correlation revenues	0.84	0.80
λ	3.00	Financial constraint 1	Avg. corporate debt/GDP	0.30	0.35
η	0.15	Financial constraint 2	Δ Entr rates w/ – w/o Sloans	5pp	5pp
ζ_1^c	0.0573	Trend income growth (college)	Income growth year 0 - 30	0.84	0.86
ζ_2^c	0.0012	Curv. income growth (college)	Income growth year 30 - 40	0.07	0.05
ζ_1^{nc}	0.031	Trend income growth (no coll)	Income growth year 0 - 30	0.48	0.48
ζ_2^{nc}	0.0004	Curv. income growth (no coll)	Income growth year 30 - 40	0.08	0.10

I also need to assign values to the parameters that define the initial distribution of wealth and the correlation between assets and productivity at birth. Assuming that the distribution of assets follows a log-normal shape, I normalize the mean to 1 and set the dispersion σ_a to match the fat right tail of the US wealth distribution, following estimates by Zucman (2019). Since the wealth agents are endowed with in period 1 influences college enrollment and the amount of student debt they choose, I check that the correlation between initial a and d in the model mimics the correlation between family contributions and student loans reported in Folch and Mazzone (2020).[60] Moreover, I calibrate the correlation between assets a and productivity z upon birth – denoted by ρ_{az} – to match the inter-generational persistence in earnings documented by Chetty et al. (2014).[61]

[57] `https://www.census.gov/newsroom/press-releases/2020/educational-attainment.html`

[58] The average tuition for 4 year degree is currently around \$112K, with the average debt at graduation being \$35K.

[59] See `https://studentaid.gov/understand-aid/types/loans/subsidized-unsubsidized`.

[60] Using US individual-level data from the Baccalaureate and Beyond Longitudinal Study, Folch and Mazzone (2020) report a correlation of 0.15 between family contributions and education loans. I compute a similarly moment in my model, and show that the correlation between initial wealth and the amount of student debt at graduation is 0.1391.

[61] A similar strategy is used in Daruich and Kozlowski (2020) to discipline inter-generational human capital.

Since the model does not feature dynasties, I instead compute the correlation between individuals' average (log) income over the life-cycle and initial (log) assets, interpreted as parental wealth.

Second, the span of control parameter is fitted such that the income share of the top 10% richest agents is the same in the data and in the model. This is because $1-\nu$ regulates firms' scale of operations and therefore affects the profits of entrepreneurs, who typically belong to the top deciles of the earnings distribution. In that, I follow an extensive literature on income and wealth inequality, which shows that the top 10% richest Americans make up for almost 45% of aggregate earnings (see Batty et al. (2019) and Zucman (2019) for example). My estimated value for $1-\nu = 0.78$ is close to the ones used by other papers on US entrepreneurship.[62] As a robustness check, I can alternatively calibrate $1-\nu$ to match the share of entrepreneurial wealth in aggregate wealth.

To identify the volatility of the entrepreneurial productivity shock σ_ϵ, I target the employment share of the top 25% largest firms, computed using the 1980-2019 Business Dynamics Statistics dataset. A bigger σ_ϵ implies greater dispersion in the productivity process (by means of thicker tails in the distribution) and hence higher employment creation by large businesses.[63] My calibrated value $\sigma_\epsilon = 0.305$ is in line with the range of US estimates provided by Lee and Mukoyama (2015). In addition, I use a standard measure for the average serial correlation of revenues across US firms to identify the persistence in the idiosyncratic entrepreneurial productivity process ρ_z.[64]

Next, to calibrate λ, which governs the extent of firms' borrowing constraints, I match the average US non-financial corporate debt over GDP.[65] I focus on non-financial corporate debt because other measures of total debt merge together household and corporate liabilities, and hence cannot be mapped directly into my theoretical framework.[66] In addition, I use the relative p.p difference in entrepreneurial rates across college-graduate entrepreneurs with and without education loans to discipline η, which affects by how much outstanding student debt balances reduce the collateral that can be pledged to rent capital. (Unconditional) entrepreneurial rates for college-educated individuals with and without student loans are computed using SCF data for the last decade.

Finally, I have to calibrate 4 parameters related to the deterministic efficiency profile of agents with and without college over their life-cycle. Using SCF data, I set the values of ζ_1^c and ζ_1^{nc} to mimic the growth in the income profiles of households with and without university degrees in the first 30 years of their working career. I then pin down ζ_2^c and ζ_2^{nc} targeting again the average growth in individuals' income profiles, but focusing instead on the last 10 years of their working life. The moments I compute for this final step of the calibration are close to those reported in

[62] Values for the US typically range from 0.78 (see Buera and Shin (2013)) to 0.88 (see Cagetti and De Nardi (2006)).

[63] Size is measured in terms of total employees, as also in Buera and Shin (2013) and Midrigan and Xu (2014).

[64] As discussed in Clementi and Palazzo (2016), estimates for ρ_z can be found to be as low as 0.8 and as high as 0.97.

[65] See the entire series on FRED website: `https://fred.stlouisfed.org/graph/?g=VLW#0`.

[66] To pin down λ, I do not use SCF due to the lack of a proper variable capturing firm liabilities. SCF only reports any assets used as collateral for business purposes, and the mean ratio of collateralized assets to gross sales is between roughly 0.70, with the median as low as 0.15. Due to this skewness, one could attribute too much weight to extremely high ratios. Compustat can be used as an alternative, which covers publicly listed US firms between 1980 and 2016. The ratio of current liabilities to revenues is on average 0.41, in line with estimates from FRED data. Moreover, Morazzoni and Sy (2021) document a similar debt-to-sales ratio for a sample of US startups using the Kauffman Firm Survey.

Lagakos et al. (2018) across different sources of US data.[67] As shown in Table 9, the estimated values for ζ_1^c, ζ_1^{nc}, ζ_2^c and ζ_2^{nc} reflect the fact that income growth is faster at the beginning of the life-cycle of individuals, and instead slows down progressively as agents move towards retirement.

As a concluding remark to this subsection, it is relevant to mention that the tax rate τ pinned down in GE to balance government expenditures and revenues in the model economy is 0.2.[68] Moreover, the fraction of bequested wealth, denoted by b, is such that the bequests of the last generation in T_{end} and of those dying before T_{end} equal the sum of the assets of new cohorts.[69]

4.2 Model Validation in the Cross-Section

In what follows, I discuss the quantitative fit of my framework with respect to untargeted dimensions of the data. First, the model predicts that the share of borrowers among college students is around 60%, as reported in recent US estimates. Second, I replicate the aggregate entrepreneurial rate and the composition of the entrepreneurial sample. It is important to stress I only targeted the average share of educated individuals and the relative p.p. difference in entrepreneurial rates across college-educated entrepreneurs with and without student debt. The quantified model can instead match – as untargeted moments – the average business ownership rate for the last decade,[70] as well as the (overall) entrepreneurial rates of individuals with and without college, and with or without student loans. For a comparison, Table 10 reports the moments computed in the model simulation and the ones documented empirically using the last 10 years of SCF data.

One can analyse further the differences in entrepreneurial outcomes across graduates with and without education loans by taking a life-cycle perspective. In the data, having attended university predicts higher chances of becoming entrepreneurs, typically due to higher human capital accumulation, strong complementarities between education and labor market experience, and peer effects.[71] Similarly, in my model, having a university degree is positively related to undertaking entrepreneurship, due to the fact that college graduates face a higher deterministic efficiency profile over the life-cycle, regardless of their occupation. However, the repayment of student loans slows down the accumulation of wealth, while outstanding college debt lowers the amount of collateral that entrepreneurs can pledge when renting capital. Both mechanisms together can rationalize the heterogeneities in entrepreneurial rates for college graduates with and without student debt. Moreover, before loans are fully repaid, college borrowing discourages or delays entry into

[67] The values for ζ_1^c, ζ_1^{nc}, ζ_2^c and ζ_2^{nc} are consistent with the elasticities of salaries to age estimated by Daruich (2018), who documents the presence of a steeper wage-profile for college vs non-college graduates using PSID data for the US.

[68] In the US, it is estimated that the average net income tax of single and married workers is 22% and 7% respectively.

[69] Since death may occur before T_{end}, the total sum of resources bequested in the economy corresponds to voluntary and accidental bequests. Voluntary bequests are precisely the calibrated share b out of $a_{T_{end}}$ for those living till T_{end}.

[70] The average share of business owners in the 1989-2019 SCF sample is 0.13, down to 0.10 considering the last decade only. Self-employment rates are slightly higher for the same periods (0.14 and 0.12 respectively). Note that I am considering averages for individuals that are active in the labor force. Considering all survey respondents and hence computing population averages leads to an average entrepreneurial rate of 0.07. Similar statistics are reported by other sources, such as the OECD (see `https://data.oecd.org/entrepreneur/self-employed-with-employees.htm`).

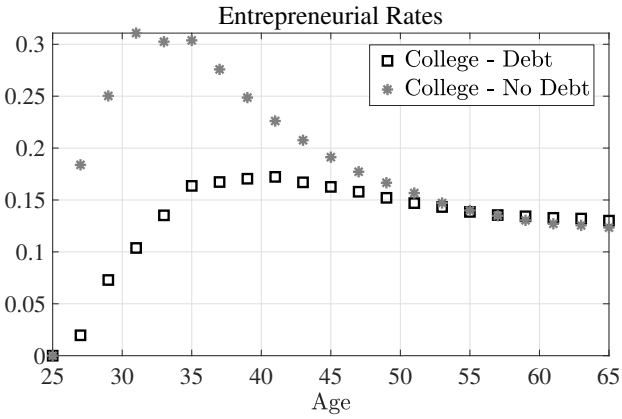
[71] See for example Michelacci and Schivardi (2020), Lerner and Malmendier (2013) and Van der Sluis et al. (2008).

Table 10: Untargeted Moments

	Model	**Data**
Entrepreneurship & Education		
Share of Student Borrowers	0.55	0.60
Average Entrepreneurial Rate	0.12	0.10
Average Entrepreneurial Rate College	0.15	0.14
Average Entrepreneurial Rate Non-College	0.10	0.08
Share of Entrepreneurs with Student Debt	0.11	0.15
Share of Entrepreneurs without Student Debt	0.37	0.44
Share of Entrepreneurs without College	0.52	0.41
Model-Implied Elasticities		
Business Size (in Employees) to Student Loans	-0.641	-0.859
Business Profits to Student Loans	-0.210	-0.082
Business Sales to Student Loans	-0.169	-0.098

entrepreneurship: as shown in Figure 2, student borrowers see a catch up in business ownership rates between 15 and 20 years after completing college compared to graduates without loans.[72]

Figure 2: Extensive Margin



Keeping the focus on college-educated business owners, the model also predicts that firms of individuals with college loans are smaller than those of owners without student debt, and can secure less external funding. Considering the number of workers employed and the total sales or profits generated, I can match between 30 and 80% of the differences across entrepreneurs with

[72]The deterministic growth in individuals' efficiency profile is also responsible for the growth in entrepreneurial rates over agents' life-cycle. In the data, the elasticity of business ownership rates to age is 0.0028 (netting out the effect of assets, demographic factors and year FE), while it is 0.0027 in the model economy. This result also highlights the importance of modeling entrepreneurial productivity as the combination of both a stochastic and deterministic component, with the latter precisely capturing the growth in skills and experience of households over their life time.

and without student debt. In particular, Table 10 collects the empirically estimated elasticities of business profits, sales and size to the amount of student debt owed by entrepreneurs.[73] Exploiting the calibrated economy, I run equivalent regressions using a simulated panel of 50,000 households. A 1% increase in outstanding student debt decreases business profits and sales by 21% and 17% in the model, compared to the 8% and 10% elasticities computed empirically. Moreover, a 1% increase in the amount of outstanding student debt leads entrepreneurs in the model to hire on average 0.64 employees less, similarly to the 0.84 coefficient I have estimated using SCF data.[74]

Note that tighter collateral frictions imply a stricter selection into entrepreneurship by graduates with student loans. To exemplify this point, I compute in the model the average product of capital ($arpk$) as the ratio between entrepreneurial output and capital. The $arpk$ is an indicator for how capital is allocated across productive units because, absent distortions, capital should flow similarly to entrepreneurs with and without student loans, ensuring no heterogeneity in $arpk$ across firms (Hsieh and Klenow (2009)). Yet, student loans decrease the collateral that can be pledged, and distort the optimal allocation of capital across units that are more productive. Consistent with that, college-indebted entrepreneurs have a 6% higher $arpk$, controlling for owners' assets. While I cannot compare such model-implied elasticity to any empirical counterpart due to the lack of data on capital in the SCF, this quantitative result implies that my calibrated economy features capital misallocation across firms run by entrepreneurs with and without student loans.

To further explore the extent of the distortions caused by outstanding college debt, I analyse a counterfactual scenario in which I eliminate the difference in firm financial frictions across individuals with and without student loans. In practice, I set the parameter η to 0, recompute the equilibrium outcomes and compare them to those in the baseline economy. First, when college debt does not tighten entrepreneurial borrowing constraints, the share of student borrowers increases by 1 p.p., and the average amount of debt taken for college scales up by 7%.[75] Second, indebted graduates leverage by more their wealth to rent capital for business purposes. As a result, their capital-to-labor ratio and output increase by 4.96% and 5.39% respectively. Finally, due to improved allocative efficiency, aggregate production in the economy increases by 2.11%.

As a final remark note that, in the model economy as in the data, entrepreneurial performance changes with individuals' age, due to assets accumulation and to the deterministic growth in agents' efficiency profiles. As a consequence of that, the gap in the average profit or capital be-

[73]For the comparison with the model, I estimate again the regressions of Section 2 in the 2009-2019 SCF sample controlling for age, assets and education (and business size when the outcome variable is either sales or profits). I net out survey year FE to control for heterogeneous economic conditions across the different years in the sample, as well as demographic characteristics that I do not explicitly model theoretically, such as gender, ethnicity and marital status.

[74]Model regressions on the simulated panel of households moderately overestimate the elasticities of business outcomes to student loans computed on SCF data for the last decade. A possible explanation for this result is that the model overpredicts by a third the average amount of college borrowing with which individuals graduate. Due to the non-linearities present in the model, this may imply relative higher barriers to entrepreneurship compared to the data.

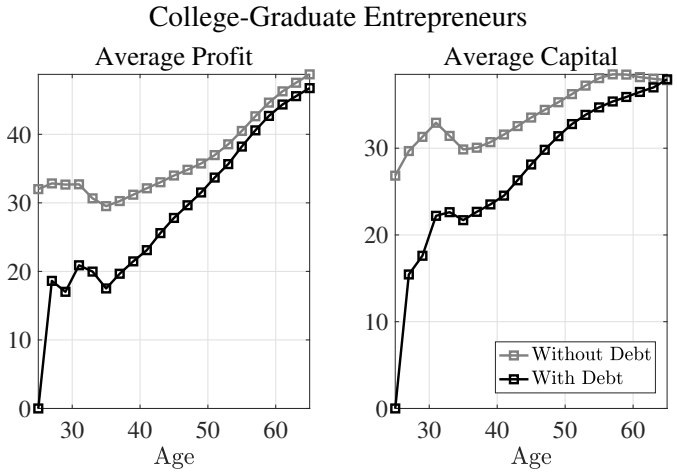
[75]The college attainment rate goes up by only 0.3 p.p. in this counterfactual economy. This suggests that, if college borrowing was not to influence entrepreneurial financial frictions, agents that choose to study would borrow more, but the increase at the borrowing margin would be relatively bigger than the increase in college enrollment itself.

Table 11: No Difference in Entrepreneurial Constraints With and Without Student Loans

	Output (w/ Student Debt)	Business Debt (w/ Student Debt)	$\frac{\text{Capital}}{\text{Labor}}$ (w/ Student Debt)	Output Aggregate
Change wrt Baseline	+5.39%	+3.75%	+4.96%	+2.11%

tween college-educated entrepreneurs with and without student debt decreases over time, especially after indebted households finish paying off their loans (i.e: 15 years after graduating college). However, since overcoming firm financial frictions through savings takes time, the gap in the average capital rented by college graduates with or without loans is wider and persists for relatively longer compared to other dimensions of business performance, as reported in Figure 3.

Figure 3: Intensive Margin



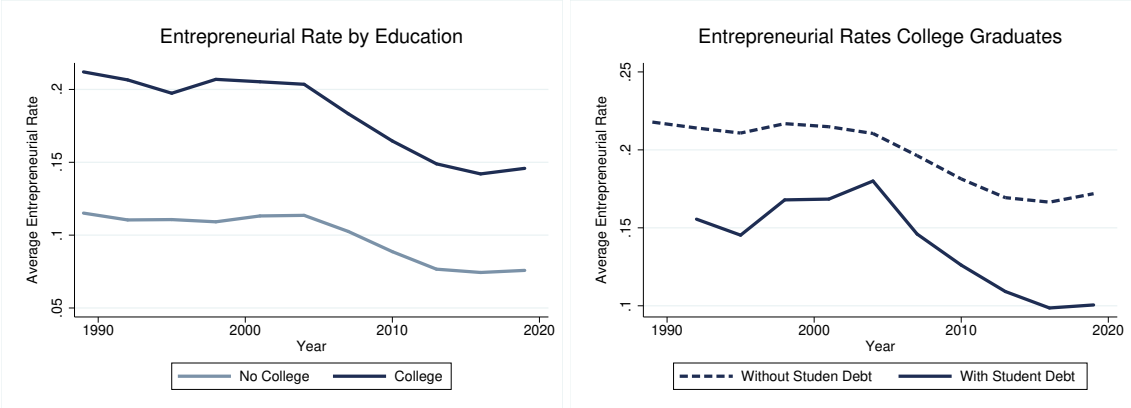
4.3 The Rise in Student Loans and the Decline in Entrepreneurship

In what follows, I use the calibrated model to analyse the rise in student loans and the drop in firm ownership rates for college graduates over the last decades. It is well documented that US entrepreneurial dynamism has been declining, and Jiang and Sohail (2017), Kozeniauskas (2018) and Salgado (2020) have shown that the drop is bigger for college graduates. Possible explanations range from the advent of a skill-biased technological change to the steady fall in the price of capital, which may have decreased skilled entrepreneurship if one assumes capital and skilled labor to be complementary in production. Both channels could have increased wages relative to entrepreneurial returns, pushing skilled individuals to select out of entrepreneurship. Kozeniauskas (2018) also argues that rising entry costs and outsized productivity gains by non-entrepreneurial firms could be responsible for the decline in entrepreneurship for relatively more educated people.

In addition to the previously discussed evidence and reasoning, Figure 4 further suggests that,

among highly-educated individuals, the decline in entrepreneurship over the recent years has been even steeper for college graduates with student loans. Could then the rise in student debt and the fall in entrepreneurship – especially for skilled individuals – be related, and, if so, how could their co-movement be rationalized through the lens of the model developed in Section 3?

Figure 4: Entrepreneurial Rates Over Time



The literature on firm dynamics has investigated various explanations for the drop in US entrepreneurial rates over time. It is beyond the scope of this section to offer an exhaustive review, and the goal of the model is not to account for all the proposed channels at once and disentangle their explanatory power. Based on the analysis done so far on the tighter constraints faced by firm owners with education loans, I rather aim to shed light on an alternative mechanism that could link the decline in the entrepreneurial rates of college graduates and the increase in student debt.

To this end, I first observe that there are two important trends related to the growth in education loans over time, namely the rise both in the college premium and in the tuition for college. As documented in Goldin and Katz (2010), Heathcote et al. (2010) and Doepke and Gaetani (2020) for example, the gap in average salaries between college and non-college graduates has widened over time. Today, workers that hold a bachelor degree earn on average 20-25% more than in the late 80's relative to high school graduates.[76] Moreover, the average price to attend either public or private universities has more than doubled since the 1980s,[77] growing faster than US inflation.

Connecting these trends together, increasing returns to higher education might have boosted the demand and the price for college. While recent research has shown the impact of other factors – such as the expansion in federal student aid and rising parental transfers – on college prices (Gordon and Hedlund (2020)), several papers have related the rise in tuition to the increase in the college premium (Jones and Yang (2016) and Fortin (2006)). In turn, higher university prices have been considered responsible for the soar in student debt (Kim and Kim (2022)). In the exercise that

[76] Researchers point at the so called skill biased technological change as a possible reason for such a rise in the college wage premium. In my exercise, I nonetheless consider such change over time as exogenously given, as it goes beyond the scope of my project to investigate what caused the rise in the wage of skilled compared to unskilled workers.

[77] `https://nces.ed.gov/fastfacts/display.asp?id=76`

follows, I link the expansion of student loans to the increase in tuition costs plausibly engineered by the rise of the college wage premium. Since, in my model, college debt disproportionately affects individuals that become entrepreneurs – especially through tighter financial constraints – I explore what is the effect of increasingly larger student loans on several entrepreneurial margins.

I estimate the model to the US economy of the late 80's, using available data to inform the main parameters already summarized in Table 8 and Table 9 for the baseline economy. I then keep everything fixed and target the following adjustments: a (i) 20% growth in the college premium, induced by a 15% increase in the parameter governing the life-cycle profile of college graduates' efficiency ζ_1^c;[78] and a (ii) rise of 16 p.p. in the college attainment rate, which is accompanied by a 180% hike in the tuition for college captured by the parameter χ.[79] The former adjustment fosters college enrollment through higher returns to education, while the latter ensures to deliver the average share of adults with a college degree in the US over the last decade, which is around 35%, as discussed in the strategy for the baseline calibration. I solve and simulate the economies of the late 80's and today: through the comparison of these two steady states, I can quantify the changes in entrepreneurial rates and outcomes attributable to the increase in college demand, college prices and student debt over time. Results for this counterfactual exercise are shown in Table 12.

Table 12: Changes between the late 1980s and Today

	Data	Model
Targeted		
College Premium	+ 20.0%	+ 20.0%
College Attainment	+ 16 p.p	+ 16 p.p.
Untargeted		
Total Student Debt	+ 788.90%	+ 689.50%
Share of Student Borrowers	+ 30.0 p.p.	+ 35.9 p.p.
Entrepreneurial Rate Overall	- 4.25 p.p.	- 0.50 p.p.
Entrepreneurial Rate College Graduates With Loans	- 5.47 p.p.	- 1.82 p.p.

The rise in both the college premium and the price to attend university leads to a consistent increase in the share of college graduates and student borrowers. From the late 80's to today, the fraction of student borrowers has gone up by 30 p.p. in the data, compared to an increase of 35.9 p.p. in my counterfactual exercise. Computing the total amount of education loans in the two steady states, the size of student debt in the economy has grown almost sevenfold, which lines

[78] The rise in ζ_1^c increases (deterministic) productivity growth for all graduates, consistent with evidence in Michelacci and Schivardi (2020) showing that the US college premium has increased similarly for both entrepreneurs and workers.

[79] I consider changes in the average tuition from the late 80's till today, using constant 2019-2020 dollars, as reported by the US Department of Education at `https://nces.ed.gov/programs/digest/d20/tables/dt20_330.10.asp`.

up well with estimates from the Congressional Budget Office of the US Government.[80] The model can then match 1/10 of the decline in entrepreneurial rates for the overall population, and 1/3 of the drop in entrepreneurial rates for college graduates with loans over the same period.

As expected, the rise in student debt engineered by soaring college demand and prices can explain a rather small share of the overall decline in entrepreneurial dynamism, suggesting indeed that many more GE forces are behind the trends observed in the data (see Decker et al. (2014) for instance). Yet, the increase in education debt and in the share of student borrowers might have played a much more important role in determining the fall in entrepreneurial dynamism for indebted highly-educated individuals over the last decades. In this, my findings complement the results in Salgado (2020) and Jiang and Sohail (2017), who focus on the relationship between the growth in the skill premium and the skill-biased entrepreneurial decline. Specifically, in the presence of firm collateral constraints that depend on entrepreneurial pledgeable assets and are hence tightened by outstanding education loans, I highlight the role of higher college tuition and student debt in depressing business ownership rates, especially for indebted highly-skilled individuals.

5 Bankruptcy Availability

A cornerstone of US credit markets are bankruptcy laws, which discipline loan discharge for distressed borrowers.[81] Unlike other forms of consumer debt, student loans have become (almost) non-dischargeable since 1998.[82] Exceptions regard individuals that join the public sector or the army, people affected by disabilities and those who can prove *undue hardships*. However, less than 0.001% of borrowers meet these standards and succeed in filing for bankruptcy (Iuliano (2012)), while roughly 10% of outstanding student debt is currently in default.[83] As discussed by Yannelis (2016), there is an active debate about education loans discharge, and the White House has discussed reintroducing bankruptcy protections for student debt holders both in 2015 and 2018.

From a macroeconomic perspective, Ionescu (2011) is one of the first works to stress the importance of studying different bankruptcy regimes for student loans, and understand their implications for repayment incentives, human capital investment and aggregate welfare. When it comes to entrepreneurship, Krishnan and Wang (2019) argue that student debt reduce the tolerance for risk, and the lack of a bankruptcy regime could increase the aversion of indebted college graduates to undertake entrepreneurial projects. Moreover, before the 1998 reform, education loans were unsecured credit that was easier to default upon, particularly in the case of financial hardships (Yannelis (2016)). Student debt discharge might have then acted as a "fresh start", especially

[80] `https://www.cbo.gov/publication/56754`.

[81] In 1934, US Supreme Court stated that bankruptcy "gives to the honest but unfortunate debtor a new opportunity in life and a clear field for future effort, unhampered by the pressure and discouragement of pre-existing debt".

[82] The *Higher Education Amendments* bill was first introduced in the House in January 1997, then it was approved by the House in May 1998 and by the Senate in July 1998, and it was finally put in place in October 1998.

[83] See `https://educationdata.org/student-loan-default-rate`.

because, in the US, credit scores recover faster for bankrupt individuals compared to those remaining insolvent (Albanesi and Nosal (2018)). According instead to the current legislation, borrowers who cannot repay or consolidate their education loans have their wages, income tax refunds or social security contributions garnished, and cannot easily dismiss their outstanding balances.

Leveraging the fact that, before the 1998 Higher Education Act, student loans were dischargeable in bankruptcy after seven years in repayment, I analyse the impact of this reform on entrepreneurship in two steps. First, I establish a link between the 1998 bankruptcy reform and the outstanding student debt balances of individuals surveyed in the SCF up to a decade after the reform. Since I have information on the repayment year in which they were by 1998,[84] I am able to further distinguish respondents who had or had not access to education loans bankruptcy. Second, I use a RDD framework to study the effect of outstanding student debt balances on entrepreneurship across cohorts who started repaying their education loans right before or after 1991.[85]

Moreover, I exploit the calibrated model from Section 3 to estimate the macroeconomic impact of the 1998 bankruptcy reform on entrepreneurial margins, capital misallocation and aggregate output. The goal is to replicate the key elasticity of business ownership to outstanding student debt that is empirically estimated through the RDD framework. In the model, outstanding college loans tighten entrepreneurial borrowing constraints, which are made less binding when bankruptcy is in place. Then, analysing the partial equilibrium (PE) response of entrepreneurship to education loans discharge serves as a counterfactual and further validation of the quantitative fit of the model, particularly with respect to the parameter η, which captures the severity of the financial constraint imposed by outstanding student debt on college-educated entrepreneurs.

5.1 The 1998 Reform to Student Debt Bankruptcy

Before 1998, borrowers could file for bankruptcy on their student debt after 7 years into repayment. While the 1998 bankruptcy reform is not a pure randomized treatment, it is a source of exogenous variation in the repayment options and hence in the amount of college loans owed by affected individuals early in their career. The discontinuity in the availability of student debt bankruptcy by repayment year when the 1998 reform stroke can then be exploited to estimate the impact of outstanding student debt on entrepreneurship through a RDD. In particular, the effect of loans discharge should first reflect in a jump in the amount of student debt owed after the 7th repayment year for individuals who had the option to declare bankruptcy. Then, through the lens of the model introduced in Section 3, lowering outstanding student debt balances could subsequently impact entrepreneurial financial constraints and the choice to become an entrepreneur.

I begin by focusing on outstanding student loans reported by individuals that started repaying

[84] It is imprecise to focus on the graduation year, due to loans grace periods and/or post-graduate education.

[85] Through an OLS model, Krishnan and Wang (2019) find that individuals graduating college with student loans but after 1998 have a lower likelihood of becoming entrepreneurs. However, the bankruptcy reform also applied to graduates from previous cohorts, who graduated before 1998 but had not reached the 7th year of repayment. This motivates my different empirical strategy through an RDD based on the repayment year individuals were by 1998.

at most 10 years before the 1998 reform. In the regression that follows, I control for the amount of debt agents graduated with and for the repayment year they were in by 1998 to account for the extent of initial balances and cohort effects. I also include as regressors their gender, ethnicity, marital and home-ownership status, and their income category by age and education as of the survey year. Within a 10-years window after the reform, Table B21 shows that agents that did not reach the 7th repayment year by 1998 are indeed associated with higher outstanding student debt.

Having established some evidence on the relation between bankruptcy availability and outstanding student debt, I then investigate the link between the 1998 reform and entrepreneurship itself. As illustrated in Table B22, being past the 7th repayment year has a strong positive effect on the likelihood of becoming an entrepreneur for cohorts entering repayment before 1991, while it does not matter after 1991. Note that almost all student debt repayment plans in the 1990s had a duration of 10 years. Accordingly, one should expect agents to have exercised the option to declare student debt bankruptcy right after reaching the 7th year into repayment, as confirmed in Table B23. As such, I exploit the discontinuity in the availability of bankruptcy represented by the 7th year into repayment at the time of the 1998 reform to estimate the differential likelihood of becoming entrepreneurs for cohorts who started repaying before 1991, compared those who started at some given point between 1992 and 1997. I first run the following parametric probit regression:

$$Pr(BusOwner_{it} = 1) = F\left(\beta_0 + \beta_1 SubjectReform_i + \beta_2 \Delta_i^{cutoff} + \boldsymbol{\gamma}' \boldsymbol{\Phi}_{it} + \alpha_t + \varepsilon_{it}\right) \tag{9}$$

where $BusOwner$ is a binary variable equal to 1 if individuals are entrepreneurs at t, and to 0 if they are not. The regressor $SubjectReform_i$ equals 1 if the respondent was before the 7th repayment year by 1998, and Δ_i^{cutoff} captures how far from the 7th year cutoff individuals were. Covariates and FEs are as in Equation 12, and results are shown in Table 13. Agents that were below the 7th repayment year cutoff in 1998 are less likely to turn entrepreneurs later on in their life-cycle. This is true across different specifications with respect to the choice of controls and bandwidths. The estimated β_1 coefficients range from -0.0568 to -0.0916, which corresponds to roughly a 1 p.p. decrease with respect to the average business ownership rates observed in the population.

The regression in Equation 9 is estimated parametrically, but coefficients do not qualitatively change when following Calonico et al. (2015) and allowing for more general specifications and data-driven choices of bandwidths.[86] Once again, Table 14 shows that individuals that were before the 7th repayment year by the 1998 reform are associated with a lower likelihood of becoming entrepreneurs.[87] In the baseline specification of Column (1), I use a linear polynomial to fit the

[86] The algorithm optimally chooses bandwidths which span 4 years above and below the 7th repayment year cutoff.

[87] For roughly 700 individuals I have information on the year in which they funded their business. Controlling for the initial amount of student debt, the repayment year by 1998 and demographic characteristics such as gender, ethnicity, marital and home-ownership status and income, the treated sample is associated with a 1.7 delay in their business funding year. Yet, the treated sample is also associated with higher sales and profits and bigger business size. This is consistent with selection into entrepreneurship becoming stricter across neighboring cohorts due to the removal of bankruptcy provisions, which could have also entailed lower net worth and a tightening of financial constraints.

Table 13: RDD Estimates of Likelihood of Business Ownership (Parametric)

	(2Yrs Bandwidth)	(2Yrs Bandwidth)	(3Yrs Bandwidth)	(4Yrs Bandwidth)	(4Yrs Bandwidth)
Subject to Reform	-0.0916***	-0.0901***	-0.0731**	-0.0772**	-0.0568**
	(0.0369)	(0.0369)	(0.0296)	(0.0261)	(0.0262)
Pre-Coll Controls	Y	Y	Y	Y	Y
General Controls	N	Y	Y	Y	N
Personal Wealth	N	Y	Y	Y	N
Survey Year FE	N	Y	Y	Y	N
Observations	1,565	1,565	2,168	2,887	2,887
R^2	0.0294	0.0472	0.0634	0.0487	0.0113
Avg Bus.Owners	0.1284	0.1284	0.1284	0.1284	0.1284

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner, and = 0 if not. Pre-College controls refer to agent's gender and ethnicity. General control variables are agents' education, age, marital and home-ownership status, initial student debt amount and income or wealth category.

regression. But estimates are robust to using a second order polynomial, applying a uniform kernel function to weight the regressions (as opposed to the default triangular one),[88] clustering standard errors at the repayment-year level and introducing the same covariates as in Table 13.

Table 14: RDD Estimates of Likelihood of Business Ownership (Non-Parametric)

	Baseline	2nd Order Poly	Kernel(uni)	Clustered St.Errs	Covariates
Subject to Reform	-0.0632**	-0.0694**	-0.0691**	-0.0672***	-0.0657**
	(0.0316)	(0.0339)	(0.0305)	(0.0153)	(0.0313)
Observations	4,782	4,782	4,782	4,782	4,782

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner, and = 0 if not. *Covariates* refer to agent's gender and ethnicity, age, marital and home-ownership status, assets and loan amount. Robust to include spousal income and the leverage ratio of the households instead of their asset positions.

As an additional robustness check, Figure B.1 illustrates graphically the discontinuity at the 7th year of student debt repayment and its relationship with the likelihood of being a business owner. The relatively small sample size leads to modest jumps in the estimated coefficients at different repayment years, but Figure B.1 shows that the only significant discontinuity is represented by the 7th repayment year cutoff. Also, the variable used to define the treatment and cutoff groups (e.g: the distance from the 7th repayment year by 1998) does not present jumps in its density around the relevant cutoff, suggesting little role for any confounding strategic behavior of individuals when approaching the 7th repayment year.[89] Finally, Table B24 illustrates that there is no correlation between being in the treated group and the main covariates included in Equation 9, while Table B25 contains standard placebos tests that strengthen the empirical validity of my results.[90]

[88] The uniform kernel function gives the same weight to all observations.

[89] That would be the case if households were to rush opening a firm before the 7th repayment year, in order to strategically discharge that loan as opposed to firm ones. The test has a T-statistics of 7.5009 and a p-value of 0.0000.

[90] As an additional check, I exploit similar RDD specifications to investigate whether the availability of student debt

5.2 Macroeconomic Impact

Next, I evaluate the impact of bankruptcy availability on entrepreneurship in my model economy. As in Kaboski and Townsend (2011), Lagakos et al. (2018) and Buera et al. (2021), this exercise is carried out in PE, without recomputing aggregate prices. To remain close to the RDD specifications above, my goal is to estimate the elasticities of entrepreneurial margins to the provision of a bankruptcy scheme, without letting the surrounding economic environment change at the same time. Moreover, it is plausible that the GE effects of the 1998 reform were not sizable, due to the fact that bankrupt individuals were a low share of all student debt borrowers back in the 1990's.

I hence fix the model parameters to the estimates in Table 8 and Table 9, keeping input prices and the tax rate to their baseline values. Second, I simulate an economy where I allow for student debt discharge after 7 years into repayment – the same way bankruptcy was implemented before the 1998 reform. In particular, I assume that households use assets to cover as much defaulted college debt as possible, liquidating the $\max\{a_t - d_t, 0\}$ in the year $t \geq 7$ in which they go bankrupt. After that, they are no longer responsible for loan repayments. Note that, to get correctly the overall impact, I have to carefully replicate in the model economy the average share of student debt that used to be discharged before the 1998 reform, estimated to be around 1.5% (Yannelis (2016)).

Two clear effects of student debt bankruptcy are worth discussing: on the one hand, college graduates who discharge their education loans after 7 years into repayment are then able to accumulate higher assets, as they become free of repayment obligations. At the same time, under the assumption that bankruptcy comes at no extra cost,[91] entrepreneurs' borrowing constraint may become less tight, leading them to rent higher levels of business capital. Both mechanisms are expected to boost the entrepreneurial rate of households with a college degree and who took out education loans to finance it, and to increase the amount of capital they rent for their business. The impact of bankruptcy availability on different entrepreneurial margins is reported in Table 15.

Table 15: Effect of Bankruptcy Availability on Entrepreneurship

Outcome	Change wrt to Baseline	Data
Entrepreneurial Rate of Graduates w/ Student Loans	+ 7.64%	*[6.32 – 9.16%]*
Entrepreneurial Debt of Graduates w/ Student Loans	+ 16.97%	
Total Entrepreneurial Output	+ 0.60%	

RDD regressions indicate that bankruptcy availability boosts the entrepreneurial rate of college graduates with loans by 6-9%, while the model simulation delivers a 7.64% elasticity, fitting more

bankruptcy affects other individuals' outcomes. Consistent with Folch and Mazzone (2020) and Ji (2021), I find that outstanding student loans reduce the likelihood of buying a house and marry. All the results are available upon request.

[91] This is not a straightforward assumption to make, as individuals declaring bankruptcy in the US are typically assigned a bankruptcy flag by banks, which lasts on their records for maximum 10 years. However, as found by Cohen-Cole et al. (2013), more than 90% of bankrupt individuals tend to receive credit shortly after filing for bankruptcy.

than 70% of the empirical estimates. The effect in the simulated economy is larger than in the data, consistent with the fact that bankruptcy availability is assigned randomly in my counterfactual, and I do not allow selection into student debt discharge along relevant individuals' characteristics. Moreover, bankruptcy availability increases business funding for college-educated entrepreneurs with student loans by 16.97%. By loosening entrepreneurial financial constraints and expanding capital rental capacity, the option of discharging outstanding student loans after 7 years into repayment reduces capital misallocation in the economy. Finally, the counterfactual exercise shows an increase in aggregate entrepreneurial output and welfare of +0.60% and +0.05% respectively.[92]

6 Policy Counterfactuals

In what follows, I use four policy experiments to further investigate the interplay between the characteristics of college financial aid and the extensive and intensive margins of entrepreneurship. I first study the effect of increasing the provision of college grants – considering need and merit-based ones. Second, I raise the borrowing limit on education loans. In the third experiment, I instead compare the baseline economy – where student debt repayment plans are *fixed* – to a counterfactual scenario where they become *income-driven*. This different scheme makes payments less binding in bad times, and also implies that remaining student debt balances are forgiven after their repayment term expires. Note that all interventions involve changes to the tax rate, as the budget constraint of the government must always balance. Moreover, by fostering college enrollment, all three experiments could in principle increase the amount of student debt per borrower and the size of the market for education loans, which makes their aggregate effects a priori unclear.

Finally, I conduct a preliminary assessment of President Biden's proposal to cancel off part of outstanding student loans. Following the plan the White House outlined in August 2022, I simulate the introduction of debt relief in my baseline economy, and compute the impact that this one-time intervention could have on entrepreneurship and the fiscal burden of affected taxpayers.

6.1 Expansion of Grants and Borrowing Limits

First, recall that the baseline model is characterized by missing markets for insuring against being born with low initial wealth a. Moreover, neither the maximum amount of student debt individuals can borrow, nor the grants provided by the government fully cover the tuition for college. As such, government interventions that ease the access to student loans or increase university

[92] Reasoning through GE dynamics, it is true the amount of student debt discharged in bankruptcy should in principle become a financial burden for the government in my framework, who would have to increase taxation to meet its budget constraint. Higher taxes would decrease consumption and savings, while higher entrepreneurial rates would raise the demand and price of capital and labor, making the resulting impact on output and welfare ambiguous. Allowing for GE effects, I find that exogenous student debt discharge would increase the tax rate by 0.5 p.p., while the entrepreneurial rate of graduates and the capital they would rent for business purposes would increase by less (+7.63% and +15.28% with respect to the baseline economy). Note that college-graduate entrepreneurs have a higher average productivity, but the increase in equilibrium prices and the tax rate would still decrease entrepreneurial output by 0.5%.

subsidies can address the under-investment in higher education, as noted in Abbott et al. (2019). In particular, they can ensure that a larger share of the population, especially highly-productive but constrained individuals, benefits from higher life-cycle earnings. Also, subsequently higher income tax contributions can in principle compensate the resulting increase in public expenditure.

I begin by analysing the effects of expanding grants schemes s_1 and s_2, noting that the former is means-tested and depends on one's family available resources, while the latter is proportional to students' merit. Moreover, I assumed s_1 is inversely related to initial wealth and given by: $s_1 = \phi_1 a^{-\psi_1}$, while s_2 increases with individuals' initial productivity according to: $s_2 = \phi_2 z$. On average, these grants cover 25% of the yearly cost of attending college. In the next counterfactuals, I follow the spirit of Abbott et al. (2019) and double the share of tuition covered by each grant separately. Then, I examine the subsequent changes on education and entrepreneurial choices, aggregate output and welfare.[93] Both exercises are performed in GE, by recomputing r, w and τ.

Table 16: Expansion of Means-Tested Grants

	Entrepreneurship (w/ Stud. Debt)	Output (w/ Stud. Debt)	Business Debt (w/ Stud. Debt)	Output Aggregate	College Attainment	Welfare Aggregate
Change wrt Baseline	+6.00%	-0.8%	-1.24%	+0.14%	+6.02%	0.72%

First, I expand need-based scholarships by raising the parameter ϕ_1 from 2.20 to 2.25 and keeping instead fixed the progressivity of the subsidy with respect to students' wealth (ψ_1). This increases the share of tuition covered by need-based grants from 12.5% to 25%. Second, I analyse an increment of merit-based scholarships by increasing the parameter ϕ_2 from 0.04 to 0.06, which raises the share of tuition covered by merit-based grants from 10% to 15%. In both cases, the government balance the rise in public expenditure with larger fiscal revenues. However, the model economy is characterized by a higher income profile for college graduates and by a proportional income tax. Therefore, the increase in the share of college-educated individuals induced by a more generous provision of grants enlarges the amount of fiscal revenues as well. Both policy changes are in fact fiscally self-sustained and do not lead to a higher equilibrium tax rate with respect to the baseline economy. Results for these counterfactuals are shown in Table 16 and Table 17.

Table 17: Expansion of Merit-Based Grants

	Entrepreneurship (w/ Stud. Debt)	Output (w/ Stud. Debt)	Business Debt (w/ Stud. Debt)	Output Aggregate	College Attainment	Welfare Aggregate
Change wrt Baseline	+8.97%	+12.29%	+0.86%	+2.30%	+9.84%	+1.82%

Expanding need and merit-based aid raises by 6% and 10% the college attainment rate in the

[93] I define aggregate welfare as the sum of utilities over consumption across the distribution of all individuals.

counterfactual economies, and by 19% and 25% the average amount of student debt per person.[94] Increasing merit-based grants induces relatively productive but constrained students to substitute education loans with publicly-provided financial aid (note that the share of student borrowers decreases by 4.9%), and allows a larger fraction of young adults to secure a high efficiency life-cycle profile thanks to college education. Both mechanisms raise entry into entrepreneurship and the output of indebted college-educated business owners. Due to a higher share of college graduates within the entrepreneurial sample, the productivity cutoff to open a firm shifts rightwards: together with the aforementioned effects, the crowding out of marginally less productive owners increases aggregate output by 2.3%, and contributes to a 1.8% increment in aggregate welfare.

On the contrary, doubling the size of need-based grants does not equally succeed in attracting potentially constrained but productive students into college, and has in fact the downside effect of marginally increasing by 5.3% the share of indebted graduates. Overall, the larger fraction of borrowers and the higher student debt burden worsen – instead of improving – the entrepreneurial performance of college-educated agents with loans. As a consequence, the counterfactual economy under higher means-tested grants does not register substantial positive compositional effects within the entrepreneurial sample, which limits the gains in aggregate output and welfare.

In a third exercise, I examine instead the effect of loosening college borrowing limits and allowing students to take out larger loans to finance their degree. In the baseline economy, the lower bound on loans $\underline{d}$ was set to a third of the average yearly tuition for a 4-years college degree. Since the model abstracts from enrollment in graduate studies, I considered an average of the maximum amount of loans granted for undergraduate degrees across dependent and independent students, including subsidized and non-subsidized federal loans, which corresponds to roughly $10,000 per year. In the experiment that follows, I increase by 25% the maximum amount students can borrow to finance college, and assess the impact of this reform on education choices, entrepreneurial margins, aggregate output and welfare. Differently from the counterfactual in Abbott et al. (2019), I do not assume student loans to fully cover the tuition, but rather look at a middle-ground case.

Table 18: Expansion of Borrowing Limits

	Entrepreneurship (w/ Stud. Debt)	Output (w/ Stud. Debt)	Business Debt (w/ Stud. Debt)	Output Aggregate	College Attainment	Welfare Aggregate
Change wrt Baseline	- 9.38%	-3.09%	-4.98%	+0.82%	+16.67%	+1.89%

As shown in Table 18, the expansion of the borrowing limit on student debt results in a 17% rise in college enrollment, and in a 58% increase in the average amount of borrowing per student. However, the share of borrowers among college graduates does barely move: this indicates that some prospective students are credit constrained, but the maximum amount of education

[94] Also, note that my framework does not include any disutility or psychic costs of attending university. An excessive increase in the provision of grants could produce a counterfactual and unrealistic rise in college enrollment.

loans granted does not affect one to one the choice of taking out loans. Moreover, a higher debt burden decreases business ownership for agents with student loans, limits the amount of business credit they get to finance capital acquisition, and reduces their entrepreneurial output. As a consequence, allocative efficiency – measured by the gap in college-educated entrepreneurs' $arpk$ by student debt – worsens by 6%. Nevertheless, the economy now features a larger share of highly-educated entrepreneurs, who enjoy a higher efficiency profile and income growth over the life-cycle. Despite a 0.3 p.p. increase in the GE tax rate to support the expansion of student debt limits, and the negative effects registered in the early stage of indebted graduates' entrepreneurial careers, this policy change still results in almost 1 p.p. higher aggregate welfare and output.[95]

As a final remark to these exercises, I want to stress two key limitations of my framework: on the one hand, I have modelled the college premium as an exogenous factor. Specifically, I have assumed that university-educated individuals enjoy a given higher efficiency profile over the life-cycle, which is not affected by the increased supply of college graduates induced by the policy changes explored above. On the other hand, the price to get a degree – denoted by χ in the model – does not move either throughout these counterfactuals, despite the fact that expanding the provision of grants or the borrowing limit on student debt causes a rise in college demand.

In future work, a possible solution to tackle these issues would be to endogenize the supply-side of higher education or to include a college market, as in Cai and Heathcote (2022). At the same time, I could also microfound further the presence and extent of the college premium by assuming skilled and unskilled labor to have a different degree of complementarity to the technology in the production function of entrepreneurs, as in Salgado (2020). This would in principle allow the premium and the price for college to react to changes in the supply of highly-educated agents and in the demand for higher education itself, which in turn could affect the quantitative results of the policy experiments I have studied. Here, I have instead followed Abbott et al. (2019) and kept the price and higher efficiency profile induced by college education fixed when assessing the impact of reforms to university financial aid, observing that the share of college graduates does not in fact increase exponentially or unrealistically in the counterfactual policy scenarios that I analyse.

6.2 Income-Based Repayment Plan

The second type of policy exercises I perform is a change to the repayment structure of student loans, by making their repayment tied to the income of borrowers in any given year. In the US, there are currently four different types of income-driven plans, which include the Revised Pay As You Earn (REPAYE), the Pay As You Earn (PAYE), the Income-Based Repayment (IBR) and the Income-Contingent Repayment (ICR).[96] All of them entail a repayment that varies between 10%

[95]The gain in individuals' efficiency induced by attending university is such that college-educated entrepreneurs, especially those without student debt, are relatively more productive than in the baseline economy, which raises both output and capital and labor demand. Higher input prices induce a mechanism of churning within the entrepreneurial sample, and make it harder for non-college individuals and college-graduates with student debt to open and run a firm.

[96]See information at: `https://studentaid.gov/manage-loans/repayment/plans/income-driven`

and 20% of agents' discretionary income.[97] Moreover, if the original loan is not paid off entirely after 20 or 25 years, depending on the plan, outstanding balances are forgiven. Interestingly, despite the fact that the US administration has passed actions requiring matriculating students to be informed about income-driven repayment options, these represent less than 15% of the plans subscribed in the last years. Similarly to Luo and Mongey (2019), I introduce in my model an IBR program, which was first launched in 2009, and assess its effects on macroeconomic outcomes.

Recall that, in my baseline economy, the initial loan balance due in repayment is divided into fixed tranches, which individuals pay along with interest rates on top of their outstanding debt until the end of their repayment term $T_{repayFIX} = 15$. Next, I assume instead that student loans get repaid through an IBR plan, under which agents have to disburse the minimum between the fixed repayment amount and 15% of their current income, as long as it exceeds 150% of the poverty line established by the government. If the latter condition is not met, the repayment due is zero. Moreover, borrowers have to pay interests on their outstanding loan balances, as for the standard repayment plan, provided that these do not exceed the payment on the principal. For now, I do not allow either for the endogenous choice of repayment plan upon graduation, or for the option to switch between plans. As for the previous exercises, this counterfactual is carried out in GE, and the government covers with fiscal revenues the higher public expenditure caused by both unpaid interests and the amount of debt forgiven after 25 years into repayment (recall that $T_{repayIBR} = 25$).

As noted by Luo and Mongey (2019), individuals that carry low amounts of student debt may benefit from the standard repayment plan, which enables them to run down quickly their small balances without bearing the burden of large interest rate payments that is involved in longer IBR plans. On the contrary, the IBR program is preferred at moderately higher debt levels, as it ensures higher consumption early on in agents' careers, when income is lower and the marginal utility of consumption is higher. The effect on aggregate outcomes is hence hard to assess a priori, as it depends on the endogenous selection of individuals into education and student debt, and is potentially interlinked to their consumption-saving and occupational decisions over the life-cycle.

Table 19: Income-Based Repayment Plan

	Entrepreneurship (w/ Stud. Debt)	Output (w/ Stud. Debt)	Business Debt (w/ Stud. Debt)	Output Aggregate	College Attainment	Welfare Aggregate
Change wrt Baseline	-12.32%	+11.60%	+9.97%	+2.65%	+8.33%	19.29%

Table 19 shows that, if all prospective students were enrolled in IBR plans, the college attainment rate would increase by more than 8%, the share of borrowers would raise by 35 p.p. and the average amount of student debt per person would double. Since the government would have to cover unpaid interest rates and guarantee debt forgiveness after 25 years of repayment, the aver-

[97] See `https://www.census.gov/library/publications/2021/demo/p60-273.html`

age GE tax rate would increase by 1 p.p. for all agents.[98] Results from this counterfactual exercise show that switching completely to IBR plans might not foster entrepreneurial entry, but may reduce the gaps in entrepreneurial outcomes across college graduates with and without loans. This is due to strong income effects, stemming from the fact that a longer repayment period and larger payments towards the middle-end of individuals' working careers reduce wealth accumulation, and discourage undertaking risky entrepreneurial activities. However, since student debt payments can effectively be delayed in bad times without increasing outstanding balances, adopting an IBR allows indebted college-educated entrepreneurs to rent higher capital and produce more on average.[99] The increase in business earnings and wages for all individuals in the economy more than compensate the higher fiscal pressure, and result in a 19% increase in welfare overall.

6.3 Student Debt Relief

In the last exercise of this section, I conduct a preliminary assessment of President Biden's recent plan to cancel off part of outstanding student loans, which was formalized and released by the White House on August 24th, 2022. While the proposal for a potential student debt relief has been discussed at least since the last US presidential campaign, the debate recently re-gained momentum, as America's working families are starting to recover from the strains associated with the COVID-19 pandemic. Behind this intervention lies the belief that the cost of college borrowing has become a burden preventing most student debt holders from enjoying the advantages post-high school education should grant. In particular, Biden's Administration has stressed how middle-class borrowers struggle with high monthly payments and ballooning balances, which make it harder – in their words – to build wealth, buy a house, open a business or save for retirement.[100]

President Biden's proposal entails up to $20,000 in debt cancellation for Pell Grant recipients with loans held by the Department of Education, and up to $10,000 in debt cancellation for non-Pell Grant recipients, provided that they do not belong to the top 5% income earners. Since it is estimated that nearly every Pell Grant recipient came from a family that made less than $60,000 a year,[101] student debt cancellation should specifically target low and middle-income debt holders, and would provide relief to 43 million individuals, including forgiving the remaining balance for roughly 40% of the borrowers. Yet, President Biden's forgiveness plan will lead the government to cover the $400 billions cost through tax increases, spending cuts, borrowing or a combination of these tools. This has spurred a debate over the redistributional consequences of the proposed intervention, and part of the public opinion argues that this measure does not address the root

[98] As noted in Abbott et al. (2019), policy reforms may have upfront costs for longer term benefits to future generations. In particular, this could imply that some of these policies would be better financed using long term government debt, instead of taxes falling on current generations. I leave the consideration of transitional effects for future work.

[99] My results are in line with the analysis of Ionescu (2009), who shows that student debt repayment flexibility increases enrollment, decreases default rates, and lead to redistributional effects that benefit low-income households.

[100] `https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/24/fact-sheet-president-biden-announces-student-loan-relief-for-borrowers-who-need-it-most/`

[101] See: `studentaid.gov/data-center/student/title-iv`.

cause of why students graduate from college with such huge debt burdens in the first place.[102]

In the counterfactual that follows, I simulate the introduction of President Biden's student debt relief in my baseline economy. Rather than offering a comprehensive discussion over whether and how to optimally conduct education loans cancellation, this exercise aims to study the impact that this particular intervention would have on specific aggregate outcomes. In practice, I take the calibrated steady state of my model and shock every cohort alive with a one-time student debt relief that mimics President Biden's proposal, and that affects individuals who are repaying their college borrowing. The set up of my framework allows me to closely replicate President Biden's plan, as Pell Grants are proxied by the need-based scholarship s_1, income is computed from either labor or entrepreneurial earnings, and a $10,000 debt cancellation corresponds to roughly a third of the average education loans balances at graduation. Since, at the moment of writing, there is still uncertainty over the steps that will follow any initial relief, I describe and focus only on the choices and outcomes of affected cohorts. In particular, I analyse how the extensive and intensive margins of entrepreneurship may react, and what the resulting fiscal pressure from this measure would be, without recomputing market clearing conditions. Results are shown in Table 20.

Table 20: Student Debt Relief

	Entrepreneurship (w/ Stud. Debt)	Capital-to-Labor (w/ Stud. Debt)	Interest Rate (Estimated Increase)	Avg Tax Rate (Estimated Increase)
Change wrt Baseline	+2.11%	+0.78%	+4.23%	+0.66 p.p.

Introducing a one-time student debt relief in the steady state of my economy would wipe out outstanding college loans for 52% of the borrowers (compared to the White House projection of 40% previously mentioned). In the cross-section, I also observe an increase of 2.11% in the entrepreneurial rate of college graduates, and a rise of 0.78% in the capital-over-labor ratio of firms run by college-educated entrepreneurs. Both effects may in principle represent improvements along the extensive and the intensive margins of entrepreneurship for indebted college graduates.

It is important to stress that these figures constitute an upper bound to the potential entrepreneurial gains that the current student debt relief proposal could obtain. Specifically, my preliminary assessment does not consider any feedback effect generated by subsequent changes in GE prices. Lower college debt repayments would free up more resources for all individuals and raise capital supply, but a higher entrepreneurial participation by graduates with loans would boost the demand for capital. On average, this could in fact increase the equilibrium interest rate by roughly 4%. Moreover, student loans forgiveness has to be covered exclusively with taxes, since the government in my model cannot issue public debt and uses only fiscal revenues to balance its budget constraint. As such, I estimate that college debt relief could increase the average

[102] See for example: `www.forbes.com/advisor/personal-finance/who-pays-for-student-loan-forgiveness/`.

fiscal pressure for all agents by almost 1 p.p., but nonetheless leave for future research a more thorough analysis of the full equilibrium response of the economy to debt forgiveness proposals.

7 Conclusion

In this paper, I have investigated the interplay of education and occupational choices over the life-cycle of households, focusing on the effect of student debt on entrepreneurship. Using micro-level data from the US Survey of Consumer Finances for the 1989-2019 period, I have documented a negative link between college borrowing and entrepreneurial outcomes. Results have shown that individuals with student loans are less likely to become business owners and obtain credit. Their firms also tend to be smaller in size, revenues and profits, but have better profitability margins.

I have rationalized my findings into a general equilibrium heterogeneous agents model, where individuals differ by wealth, productivity, age, education and student debt. During youth, households decide whether to attend college and how much to take out in education loans. When adults, they face productivity shocks and choose whether to open a firm or be workers. Importantly, college gives agents an income premium through higher deterministic productivity growth, but education loans slow down wealth accumulation and tighten the borrowing constraint of indebted entrepreneurs. Calibrated to the US, my model replicates between 30 and 80% of the empirical differences across entrepreneurs with and without education, and with or without student debt.

Second, I have exploited the 1998 reform to student debt bankruptcy and a Regression Discontinuity Design to estimate a 6 to 9% elasticity of firm ownership rates to education loans. I have then expanded my quantitative framework to include bankruptcy under the legal terms in order before 1998. I found a 7.64% partial equilibrium elasticity of entrepreneurship to student debt bankruptcy in the model, which is close to its empirical counterpart. In such scenario, capital misallocation would decrease, and entrepreneurial credit and output in the US would increase.

Finally, I have used the model to show that the boom in the average price of higher education – likely caused by the rise in the college premium – can account for the increase in the amount of student debt per person and in the share of borrowers over the past three decades. In turn, higher student debt levels could be responsible for a third of the decrease in business ownership rates for college graduates with loans. The model has also served as a quantitative laboratory to assess the effect of specific public policies on both individuals' choices and aggregate outcomes. In particular, I have studied the impact of college aid expansions and income-based student debt repayment plans on entrepreneurship, capital allocation and aggregate productivity in the US.

Looking ahead, I believe it would be important to endogenize the supply-side of education and the college premium in the model. This would allow me to analyse the equilibrium response of university demand and prices to shocks affecting the technology of firms, and investigate how changes in the higher education system influence individuals' labor market outcomes in the US.

Appendix

A Data Appendix

A.1 Variable Definition and Datasets Comparison

Table A1: Description of Demographic Controls

Variable	*Description*
Age	Age of the household (25 to 65 years old).
Ethnicity	Ethnicity of the household (White, Black, Latino, Other).
Education	It is a categorical variable measuring the highest level of education attained by owners. The original scale is from 1 (less than 4th grade) to 12 (professional school or doctorate). When specified, they are recoded into two levels, namely high school (and lower) and college (and higher) level. The latter refers to education categories "some college, but no degree", "associate's degree" and "bachelor's degree", "master's degree" and "professional school or doctorate".
Marital status	It is a binary variable equal to 1 if the household is married.
Number of Kids	Total number of kids in the household (0 to 10+).
Personal Debt	Includes principal residence debt (mortgages and HELOCs), other lines of credit, debt for other residential property, credit card debt, installment loans,and other debt.
Personal Assets	The sum of financial assets and non-financial assets held by households, such as savings account, bonds, annuities, retirement accounts, residences, vehicles among others.
Spouse Income	Income of working spouse, either from employment of self-employment
Home-Ownership	It is a categorical variable equal to 1 if households own the house where they live, and to 0 otherwise.
Parents' Education	It is a categorical variable measuring the educational attainment of the father and the mother. The levels are "less than high-school", "high-school diploma", and "college degree".

In Table A1, I describe the variables used in the main regressions of the paper, which refer to individuals' demographic characteristics, their average income or financial position. Note that Table A2 and Table A3 define instead the variables related to the businesses run by respondents and to their student loans. In Table A4, I also offer a comparison between the SCF and other datasets used to investigate trends and patterns in US college borrowing over time and within student cohorts. In particular, aggregate statistics from SCF related to the share of borrowers within college recipients and to the civilian population are compared to those obtained with data from (i) the

National Center of Education Statistics (NCES), which includes surveys such as the National Postsecondary Aid Study (NPSAS) and the Baccalaureate and Beyond (BB); (ii) the US Department of Education, and (iii) the Federal Reserve of New York Consumer Credit Panel (CCP), jointly with Equifax, which collects information for over 40 million agents.

Table A2: Description of Main Business Variables

Variable	*Description*
Ownership share	Continuous measure for the share in firm's ownership by respondents.
Hours worked	Average number of hours per week devoted to the business.
Legal status	Categorical variable for the legal status of the firm. Categories are sole proprietorship, partnership, limited liability company or corporation.
Collateralized debt	Business finance collateralized by the owner using personal assets.
Employees	Number of employees working for the business of the respondent.
Gross sales	Gross sales receipt in the year before the time of the interview.
Profits	Total pre-tax net income in the year before the time of the interview.
Net worth	Value at which respondent could sell the business at the time of the interview. Should exclude business loans and include business assets (implements and materials too).
Business age	Survey year minus the year in which the business was started.
Business origin	Categorical variable for whether the business was "started", "bought", "inherited" or "joined" by the respondent.
Sector FE	It refers to the 1-digit industry code.

Table A3: Description of Student Loans Variables

Variable	*Description*
Number of loans	Total number of education loans. Possible range: 0 to 6. However, 99% of the sample considered has between 0 and 3 education loans.
Amount of loan	How much was borrowed, not counting the finance charges
Amount to be repaid	How much is still owed on the loan at the time of interview
Repayment rate	Amount to be repaid periodically until extinguishing the loan
Interest rate	Annual rate of interest charged on the loan
Year loan taken	Year respondent took out his/her loan
Year started repayment	Year respondent started making payments on his/her loan
On schedule	Categorical variable for whether the loan is being paid off ahead of schedule, behind schedule, or on schedule.
IBR	Whether the respondent is enrolled in a income based repayment plan

Table A5 reports figures related to the average and median amount of student debt, considering all borrowers. The average amount of student debt upon graduation and per graduate (as opposed to per borrower) was $18,650 in 2004 and $24,200 in 2011 according to NPSAS, similarly to estimates from SCF. In 1992, the average debt at graduation was 13,500 according to NPSAS, and 12,538 according to SCF. As of 2019, the total amount of student loans is reported to be worth 1.4 trillions of dollars in SCF, 1.6 trillions of dollars in NCES and 1.7 trillions of dollars in FRED.

Table A4: Student Loans in SCF and Other Sources: Part 1

	1989 – 1992		2007 – 2010	
	SCF	NPSAS	SCF	NPSAS (NCES)
% Borrowers in College Recipients	53%	55%	63%	68% (62%)
	2007 – 2010		2016 – 2019	
	SCF	Census	SCF	Census
% Borrowers in Civilian Population	11%	12%	14%	16%
% Borrowers in College Educated Households	30%	33%	36%	37%

Notes: When computing estimates in SCF, survey weights are used. Number of borrowers are from `https://educationdata.org/student-loan-debt-statistics`. Share of college educated households can be found at `https://www.statista.com/statistics/184260/educational-attainment-in-the-us/`. Civilian noninstitutional population is from `https://www.bls.gov/emp/tables/civilian-noninstitutional-population.htm`. Estimates from the National Postsecondary Aid Study (NPSAS) are from Hershbein and Hollenbeck (2015). Estimates from National Center Education Statistics (NCES) can be found at `https://nces.ed.gov/programs/digest/d20/`.

One can also compare the SCF to other datasets under different dimensions, such as patterns in loans repayment and the distribution of loan balances. First, according to NCES, the cohort that entered student debt repayments in 2014 has shown a 12% default rate, compared to a 15% default rate computed using SCF and focusing on agents declaring that their student loan payments are "behind schedule". As reported by Brown et al. (2015) using CCP data on 40 millions individuals, 20% of borrowers still in repayment by 2004 were 90+ days late on their payments, against a 18% computed in SCF for the same year. Secondly, in 2014, the National Student Loan Data System (NSLDS) estimated that, among all borrowers, 42% of them had balances in excess of $25K, 17% of them had more than $50K and 5% of them had more than $100K. Using SCF data, I can compute those shares to be 48%, 24% and 5% respectively in 2014. Going back in time instead, in 1992 only 8% and 2% of borrowers had more than $25K and $50K student debt balances respectively according to NSLDS, and such figures line up with those estimated in SCF (9% and 2%).

On the negative side, it has been argued that, in 2013, the SCF underestimated the share of debt held by the top quintile of the income distribution compared to what administrative data merged with sources from the US Department of Education seem to suggest (27% against 35%).[1]

[1]See: `https://www.brookings.edu/blog/up-front/2019/06/28/who-owes-the-most-student-debt/`.

Table A5: Student Loans in SCF and Other Sources: Part 2

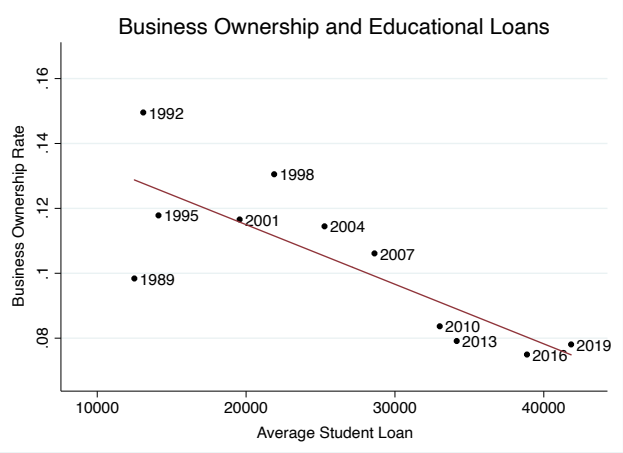
	2004			2010			2019		
	SCF	NPSAS	CCP	SCF	NPSAS	CCP	SCF	NCES	FRED
Avg. Amount	16,908	18,650	15,308	21,745	24,200	21,842	29,488	29,500	–
Median Amount	11,800	11,600	12,332	15,000	14,083	–	25,000	–	–

Notes: When computing estimates in SCF, survey weights are used and I winsorize data at the 99th percentile to exclude possible outliers and most likely misreported figures. Recent data on the total value of student debt is from the Federal Reserve Bank of St. Louis at `https://fred.stlouisfed.org/series/SLOAS`. Estimates from the National Postsecondary Aid Study (NPSAS) are from Hershbein and Hollenbeck (2015). For the *median amount* of 2010, I impute the value based on the growth rate of the median amount in NPSAS data over the 2004-2008 period. Estimates from National Center Education Statistics (NCES) can be found at `https://nces.ed.gov/programs/digest/d20/`.

A.2 Descriptive Statistics

In Figure A.1, I report the negative correlation between the average business ownership rate and the average student debt per person over time, considering loans with balances greater than 0 at the time of the interview for the sake of the computation. The graph controls for demographic characteristics such as gender, age, educational level, marital status, ethnicity and assets, and uses survey weights to ensure representativeness. Then, Figure A.2 breaks down the legal type of the businesses opened by college graduates with and without student loans. Possible categories are given by "sole-proprietorships", "partnerships", "corporations" (including C and S-corporations), and "limited liabilities companies". In the first two categories, the entrepreneurs have themselves unlimited liability for the business they run, either alone or with a partner. Both the second two categories provide limited liability protection, with the main difference being that a LLC is owned by one or more individuals, and a corporation is owned by its shareholders.

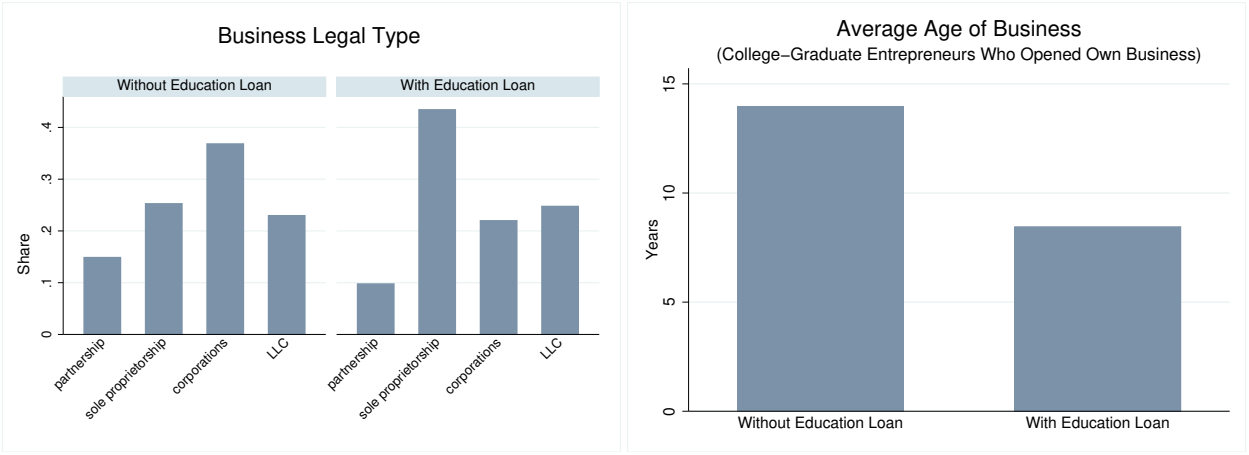
Figure A.1: Comparison over Time: 1989-2019



Moreover, in the right panel of Figure A.2, I report the average age (in years) of the firms started by entrepreneurs that have a college degree, distinguishing for whether they had to take

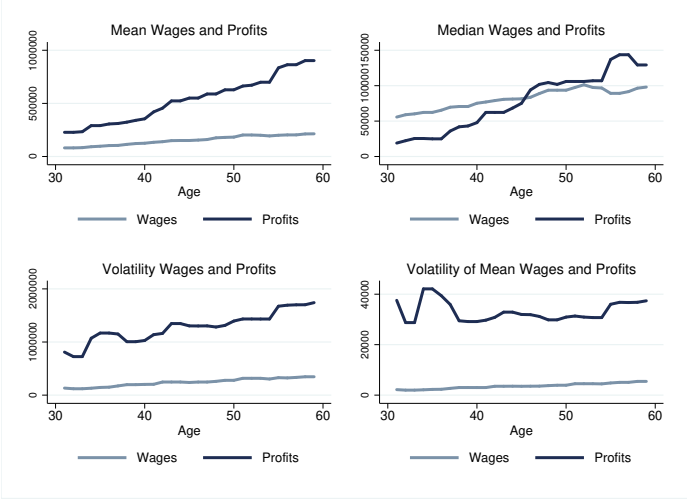
student loans or not (I could alternatively focus as well on those still repaying their loans at the time of the survey interview). In the SCF, individuals can indicate whether the business they own and actively manage was either "bought", "started", "inherited" or "joined". In the right panel of Figure A.2, I consider entrepreneurs that started their own business and have the same educational attainment, and I find that owners who had to borrow for college run firms that are on average 5 years younger, suggesting a delay in year in which entreprenenurs get to found their business.

Figure A.2: Legal Status and Business Age



Finally, I analyse some distributional properties of wages and profits for workers and entrepreneurs in the SCF data, pooling together all sample years and without conditioning on any control variable. Figure A.3 shows that, while the average and median values of wages and profits follow different patterns and growth trajectories over individuals' life-cycle, measures of relative volatilities stay virtually unchanged and stable. This justifies the modeling choice of assuming the stochastic component of productivity to only influence entrepreneurial profits and not wages.

Figure A.3: Distributional Properties of Wages and Profits over the Life-Cycle



A.3 Additional Regression Results

Table A6 reports that entrepreneurs with larger amounts of student debt (considering the initial debt taken or the balance still to be repaid at the time of the interview) have a higher probability of using their own assets as collateral for business purposes, and have larger share of collateralized firm debt, compared to owners of similar characteristics but without student loans.

Table A6: Collateral

	(1)	(2)	(3)	(4)
log(Original Student Debt Taken)	-0.0018	0.0168*		
	(0.0086)	(0.0088)		
Dummy(Have Loan)			0.1672*	
			(0.0873)	
log(Student Debt Still Owed)				0.0158*
				(0.0092)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	Y	Y
Firm Controls	N	Y	Y	Y
Survey Year FE	Y	Y	Y	Y
Industry FE	N	Y	Y	Y
Observations	40,085	39,401	39,401	39,401
R^2	0.0169	0.0846	0.0846	0.0846

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner, and = 0 if not. Pre-College controls refer to agent's gender and ethnicity. General control variables are agents' education, age, marital and home-ownership status and personal wealth. Firm controls include profits, business size, legal type and individuals working hours. Robust to include also spousal income and the leverage ratio of the households instead of their asset positions.

In Table A7, I provide a robustness check for the regressions estimated in Table 2, in which I control for respondents' net worth and isolate the correlation between student debt and business ownership beyond the impact that wealth and other outstanding loans can have on entrepreneurial entry. Note that, for this specific exercise, I use a different version of the SCF dataset, which contains summary variables for individuals' assets and liabilities. In particular, the website of the Federal Reserve provides access to an online tool called Summary Extract Public Data Files (SDA), from which I am able to construct a net worth variable defined as *Total Assets – Total Liabilities* and that excludes student loans. For instance, "total assets" merge together financial and non-financial wealth, including residences, vehicles, saving accounts, and any amount invested in mutual funds, stocks, pensions and bonds, among others. On the contrary, "total debt" includes principal residence debt (mortgages and HELOCs), lines of credit, debt for other residential property, credit card debt and installment loans, among others. Liabilities are to be considered as outstanding loans, including the amount of student debt reported (up to six education loans).

The SDA dataset differs from the one used in my main analysis insofar as it does not contain all the variables from the SCF questionnaire. For this reason, here I define as a business owner any respondent that actively manages a business, and then estimate again Equation 1 with outstanding student debt and individuals' net worth as main regressors. I also control for both pre-determined

variables (eg: gender and ethnicity) and contemporaneous ones (eg: age, educational attainment, number of kids, marital status). Finally, I include survey year FE and apply survey weights.

Table A7: Business Ownership (Summary Extract Public Data Files)

	(1)	(2)
log(Student Debt Still Owed)	-0.0034***	-0.0018***
	(0.0002)	(0.0002)
Pre-College Controls	Y	Y
General Controls	N	Y
Survey Year FE	N	Y
Observations	170,357	170,357
Pseudo-R^2	0.0218	0.0641

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner. Pre-College controls refer to agent's gender and ethnicity. General controls are agents' net worth, education, age, marital status and number of kids. Robust to including individual and spousal income.

Back to the dataset used for the main analysis, Table A8 reports the same regression as in Columns (1)-(2) of Table 2 and Table 5 controlling for parental education, which is available only for the 2016 and 2019 surveys. In Table A9, I instead conduct a robustness check for the results in Table 2 without restricting the firm ownership share to be 100% in order for individuals to count as business owners. In the SCF sample of entrepreneurs, 74% of them hold the entire ownership of their business, while almost 25% of them have at least a 50% share of their business. The share of entrepreneurs owning less than 50% of their firm is hence smaller than 1%, and it is not likely to change the quality and extent of my results. Finally, Table A10 carries out again the analysis in Table 2 but focusing only on the largest education loan reported by survey respondents.

Table A8: Entrepreneurial Margins (Controlling for Parental Education)

	Ownership	Ownership	Loan Approval	Loan Approval
log(Original Student Debt Taken)	-0.0031***	-0.0013**	-0.0180***	-0.0138***
	(0.0004)	(0.0004)	(0.0051)	(0.0033)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	N	Y
Firm Controls	N	N	N	Y
Survey Year FE	N	Y	Y	Y
Observations	31,652	31,004	1,422	1,422
R^2	0.0475	0.0641	0.2164	0.6311

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. In Columns (1)-(2), the dependent variable is a binary indicator = 1 if the individual is a business owner. In Columns (3)-(4), the dependent variable is a binary indicator = 1 if the business owner received a business loan over the 12 months previous to the survey interview. *Pre-College Controls* refer to agent's gender, ethnicity and parental education. *General Control* variables include agents' education level, age, marital status and home-ownership status, and income. Firm controls include size, business age, legal type and individuals working hours. Robust to including spousal income, the leverage or the assets of the households, and to using an income or wealth category by age and education instead of their personal income.

Table A9: Entrepreneurial Rates (No Ownership Share Restriction)

	(1)	(2)	(3)	(4)
log(Original Student Debt Taken)	-0.0028***	-0.0017***		
	(0.0002)	(0.0003)		
Dummy(Have Loan)			-0.0188***	
			(0.0024)	
log(Student Debt Still Owed)				-0.0017***
				(0.0003)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	Y	Y
Firm Controls	N	Y	Y	Y
Survey Year FE	Y	Y	Y	Y
Industry FE	N	Y	Y	Y
Observations	160,262	160,262	160,262	160,262
Pseudo-R^2	0.0383	0.0456	0.0457	0.0456

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner. Pre-College controls refer to agent's gender and ethnicity (robust to including parental education, available only for the years 2016/2019). General control variables are agents' years, age, marital and home-ownership status and income. Robust to including spousal income, the leverage or the assets of the households, and to using an income or wealth category by age and education instead of their personal income.

Table A10: Business Ownership, Largest Education Loan Only

	(1)	(2)	(3)	(4)
log(Original Student Debt Taken)	-0.0030***	-0.0019***		
	(0.0002)	(0.0002)		
Dummy(Have Loan)			-0.0166***	
			(0.0025)	
log(Student Debt Still Owed)				-0.0021***
				(0.0002)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	Y	Y
Survey Year FE	N	Y	Y	Y
Observations	170,302	170,302	170,302	170,302
Pseudo-R^2	0.0279	0.0554	0.0552	0.0594

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner. Pre-College controls refer to agent's gender and ethnicity (robust to including parental education, only available in 2016/2019). General controls are agents' education, age, marital and home-ownership status and income. Robust to including spousal income, households' leverage or assets, to using either an income or wealth category by age and educational level instead of agents' personal income, and to considering owners with any given equity share.

To complement the analysis conducted in Table 4, Table A11 shows how outstanding student debt balances correlate with the likelihood of business ownership for individuals of different age categories. I control for both pre-determined variables (eg: gender and ethnicity) and contemporaneous ones in a sequential way (eg: income, educational attainment, marital and home-ownership status). Finally, I include survey year FE and apply survey weights. Note that the regression is estimated non-parametrically and shows that the negative correlation between the amount of student debt owed at the time of the survey and business ownership decreases as individuals age.

This is in line with the economic intuition that the repayment of college borrowing should have a stronger impact on entrepreneurial margins at the beginning of individuals' working career.

Table A11: Business Ownership (Interaction Student Debt and Age)

	(1)	(2)
log(Student Debt Still Owed)	-0.0202***	-0.0303***
	(0.0039)	(0.0040)
log(Student Debt Still Owed) × 31-40yo	+0.0045	+0.0088**
	(0.0036)	(0.0035)
log(Student Debt Still Owed) × 41-50yo	+0.0078***	+0.0148***
	(0.0041)	(0.0039)
log(Student Debt Still Owed) × >50yo	+0.0180***	+0.0275***
	(0.0042)	(0.0040)
Pre-College Controls	Y	Y
General Controls	N	Y
Survey Year FE	N	Y
Observations	27,587	27,330
Pseudo-R^2	0.0290	0.0919

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner. Pre-College controls refer to agent's gender and ethnicity. General controls are agents' income, education, marital and home-ownership status, and the (log) original amount of student loan individuals graduated with.

In Table A12, I report the estimates for the likelihood of applying for a firm loan, given a set of control variables and the presence and extent of student loans in the household's balance sheet. The probability of applying for business credit is estimated via the following probit regression:

$$Pr(Apply_{it} = 1) = F\left(\beta_0 + \beta_1 Student\ Loan_{it} + \boldsymbol{\delta}'\boldsymbol{\Gamma}_i + \boldsymbol{\gamma}'\boldsymbol{\Phi}_{it} + \alpha_t + \epsilon_{it}\right) \tag{10}$$

where the outcome variable $Apply$ is an indicator equal to 1 if the entrepreneur mentions to have applied for a business loan in the 12 months before the interview took place, and 0 otherwise. Controls and regressors are the same as for the specifications reported in Table 5. The initial amount of student loans taken for college education does not correlate with the probability of applying for business funding (see Columns (1)-(2)). A similar observation holds true when using as main regressor a dummy for whether the individual carries still student debt balances to repay at the time of the interview, as shown in Column (3). The total amount to be repaid is only mildly significant, but the size of the standard errors calls for caution in interpreting the result.

In Table A13, I run alternative specifications for the regressions included in Table 6, where I have analysed the association between student loans and business outcomes such as size and gross sales. Differently from the specifications in the main text, here I use as main regressors either a dummy variable that signals the presence of pending student loans in the balance sheet of the households, or the actual amount still to be repaid as of the survey year t. In Table A14, I

Table A12: Business Loan Applications

	(1)	(2)	(3)	(4)
log(Original Student Debt Taken)	-0.0006	0.0014		
	(0.0009)	(0.0009)		
Dummy(Have Loan)			0.0098	
			(0.0093)	
log(Student Debt Still Owed)				-0.0017*
				(0.0009)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	Y	Y
Firm Controls	N	Y	Y	Y
Survey Year FE	Y	Y	Y	Y
Industry FE	N	Y	Y	Y
Observations	20,017	19,693	19,693	19,693
Pseudo-R^2	0.0283	0.1155	0.1154	0.1156

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner, and = 0 if not. Pre-College controls refer to agent's gender and ethnicity. General control variables are agents' education, age, marital and home-ownership status and personal wealth. Firm controls include profits, business size, legal type and individuals working hours. Robust to include also spousal income and the leverage ratio of the households instead of their asset positions.

report instead the results from the regression in Equation 3, focusing on profits and business net worth. Then, in Table A15, I conduct robustness checks on these very same specifications using as main regressors either a dummy variable that signals the presence of pending student loans in the balance sheet of the households, or the actual amount still to be repaid as of the survey year t. All the results are consistent with the baseline regressions in the main text.

Table A13: Business Outcomes: Size and Gross Sales

	Employees	Employees	Sales	Sales
Dummy(Have Loan)	-18.5950***		-0.4475***	
	(1.7959)		(0.0474)	
log(Student Debt Still Owed)		-2.0644***		-0.0436***
		(0.1975)		(0.0051)
Pre-College Controls	Y	Y	Y	Y
General Controls	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y
Survey Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Observations	39,461	39,461	36,855	36,855
Pseudo-R^2	0.0339	0.0339	0.4059	0.4053

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variables are either the number of employees or $\log(Sales)$. Pre-College controls refer to agent's gender and ethnicity (robust to include parental education, only available in 2016/2019). General control variables are agents' education, age, marital and home-ownership status and personal wealth. Firm controls include business age, legal type and individuals working hours (and business size in Columns (3)-(4)). Robust to include also spousal income and the leverage ratio of the households instead of their asset positions.

In Table A16, I run alternative specifications for the regressions on firms' profitability included in Table 7, using as main regressors either a dummy variable that signals the presence of pending

student loans in the balance sheet of the households, or the actual amount still to be repaid as of the survey year t. The full set of controls is used. Results are consistent with the baseline specifications in the main text: entrepreneurs with student loans to repay tend to have between 6% and 12% higher profitability, depending on the specification. Furthermore, an increase of 1000$ in the amount of student debt still to be paid is associated with 4% to 9% higher business profitability.

Table A14: Business Outcomes: Profits and Net Worth

	Profits	Profits	Net Worth	Net Worth
log(Original Student Debt Taken)	-0.0376***	-0.0294***	-0.0660***	-0.0523***
	(0.0057)	(0.0052)	(0.0045)	(0.0036)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	Y	Y
Firm Controls	N	Y	Y	Y
Survey Year FE	Y	Y	Y	Y
Industry FE	N	Y	Y	Y
Observations	33,673	33,014	36,001	43,988
R^2	0.0658	0.3219	0.0787	0.3150

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variables are the log(*Profits*) and log(*Net Worth*) of businesses, as reported by entrepreneurs in the sample. Pre-College controls refer to agent's gender and ethnicity (robust to including parental education, only available in 2016/2019). General controls are agents' education, age, marital and home-ownership status and income. Firm controls include business size, age, legal type and individuals working hours. Robust to including spousal income, households' leverage or assets, to using either an income or wealth category by age and educational level instead of personal income, and to considering owners with any given equity share.

Table A15: Business Outcomes: Profits and Net Worth

	Profits	Profits	Net Worth	Net Worth
Dummy(Have Loan)	-0.3314***		-0.5395***	
	(0.0504)		(0.0356)	
log(Student Debt Still Owed)		-0.0306***		-0.0550***
		(0.0055)		(0.0038)
Pre-College Controls	Y	Y	Y	Y
General Controls	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y
Survey Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Observations	33,014	33,014	43,988	43,988
Pseudo-R^2	0.3224	0.3218	0.3157	0.3151

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variables are the log(*Profits*) and log(*Net Worth*) of businesses, as reported by entrepreneurs in the sample. Pre-College controls refer to agent's gender and ethnicity (robust to including parental education, only available in 2016/2019). General controls are agents' education, age, marital and home-ownership status and income. Firm controls include business size, age, legal type and individuals working hours. Robust to including spousal income, households' leverage or assets, to using either an income or wealth category by age and educational level instead of personal income, and to considering owners with any given equity share.

In Table A17, I show that individuals' cognitive abilities are correlated with both higher amounts of grants and education loans. To this end, I use the US 1997 National Longitudinal Survey of Youth, which surveys and track a panel of households that were between 12 and 17 years old in

Table A16: Business Outcomes: Profitability

	$\log\left(\frac{\text{Profits}}{\text{Revenues}}\right)$	$\log\left(\frac{\text{Profits}}{\text{Revenues}}\right)$	$\log\left(\frac{\text{Profits}}{\text{CollDebt}}\right)$	$\log\left(\frac{\text{Profits}}{\text{CollDebt}}\right)$
Dummy(Have Loan)	0.1227***		0.0579***	
	(0.0243)		(0.0172)	
log(Student Debt Still Owed)		0.0128***		0.0062***
		(0.0027)		(0.0017)
Pre-College Controls	Y	Y	Y	Y
General Controls	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y
Personal Wealth	Y	Y	Y	Y
Survey Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Observations	39,461	39,461	39,461	39,461
R^2	0.1415	0.1413	0.0575	0.0575

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. Pre-College controls refer to agent's gender and ethnicity (robust to including parental education, only available in 2016/2019). General controls are agents' education, age, marital and home-ownership status and income. Firm controls include business age, legal type and individuals working hours. Robust to including spousal income, households' leverage or assets, to using either an income or wealth category by age and educational level instead of personal income, and to considering owners with any given equity share.

1997 and were followed since then. The survey means to be representative of the population, but I again make use of sample weights to further ensure representativeness. In terms of educational outcomes, the survey records the amount of grants and loans received by agents during college. Moreover, it reports the results to the Armed Services Vocational Aptitude Battery (CAT-ASVAB), which measures the respondents' skills in Arithmetic Reasoning, Electronics Information, Numerical Operations, Assembling Objects, General Science, Paragraph Comprehension, Auto Information, Mathematics Knowledge, Shop Information, Coding Speed, Mechanical Comprehension and Word Knowledge. The resulting estimates summarize the respondent's performance on each subtest on a scale that can be compared across respondents: a lower score indicates poorer performance, and a higher score indicates better performance This measure was included also in the previous 1979 National Longitudinal Survey of Youth and has been used by researches to proxy for households' underlying abilities (see for example Guvenen et al. (2020)). In the regressions that follow, I hence use the scores of respondents as a measure of cognitive abilities.

I control for college characteristics (eg: public vs private), and individuals' characteristics that were pre-determined to their college choices, such as their gender, ethnicity, parental education, family income and birthday year. Higher cognitive abilities correlate with higher amounts of grants, which are likely to capture students' access to merit-based aid, whereas they do not relate to the total amount of loans take out by respondents to finance college education. Moreover, I can check that higher cognitive skills do not predict a higher amount of grants compared to loans. This is consistent with the fact that grants for US universities typically cover a fifth of the total university tuition and are available only to individuals meeting specific background characteristics. Moreover, grants tend to be complemented by either borrowing or out-of-pocket contributions.

Table A17: Educational Outcomes in NLSY97

	Difference Grants vs Loans	Total Loans	Total Grants
Cognitive Skills	0.0025	0.0007	0.0031**
	(0.0019)	(0.0014)	(0.0013)
Controls	Y	Y	Y
Observations	4,107	4,873	5,765
R^2	0.1005	0.0776	0.1317

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. Controls include agent's gender and ethnicity, parental education, age, college type, college tuition, full-time vs part-time college attendance, and family income. Robust to the inclusion of *Cognitive Skills* as the only main regressor.

Using again the panel of respondents from the NLSY97, Table A18 shows that student debt is negatively associated with the likelihood of owning a firm even after controlling for individuals' cognitive skills. This strengthens the idea that the negative correlation between student debt and entrepreneurial outcomes found in the SCF is not driven by a group of particularly low-skilled households who happen to have taken out large amounts of education loans. In particular, I run the following set of probit regressions:

$$Pr(BusOwn_{it} = 1) = F\left(\beta_0 + \beta_1 Student\ Loan_i * Cognitive\ Skills_i + \delta' \mathbf{\Gamma}_i + \gamma' \mathbf{\Phi}_{it} + \alpha_t + \epsilon_{it}\right) \quad (11)$$

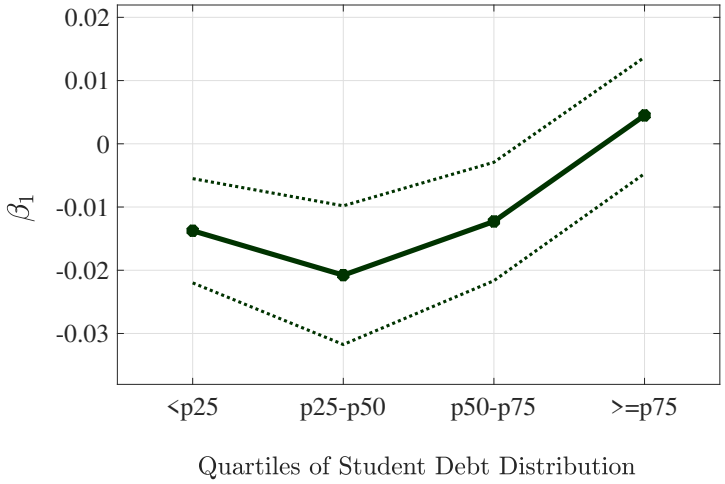
Table A18: Business Outcomes in NSLY97

	Ownership	Ownership	Ownership	Ownership
Dummy(Have Loan)	-0.0231***	-0.0279***		
	(0.0053)	(0.0072)		
Amount Taken			-0.0189***	-0.0189
			(0.0061)	(0.0122)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	48,345	28,688	8,354	8,354
R^2	0.0225	0.0242	0.0411	0.0411

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. Pre-College controls refer to agent's gender and ethnicity, parental education and income and birthday year. General control variables are agents' marital status, region of residency and assets. Column (4) clusters standard errors at the individual level and has a *p-value*=0.12.

where Y_{it} is a dummy signaling whether the respondent is an active business owner or not. I include self-employed individuals as I cannot define firm owners in the exact same way I did for SCF, namely focusing on ownership shares and presence of salaried workers. I include both controls that were pre-determined to the choice of education, as in Table A17, and contemporaneous control variables such as their region, marital status and wealth. Results are shown in Table A18 for the main regressors of interest, which are (i) an indicator for whether the household took out student debt, and (ii) the original amount of education loans contracted.

Figure A.4: Elasticity of Business Ownership to Student Loans



Finally, Figure A.4 shows the different elasticities of business ownership to outstanding student loans by quartiles in the distribution of total student debt taken out for college purposes (in dashed are the 95% confidence intervals). Regressions include controls as in Column (4) of Table 2 and survey weights, but condition on individuals that contracted education loans, as opposed to use the entire sample of SCF respondents. The purpose is to illustrate heterogeneity in the negative association between college debt and the extensive margin of entrepreneurship, and to show that results are not driven by individuals in the top percentiles of the student debt distribution.

B Bankruptcy Reform

Instead of an RDD, to quantify the impact of the 1998 bankruptcy reform on the extensive margin of entrepreneurship I can estimate a diff-in-diff probit regression of the following form:

$$Pr(BusOwner_{it} = 1) = F\left(\beta_0 + \beta_1 Post_{it} + \beta_2 Reform_{it} + \beta_3 Post_{it} \times Treated_{it} + \boldsymbol{\gamma}' \boldsymbol{\Phi}_{it} + \alpha_t + \epsilon_{it}\right) \tag{12}$$

where $BusOwner$ is a binary variable equal to 1 if individuals are entrepreneurs at the time of the survey, and to 0 if they are not. The regressor $Post_{it}$ captures the difference in business ownership rates before and after the 7th year of repayment, while $Treated_{it}$ is an indicator equal to 1 if individuals fall in the treated group and 0 if they belong to the control group. I consider three cases: in the first regression, the treatment group includes agents that started repaying their debt between 1992 and 1997, and the control group includes those that started repaying in or before 1991. In the second case, the treatment group is composed of individuals that started their repayment in or before 1991 but had still not finished repaying their education loans, while the control group contains households that had finished their repayment period by the time the reform stroke. Finally, a

third set of regressions compares individuals who started repaying their loans between 1992 and 1997 to a control group composed of those who started repaying after the 1998 reform took place.

Table B19: Business Ownership

	(1)	(2)	(3)	(4)
Post×*Reform*	-0.1190***	-0.1348***	-0.2363***	0.0118
	(0.0269)	(0.0299)	(0.0492)	(0.0186)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	Y	Y	Y
Personal Wealth	N	Y	Y	Y
Survey Year FE	Y	Y	Y	Y
Observations	4,398	4,398	3,421	17,756
Pseudo-R^2	0.0390	0.0644	0.0772	0.0213

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner, and = 0 if not. Pre-College controls refer to agent's gender and ethnicity. General control variables are agents' education, age, marital and home-ownership status. Robust to include also spousal income and the leverage ratio of the households instead of their asset positions.

In all three cases, the coefficient of interest is β_3, which captures the differential likelihood of transitioning into entrepreneurship for individuals that were subject to the reform and after their 7th year in student debt repayment. I then include a set of controls $\mathbf{\Phi}$, which capture factors pre-determined to the choice of taking on student loans and also include variables recorded at the time of the survey that were not pre-determined at the time in which the individuals made their student loans choices, such as their age, educational level, marital and home-ownership status, and personal wealth. All regressions include survey year fixed effects (α_t) and use survey weights.

Table B20: Business Performance: $\frac{\text{Profits}}{\text{Revenues}}$

	(1)	(2)	(3)
Post×*Reform*	0.0603**	0.16138***	-0.0065
	(0.0311)	(0.0485)	(0.0238)
Pre-College Controls	Y	Y	Y
General Controls	Y	Y	Y
Personal Wealth	Y	Y	Y
Survey Year FE	Y	Y	Y
Observations	4,398	3,421	17,756
R^2	0.0783	0.0832	0.0884

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner, and = 0 if not. Pre-College controls refer to agent's gender and ethnicity. General control variables are agents' education, age, marital and home-ownership status. Robust to include also spousal income and the leverage ratio of the households instead of their asset positions.

Columns (1) to (2) in Table B19 report the results of the first set of regressions, comparing individuals who started repaying their student loans before or after 1991. The inclusion of controls that are not pre-determined by the time the loan was taken does not alter the estimates: households who did not reach the 7th year into repayment by 1998 are 13% less likely to have

become entrepreneurs. Moreover, Column (3) focuses on agents that started repaying before 1991 but compares those who had and had not finishing paying their loans by 1998. Interestingly, the sign and magnitude of the estimated coefficient illustrates that those who were on time to declare bankruptcy before the reform took place, but lost such opportunity, are less likely to become entrepreneurs compared to those who were completely done paying by 1998. Since the regressions control for survey year fixed effects, the results are unlikely to be due to a declining time trend in business entry only. This is further confirmed by the estimate in Column (4), which shows that college graduates who started repaying between 1992 and 1997 are not less likely to become entrepreneurs compared to the new cohorts who started repaying after the reform took place.

Furthermore, as reported in Table B20, being subject to the reform and hence not being able to discharge student loans in bankruptcy has a positive effect on the profit margin of treated entrepreneurs, consistent with a phenomenon of stricter selection into the entrepreneurial pool. Once again, the effect primarily regards individuals who started repaying after 1991 but before the reform took place, and agents who started repaying before 1991 but did not finish repaying their loans by 1998. The results therefore suggest an effect of the 1998 reform to student loans bankruptcy availability also on the *intensive* margin of entrepreneurship for treated cohorts.

Table B21: Outstanding Student Debt and Bankruptcy

	(1)	(2)
Past 7th Repayment Year by 1998	0.0997**	0.0788*
	(0.0449)	(0.0446)
Pre-College Controls	Y	Y
General Controls	N	Y
Survey Year FE	Y	Y
Observations	2,167	2,142
R^2	0.5374	0.5533
F-Statistic	477.70	266.10

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is the outstanding student debt balances reported by individuals interviewed up to 10 years after the 1998 reform that were within 10 years into their loans repayment by 1998. Pre-College controls refer to agent's gender, cohort year, and ethnicity. General control variables are agents' education, loan size, marital and home-ownership status, income and age. Robust to include also spousal income and the leverage ratio of the households instead of their asset positions.

In Table B21, RDD regressions show that being past the 7th year of education loan repayment correlates with lower outstanding student debt balances for cohorts that had the bankruptcy option available. I both control for factors that pre-determined to the choice of college and student debt as well as a battery of subsequent controls that can be contemporaneous to the choice of becoming entrepreneurs. To avoid the confounding effect of few outliers that repaid their loans for more than 2 decades, I consider respondents that started repaying before 1998 are were surveyed at most 10 years after the 1998 bankruptcy reform was passed (i.e. up to the 2009 survey). In particular, after controlling for age effects (including interactions as well), being past the 7th year of repayment is shown to be associated with a lower amount of outstanding student debt balances.

In Table B22, I document that being past the 7th year of educational loan repayment correlates with the likelihood of transitioning into entrepreneurship only for cohorts that had the bankruptcy option available. I both control for factors that pre-determined to the choice of college and student debt as well as a battery of subsequent controls that can be contemporaneous to the choice of becoming entrepreneurs. In particular, after controlling for age effects, being past the 7th year of repayment for recent cohorts does not matter anymore, but used to matter for cohorts that had the possibility to declare bankruptcy on their student debt after 7 years into full repayment.

Table B22: Business Ownership

	(1) After 1991	(2) Before 1991	(3) After 1991	(4) Before 1991
Past 7th Year	-0.0269	0.5745***	-0.0286	0.5773***
	(0.0247)	(0.0971)	(0.0251)	(0.1121)
Pre-College Controls	Y	Y	Y	Y
General Controls	N	N	Y	Y
Personal Wealth	N	N	Y	Y
Survey Year FE	N	N	Y	Y
Observations	17,751	1,768	17,751	1,768
Pseudo-R^2	0.0141	0.0569	0.0232	0.0973

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner, and = 0 if not. Pre-College controls refer to agent's gender, cohort year, and ethnicity. General control variables are agents' education, loan size, marital and home-ownership status. Robust to include also spousal income and the leverage ratio of the households instead of their asset positions.

In Table B23, I run a similar set of regressions as in Table B22 to show that, before the 1998 reform took place, being past the 9th or 10th (or higher) repayment year cutoffs had no relationship with the likelihood of transitioning into entrepreneurship. The relevant repayment year cutoff was the 7th or the 8th one, suggesting that probably most of bankruptcy discharges were happening as soon as agents were past the 7th year into repayment had had legal access to the bankruptcy option. Moreover, I also check that these cutoffs are no longer significantly associated with the likelihood of transitioning into entrepreneurship for cohorts that started repaying their loans after 1991 and hence did not have any bankruptcy regime available (all results available upon request).

Figure B.1 shows the discontinuity in the likelihood of becoming an entrepreneur by repayment year, considering individuals that were repaying their student loans around the time of the 1998 bankruptcy reform. The underlying regression is estimated using the - rdplot - package from Calonico et al. (2015), using a polynomial fit of order 1, survey weights, no covariates and the default triangular kernel function to smooth observations.

Furthermore, Table B24 checks that the main covariates included in Table 13 and Table 14 do not correlate with being in the treated or control group. To do that, I perform simple OLS regressions to assess the correlation between the covariates and the indicator function for whether households are in the treated group, considering individuals that were in a window of 3 years from the 7th repayment year cutoff. Note that Columns (3)-(6) also include the running variable

Table B23: Business Ownership

	(1) Before 1991	(2) Before 1991	(3) Before 1991
Past 8th Year	0.3375**		
	(0.1233)		
Past 9th Year		-0.0794	
		(0.1299)	
Past 10th Year			-0.1580
			(0.1194)
Pre-College Controls	Y	Y	Y
General Controls	Y	Y	Y
Personal Wealth	Y	Y	Y
Survey Year FE	Y	Y	Y
Observations	1,768	1,768	1,768
Pseudo-R^2	0.0818	0.0741	0.0956

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner, and = 0 if not. Pre-College controls refer to agent's gender, cohort year, and ethnicity. General control variables are agents' education, loan size, marital and home-ownership status. Robust to include also spousal income and the leverage ratio of the households instead of their asset positions.

Figure B.1: RDD Estimates

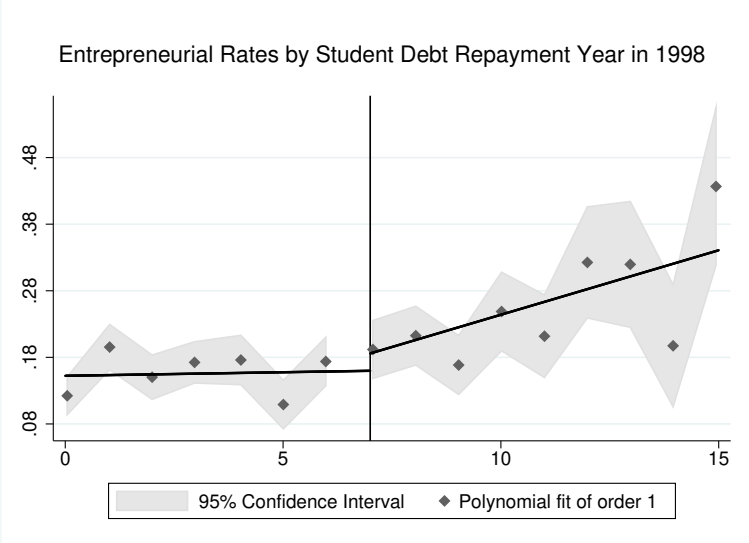


Table B24: Covariates and Treatment Effect

	Gender	Ethnicity	Marital Status	Assets	Amt Ed.Loan	Age
Subject to Reform	-0.0206	0.0486	0.0239	0.3265	-0.0811	0.3313
	(0.0175)	(0.0313)	(0.0221)	(0.3283)	(0.0924)	(0.7850)

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used.

as in Equation 9 to control for time (or cohort) effects that could otherwise confound the estimates.[2]

Finally, Table B25 conducts placebo tests to assess the validity of the RDD regressions in Ta-

[2]Within a window around the cutoff point, individuals belong to different cohorts. What this means is that, for example, they would be likely to have accumulated more or less assets, or to be a couple of years younger or older.

Table B25: Business Ownership

	(1) Non-Affected 2-Y Bandwidth	(2) Non-Affected 4-Y Bandwidth	(3) Affected 2-Y Bandwidth	(4) Affected 4-Y Bandwidth
Subject to Reform	0.0113	0.0111	0.0286	0.0075
	(0.0471)	(0.0431)	(0.0280)	(0.0261)
Pre-College Controls	Y	Y	Y	Y
General Controls	Y	Y	Y	Y
Personal Wealth	Y	Y	Y	Y
Survey Year FE	Y	Y	Y	Y
Observations	1,310	1,531	2,133	2,660
Pseudo-R^2	0.0918	0.0755	0.0680	0.0538

Notes: Estimates are average marginal effects. Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Survey weights are used. The dependent variable is a binary indicator = 1 if the individual is a business owner, and = 0 if not. Pre-College controls refer to agent's gender, cohort year, and ethnicity. General control variables are agents' education, loan size, marital and home-ownership status. Robust to include also spousal income and the leverage ratio of the households instead of their asset positions.

ble 13. In Columns (1) and (2) I include individuals that were theoretically past the 7th year repayment cutoff. My running variable counts the distance (in years) from a fictitious 9th repayment year cutoff and hence compare cohorts that, for example, started repaying their loans between 1988 and 1991 and cohorts that started repaying between 1984 and 1987. In Columns (3) and (4) I include individuals that were theoretically all below the 7th year repayment cutoff and hence are all treated by the reform in 1998. My running variable counts the distance from a fictitious 4th repayment year cutoff and hence compare cohorts that, for example, started repay their loans between 1992 and 1994 and cohorts that started repaying between 1995 and 1997. I consider 2 years and 4 years bandwidths to show that the results are not driven by the choice of the window around the cutoff year of interest. I show regression outcomes for the full set of control variables, but results are robust to the inclusion of pre-determined controls only (available upon request).

C Model Specifications

C.1 Time Transformation: the Education Stage

In Section 3, I have developed a life-cycle model of education and occupational choices, where the reference period for calibration purposes is a year. Since my framework has abstracted from other dynamic choices during the education stage of individuals' life after they decide to enroll in university (eg: college dropout), and there is full commitment to graduate, I have assumed that agents spend only 1 period in college to save on notation and simplify the analysis. Yet, I have to ensure the time-consistency across all three stages in life (i.e: education, working life and retirement) for the correct quantification and calibration of the model. In particular, since in real-

life agents spend 4 years in college, the value function for young adults that decide to enroll in university in their first year of their life $t = 1$ (or T_{edu}) is given by:

$$V^c(a_t, z_t, age_t) = \max_{a_{t+4}, d_{edu,t}, c_t} \left\{ \sum_{t=1}^{4} \beta^{t-1} u(c_t) + (\beta \theta_{age_t})^4 \int W^c(a_{t+4}, z_{t+4}, d_{t+4}, age_{t+4}) d\Xi(z_{t+4}|z_t) \right\}$$
$$\text{s.t.} : 4 * c_t + a_{t+4} = (1 + r_t)^4 a_t + 4 * (d_{edu,t} - \chi_t)$$
$$\text{and} : a_{t+4} \geq 0, \quad c_t \geq 0, \quad 0 \leq d_{edu,t} \leq \underline{d}$$

where I assume that individuals maintain the same profile of consumption across the 4 years spent in university, they pay the same yearly tuition – net of grants, as explained in previous sections – and choose the same yearly amount of college loans to pay for it. Their assets a_t are capitalized for 4 periods, and their future value W^c is discounted at the rate β^4. In a similar spirit, the value function for young adults that do not enroll in college in their first year of their life $t = 1$ (or T_{edu}), enter directly the labor markets and choose between being workers or entrepreneurs is given by:

$$V^{nc}(a_t, z_t, age_t) = \max_{a_{t+4}, c_t} \left\{ \sum_{t=1}^{4} \beta^{t-1} u(c_t) + (\beta \theta_{age_t})^4 \int W^{nc}(a_{t+4}, z_{t+4}, age_{t+4}) d\Xi(z_{t+4}|z_t) \right\}$$
$$\text{s.t.} : c_t + a_{t+4} = (1 + r_t)^4 a_t + (1 - \tau) \max\{\pi(a_t, z_t, age_t; r_t, w_t); \tilde{w}_{age_t}\}$$
$$\text{and} : a_{t+4} \geq 0, \quad c_t \geq 0, \quad k_t \leq \lambda a_t$$

C.2 Introducing a Corporate Sector

In an alternative version of the model, I include an unconstrained sector that contributes to total production in equilibrium. I do this to check that my results are not driven by the fact that my baseline economy has only one productive sector, in which entrepreneurs are constrained and in which outstanding student loans reduce the collateral that can be pledged to rent capital. Note that, in models à la Cagetti and De Nardi (2006) that include both entrepreneurial and non-entrepreneurial firms, it is often assumed that entrepreneurs produce using only capital, so that the size of the non-entrepreneurial sector is pinned down by the measure of workers in equilibrium (i.e: the share of the population who is not entrepreneurs). To remain close to the assumptions of the framework laid down in Section 3, I augment my economy with a corporate sector where unconstrained firms have all the same productivity and produce using capital and labor. Since corporate firms rent capital and labor as well, to obtain a well-defined measure of the unconstrained sector I have to assume that corporate firms operate according to a decreasing returns to scale technology with span of control parameter ν. Their production function is given by:

$$f(k, l) = A(k^\alpha l^{1-\alpha})^{1-\nu}, \quad \text{with} \qquad 0 < 1 - \nu < 1$$

In each period t, corporate firms rent capital and hire labor at the equilibrium input prices $r_t + \delta$

Table C26: Alternative Calibration w/ a Corporate Sector

Fitted	Value	Description	Moment	Model	Data
β	0.99	Discount factor	Interest rate	0.05	0.04
χ	1.00	College tuition	Educational rate	0.31	0.35
σ_a	3.50	Dispersion initial wealth	Top10 wealth share	0.69	0.70
ρ_{az}	0.25	Correlation initial (a, z)	Inter-generational earnings	0.30	0.28
ν	0.78	Entrepreneurs span of control	Top10 income share	0.43	0.45
A	1.475	Corporate productivity	Share corporate employment	0.30	0.30
σ_ϵ	0.305	St deviation prod shocks	Top25 employment share	0.57	0.65
ρ_z	0.92	Persistence entrep prod	Serial correlation revenues	0.84	0.80
λ	1.65	Financial constraint 1	Avg. corporate debt/GDP	0.27	0.35
η	0.125	Financial constraint 2	Δ Entr rates w/ – w/o Sloans	5pp	5pp
ζ_1^c	0.0573	Trend income growth (college)	Income growth year 0 - 30	0.84	0.86
ζ_2^c	0.0012	Curv. income growth (college)	Income growth year 30 - 40	0.07	0.05
ζ_1^{nc}	0.0310	Trend income growth (no coll)	Income growth year 0 - 30	0.48	0.48
ζ_2^{nc}	0.0004	Curv. income growth (no coll)	Income growth year 30 - 40	0.08	0.10

and w_t, always determined in GE. Their profits are then distributed lump-sum to all households in the economy. In essence, corporate firms will differ from entrepreneurial businesses in two dimensions. First, their productivity A will be allowed to differ from the one of the entrepreneurial sector to reflect size differences across entrepreneurial businesses and corporations. Second, corporate firms will not face a borrowing limit when renting capital using financial markets. Thus, I modify my calibration strategy to be so that the value assigned to A imply that the share of employment of the corporate sector is 30%, as estimated for the US based on Compustat firms (see Davis et al. (2006)). Results from the estimation are presented in Table C26.

There are three main differences in the calibrated values of this extended model version with respect to the baseline case. The first one, is a 20% decrease in the parameter η that governs the student debt-related entrepreneurial borrowing constraint. Since the presence of another productive sector increases the demand for capital and labor, the GE wage and interest rate increase, further discouraging indebted college graduates from entering entrepreneurship. Secondly, the discount factor β has to rise to compensate for the upwards pressure on the equilibrium interest rate caused by the increase in the demand for capital in the economy. Moreover, a higher GE wage induces young adults at the margin to select out of college, which implies a slightly lower calibrated value for the college tuition κ in order to match the average college attainment rate in the US over the last decade (parallel to that, the value for the parameter ϕ_1 governing the extent of need-based grants increases by more than 20% to match the average share of tuition covered by means-tested scholarship). Finally, the fit of untargeted moments is close to the one of the baseline model: yet,

since the presence of another productive sector increases the demand for capital and labor, the GE wage and interest rate increases, which lowers entrepreneurship by roughly 1 p.p. with respect to the baseline economy for both college and non-college graduates, with and without loans. Their respective share within the entrepreneurial sample stays instead relatively the same.

C.3 Introducing Student Debt Forbearance

As of today, roughly 20% of outstanding education loans are reported to be in deferment or forbearance, two available options for borrowers who are (currently) unable to pay back their debt, but intend to in the future.[3] The main differences between these two options for pausing student debt payments regard the average length of the programs, their qualifying requirements and the accrue of interest rates. In particular, deferment typically can last three years, while forbearance is granted for maximum 12 months for at most 3 times. To qualify for deferment, agents have to prove they are enrolled in school at least half time, or they are facing financial hardships, such as being unemployed or undergoing medical treatment for example. Instead, a specific qualifying event is usually not necessary to file for forbearance. Finally, under deferment, interest does not accrue on subsidized federal student loans and Perkins loans, while interest accrues on all types of loans under forbearance. Since 90% of borrowers in deferment are those who enroll in post-graduate schools, not included in my model, I keep my focus on student debt forbearance, especially given the relevance that forbearance has played in the recent pandemic years.[4]

I introduce forbearance in the baseline model in a stylized way, by assuming that college borrowers are subject to a "forbearance" shock with probability μ, which allows them to stop repayments for a year. Although the decision to apply for forbearance is surely an endogenous choice, such simplifying assumption keeps the model tractable and allows me to qualitatively study the implications of student debt forbearance for my framework. Since, according to the current US legislation, student debt forbearance doe not impact individuals' credit scores, I assume that the only cost of forbearance is the interest rate accrued during the pause from repayment, which is capitalized on top of individuals' outstanding balances. Note that, since payments are suspended and interest is capitalized during the period spent in forbearance, the subsequent amount individuals have to pay by the end of their repayment term increases after (any) episode of forbearance. Finally, I calibrate μ such that the average time individuals spend in forbearance is 1.75 years.[5] Results from the calibration exercise for the internally fitted parameters are reported in Table C27.

Externally fixed parameters are by default kept at their baseline values. The main difference in the quantification of this model extension is that the value of η – the student debt-related entrepreneurial borrowing constraint – inferred through the calibration procedure is roughly 25% lower than in the baseline economy. This is consistent with the fact that, under forbearance, agents

[3] See `https://www.experian.com/blogs/ask-experian/research/student-loan-debt-and-repayment/`.
[4] For more information see `https://educationdata.org/deferment-vs-forbearance-student-loan`.
[5] See the report at `https://www.gao.gov/products/gao-18-163`.

Table C27: Alternative Calibration w/ a Student Debt Forbearance

Fitted	Value	Description	Moment	Model	Data
β	0.98	Discount factor	Interest rate	0.04	0.04
χ	1.25	College tuition	Educational rate	0.37	0.35
σ_a	3.50	Dispersion initial wealth	Top10 wealth share	0.69	0.70
ρ_{az}	0.25	Correlation initial (a, z)	Inter-generational earnings	0.31	0.28
ν	0.79	Entrepreneurs span of control	Top10 income share	0.45	0.45
μ	0.875	Prob delaying payments	Share Sdebt in forbearance	0.20	0.20
σ_ϵ	0.305	St deviation prod shocks	Top25 employment share	0.63	0.65
ρ_z	0.92	Persistence entrep prod	Serial correlation revenues	0.84	0.80
λ	1.65	Financial constraint 1	Avg. corporate debt/GDP	0.30	0.35
η	0.11	Financial constraint 2	Δ Entr rates w/ – w/o Sloans	5pp	5pp
ζ_1^c	0.0573	Trend income growth (college)	Income growth year 0 - 30	0.84	0.86
ζ_2^c	0.0012	Curv. income growth (college)	Income growth year 30 - 40	0.07	0.05
ζ_1^{nc}	0.031	Trend income growth (no coll)	Income growth year 0 - 30	0.48	0.48
ζ_2^{nc}	0.0004	Curv. income growth (no coll)	Income growth year 30 - 40	0.08	0.10

can pause their yearly payments and hence do not have to serve on their student debt obligations, which may increase the amount of capital they are able to rent as entrepreneurs through collateral pledgeability.[6] No other cost or credit reduction is in place after forbearance, and the higher repayment amounts individuals have to disburse after an episode of forbearance on average hit them later on in their life-cycle, when they have already accumulated savings as a buffer. As a final remark, note that the estimation of the model predicts a slightly higher value for the span of control parameter: this may indicative of the fact that, as forbearance allows entrepreneurs to rent higher capital, this counterfactual economy may in principle register an increase in entrepreneurship, which hence is partially counterbalanced by a decrease in the extent of entrepreneurial profits.

[6]Interestingly, while almost all untargeted moments stay roughly the same in this model extension, the share of student borrowers decreases by 15 p.p. with respect to the baseline model (the education rate is instead targeted). This suggests that, the higher expected cost of taking out loans to finance college, given by the probability of pausing repayments and accumulate higher interest rates, discourage some borrowers at the margin from getting student debt.

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