The Strategic Overuse of Student Loans*

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February 24, 2019

Abstract

This theoretical model shows that students strategically overuse student loans. In imperfect labour and credit markets, firms compensate graduates for a share of their loans via higher wages. This shifts some costs to firms and low-skilled workers who suffer from higher unemployment and lower wages. While any student loan increases unemployment, the effects on welfare and inequality depend on the purpose of the loan: A loan for tuition fees reduces human capital and credit accessibility, the college premium increases significantly, and welfare declines. A loan spent on consumption increases education and credit accessibility, while wage inequality and welfare change marginally.

JEL classification: J23, J24, J41, J64
Keywords: search frictions, imperfect credit markets, student loans, college premium

*I am grateful to Leo Kaas, Stefan Zink, Carlos Alós–Ferrer and two anonymous referees for numerous helpful comments and remarks. I would also like to thank the German Research Foundation (DFG) for funding.

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1 Introduction

In the past years, the "student loan bubble" and the "student loan crisis" have captured increasing attention by the media, politicians, and economists. Student debt as share of total non-mortgage consumer debt has increased from 10.5% in 2001 to 32.2% in 2017 (Center for Microeconomic Research, 2018). While rising tuition fees and declining public contributions to colleges have contributed to these loans, there is also evidence that students take on higher or more expensive loans than necessary. Dynarski and Scott-Clayton (2006) argue that the federal system for student aid is too complex in order to achieve its redistributive goals. In a natural experiment, Stoddard et al. (2017) show that students who receive information on their individual student loan debt improve their academic outcomes. However, they do not adjust their borrowing. A survey by Wilbert and Haddad (2014) among 962 students finds that 23.1% of the students who consume "luxury items and services" such as television game systems, pedicures/manicures, going out to eat, or vacations, choose to use their loans to pay for these luxury items. One might argue that this is just irrational overspending by young adults or an attempt to intertemporarily smooth consumption. However, this paper shows that in presence of credit and labour market frictions, students can increase the net present value of their consumption by strategically overusing student loans.

There is a large strand of literature discussing credit market frictions and borrowing constraints for students. While firms that invest in machines can offer this physical capital as collateral, banks cannot directly seize a student's education, skills and knowledge. This may restrict the credit market access of potential students with few own funds and can prevent efficient investments in human capital (Galor and Zeira, 1993). Even for the high school graduates who have access to student loans, credit market imperfections distort the education decision if banks exhibit market power and extract rents.

Once a worker has graduated she must apply her skills in imperfect labour markets. Informational and coordination frictions prevent the invisible hand from clearing the market and give rise to unemployment and unfilled vacancies. Amongst others, Acemoglu (1997), Albrecht and Vroman (2002) and Sato and Sugiura (2003)

consider the effects of these imperfections on human capital. Acemoglu and Shimer (1999) show how labour market imperfections can create hold-up problems that distort the incentives to invest in capital: the costs of investing in capital are already sunk when firms and workers later decide how to split the surplus of a worker-firm match. Therefore, these costs are not considered during the wage-bargaining process. If investors pay the entire costs but only receive a fraction of the benefits of their investment due to the market power of their counterpart, investment is inefficiently low. Acemoglu and Shimer (1999) focus on physical capital, but the same mechanism works for human capital: The worker pays for her education, but when firms and workers bargain on the wage these costs are sunk. However, Moen (1998) argues that contingent loans shift the costs of education back into the wage-bargaining process and seem to solve the hold-up problem: workers pay the credit rates for their student loan only while they are employed at a firm, but the payment is interrupted if a worker becomes unemployed. This way the credit rates are considered as opportunity costs of working during the surplus splitting and efficiency is restored. In a related study, Kaas and Zink (2011) use a model with directed search to illustrate that contingent loans provide incentives to search for jobs that offer higher wages, giving rise to higher unemployment.

This paper shows how such a combination of imperfect credit and labour markets shifts some burden of the student loans from students to firms and unskilled workers. In order to model the informational frictions and the complicated procedure of finding the best way to pay for college, I do not assume an exogenous borrowing constraint, but students must first *search* for a bank that provides a student loan. The imperfections on the credit market are similar to the ones on the labour market, both with search frictions in the spirit of Pissarides (2000). It takes some time to obtain a loan (or respectively for banks to find a borrower), depending on the ratio of the credit supply of banks to the credit demand of prospective students. Students pay an endogenous interest rate above the risk-free rate on their debt. Wasmer and Weil (2004) use an analogous approach to show how imperfect markets for venture capital amplify the adverse effects of labour market imperfections, and how even moderate frictions on both markets are sufficient to generate substantial unemployment. The credit market for student loans differs from the credit market for venture

capital in various dimensions. In particular, students usually can offer only little collateral, and in contrast to physical capital, human capital cannot be seized if the student cannot pay back his credit. While "only" 11.5% of all student loans were delinquent for at least 90 days in Q3 2018 (Center for Microeconomic Research, 2018), a significantly higher share of students with student loans go through some periods of default. According to Scott-Clayton (2018), 27.2% of the students who entered college in 2004 had defaulted on a student loan at least once in the following 12 years. They project that the cumulative default rate of this cohort will rise to 38.2% within 20 years after these students had entered college. This demonstrates that a lot of students struggle to pay their credit rates for an extended amount of time, for instance during unemployment. However, in contrast to most other types of debt, it is very hard to declare bankruptcy on student loans.[1] This also explains why the outstanding student loan debt does not decline significantly during recessions. As soon as the borrower finds a new job, he has to continue to pay the credit rates. I implement this observation by assuming that the credit takes the form of a contingent loan. That is, banks and students anticipate (or even explicitly write into the credit contract) that workers cannot pay credit rates while they are unemployed, but that the credit cannot be forgiven. As soon as the worker finds a new job, the credit rates are paid again.

This provides incentives for workers and banks to strategically use contingent loans to establish higher wages for well educated workers. The main mechanism works as follows: the imperfections in both markets give all participants some bargaining power when they decide how to split the surplus of a bank-worker match (the bargaining on the credit contract) and a firm-worker match (the wage bargaining). As workers must only pay back the contingent loan during employment, the repayments are considered as part of the opportunity costs of working. Therefore, firms compensate skilled workers for a share of their credit costs via higher wages. Banks and workers internalise this effect when they bargain on the credit contract, giving rise to higher credit rates and a further increase in wages for skilled workers. Thus, students are willing to accept higher credit rates, anticipating that they will be at

[1] Iuliano (2012) finds that "barely 0.1 percent of student loan debtors in bankruptcy sought to discharge their educational debts".

least partially compensated by higher wages.

An increase in student loans can be used to pay for higher tuition fees or to finance more consumption. While in both cases some of the costs are indirectly paid by firms and low-skilled workers, they have opposing effects on credit supply and the incentives to study. If loans increase because tuition fees rise, the increase in wages for college graduates is not sufficient to compensate students for the higher costs of education. Thus, the surplus of a match between a student and a bank declines, fewer people go to college and credit supply tightens. In contrast, if loans increase to pay for consumption, the surplus between student and bank rises: The credit is a transfer between both parties, but firms increase wages to compensate workers for higher loans. Thus, if loans grow in order to pay for more consumption, the incentives to study increase and credit supply rises. Students have an incentive to take on excess student loans to pay for consumption despite significant premia on the interest rates.

A numerical simulation illustrates some additional quantitative results: While both types of student loans increase unemployment as well as the college premium, and both types of loans reduce welfare, these effects are stronger if the loan is used to pay for tuition fees. An increase in student debt to pay for consumption has only marginal effects on unemployment, welfare, and the skill premium, and it has even a positive (albeit small) effect on the wages of low-skilled workers.

The paper is organised as follows. Section 2 introduces the economic environment, section 3 derives the equilibrium. Section 4 simulates two experiments, an increase in student loans to pay for higher tuition fees and another increase to pay for higher consumption. Section 5 concludes.

2 The Model

Consider an economy that is populated by three types of risk-neutral agents: workers, banks and firms. Workers enter the model after having finished their secondary education and they must decide whether or not they want to go to college. Study-

ing raises productivity, but it is costly: colleges charge tuition fees and prospective students are not endowed with sufficient funds to finance their studies on their own. Therefore, students have to find a bank that will give them a loan to cover their expenses. After obtaining their degrees, students enter the labour market as skilled workers and try to find a job. Those who do not go to college search directly for a job as unskilled workers without entering the credit market.

2.1 The Labour Market

We follow Pissarides (2000) and assume that searching for a job or a worker is costly and takes time. In particular, if there are $\mathcal{U}$ unemployed workers and $\mathcal{V}$ vacancies in the labour market, the total number of matches can be described by the function $m(\mathcal{U}, \mathcal{V})$. This matching function is homogeneous of degree one. The flow probability that an individual firm with a vacancy meets a worker $q(\theta)$ is

$$\frac{m(\mathcal{U}, \mathcal{V})}{\mathcal{V}} = m\left(\frac{1}{\theta}, 1\right) = q(\theta). \tag{1}$$

This probability depends only on the ratio of vacancies to unemployed workers, the *labour market tightness* $\theta = \mathcal{V}/\mathcal{U}$ (from a firm's perspective). The probability that an unemployed worker finds a job vacancy is

$$\frac{m(\mathcal{U}, \mathcal{V})}{\mathcal{U}} = \frac{m(\mathcal{U}, \mathcal{V})}{\mathcal{V}} \cdot \theta = m\left(\frac{1}{\theta}, 1\right) \cdot \theta = \theta q(\theta). \tag{2}$$

The higher the ratio of open vacancies to unemployed workers θ, the longer it takes for an individual firm to fill a vacancy and the easier it becomes for a worker to find a job, so

$$\frac{\partial q(\theta)}{\partial \theta} < 0 \text{ and } \frac{\partial \theta q(\theta)}{\partial \theta} > 0. \tag{3}$$

2.2 The Credit Market

We use a similar approach as Wasmer and Weil (2004) and model credit market imperfections as search frictions, symmetric to the labour market[2]: Let $\mathcal{B}$ be the

[2]This approach not only keeps the model tractable, but also accommodates the findings of Carneiro and Heckman (2002) that direct credit constraints prevent only a small fraction of young women and men from acquiring higher education. Thus, "softer" credit constraints, such as search frictions, are more suitable to model the credit market for student loans.

number of banks searching for a debtor on the credit market[3], and $\mathcal{S}$ the number of students searching for a loan. Then the total number of matches between prospective students and banks is determined by the function $h(\mathcal{B}, \mathcal{S})$, again homogeneous of degree one. The flow probability that a student finds a bank at every instant can be written as function of the *credit market tightness* $\phi = \mathcal{S}/\mathcal{B}$ (from a student's perspective),

$$\frac{h(\mathcal{B}, \mathcal{S})}{\mathcal{S}} = h\left(\frac{1}{\phi}, 1\right) = p(\phi). \tag{4}$$

The probability that a bank finds a matching partner is

$$\frac{h(\mathcal{B}, \mathcal{S})}{\mathcal{B}} = \frac{h(\mathcal{B}, \mathcal{S})}{\mathcal{S}} \cdot \phi = h\left(\frac{1}{\phi}, 1\right) \cdot \phi = \phi p(\phi). \tag{5}$$

The higher the number of students per bank ϕ the harder it is for workers to find a matching partner and the easier it becomes for banks to find a debtor,

$$\frac{\partial p(\phi)}{\partial \phi} < 0 \text{ and } \frac{\partial \phi p(\phi)}{\partial \phi} > 0. \tag{6}$$

2.3 Unskilled Workers

Workers who decide on their education compare the present value of a career as a skilled worker to the present value of the earnings as an unskilled one. First consider an agent who decides against going to college but directly searches for a job as an unskilled worker. The present value of all cash flows of an unemployed unskilled worker W_0^u and an employed unskilled worker W_1^u can be described by the following Bellman equations:

$$rW_0^u = b + \theta q(\theta)[W_1^u - W_0^u], \tag{7}$$

$$rW_1^u = w^u + s[W_0^u - W_1^u]. \tag{8}$$

The agent enters the labour market in phase 0 as an unemployed unskilled worker and earns flow income b (domestic work, social benefits for agents without income, and the value of leisure). He is matched to a firm with probability $\theta q(\theta)$. In this case he bargains for his wage w^u and starts to work for the firm (phase 1). With

[3]We can also interpret $\mathcal{B}$ as a measure for the credit supply of banks, determined by the funds reserved for student loans.

the exogenous probability s a shock hits the firm, the match is destroyed and the worker is unemployed again. We solve these equations for W_0^u and obtain the net present value of a career as an unskilled worker:

$$\begin{aligned} W_0^u(\theta) &= bd(\theta)/r + w^u[1 - d(\theta)]/r \text{ with} \\ d(\theta) &= \frac{r+s}{r+s+\theta q(\theta)}, \frac{\partial d(\theta)}{\partial \theta} < 0. \end{aligned} \tag{9}$$

The total income of this worker consists of unemployment benefits b during spells of unemployment and wage income w^u while the worker is employed. The term $d(\theta)$ helps to determine the present value of all cash flows that an agent expects to receive in all unemployment periods[4]. The worker receives unemployment benefits b in phase 0 until he leaves unemployment, which happens with probability $\theta q(\theta)$, and also discounts cash flows with rate r. However, with probability s the worker loses his job and is unemployed again. On the other hand, the unskilled worker can also expect some wage income. The present value of all wage earnings consists of all potential earnings minus the earnings that are forgone because the worker is unemployed every now and then, thus $w^u - w^u d(\theta)$.

2.4 Skilled Workers

Now consider a worker who has decided to go to college and the corresponding Bellman equations:

$$rW_0^s = b + p(\phi)[W_1^s - W_0^s + C], \tag{10}$$

$$rW_1^s = b + \theta q(\theta)[W_2^s - W_1^s], \tag{11}$$

$$rW_2^s = w^s - \rho + s[W_1^s - W_2^s]. \tag{12}$$

First, the worker has to search for a bank in order to obtain financial support for his studies (phase 0). In this state he earns flow income b. With probability $p(\phi)$ he finds a bank and bargains for the conditions of the credit contract, in particular the size of the repayment rate ρ, and studies.[5] The bank pays the tuition T directly

[4]It is also possible to broadly interpret $d(\theta)$ as the fraction of cash flows that is generated in periods of unemployment. However, note that $d(\theta)$ also considers discounting.

[5]For now, we assume that studying does not take any time and that no students drop out of college. However, we will consider these in the simulation.

to the university and an additional amount C directly to the student, who uses it for consumption during his education. The student graduates and enters the labour market as skilled worker at the beginning of phase 1. As an unemployed worker he receives unemployment benefits b and is matched to a firm with probability $\theta q(\theta)$. In this case he bargains for his wage and starts working (phase 2), earns the wage w^s and starts paying back his loan ρ until the match is destroyed exogenously with probability s.

We can derive the value of a skilled worker who has just obtained a loan and now starts to study W_1^s in two different ways: First, we compute the expected costs to find a bank, that is solving (10) w.r.t. W_1^s to obtain (13). Second, we compute the net present value of all future cash flows this worker can expect by using (11) and (12) to obtain (14).

$$W_1^s = W_0^s - C + \frac{rW_0^s - b}{p(\phi)}, \text{ and} \tag{13}$$

$$W_1^s = bd(\theta)/r + (w^s - \rho)[1 - d(\theta)]/r. \tag{14}$$

The value of a worker who has found a bank (13) is equal to a worker who just entered the credit market W_0^s plus the expected costs of finding the bank, net of the transfer of the bank that has been consumed and is therefore sunk immediately before the worker enters phase 2. The present value of all following cash flows (14) is similar to the one of unskilled workers, but the skilled worker receives the wage w^s and has to pay credit rates ρ while he is employed.

2.5 Banks

Next consider the value of a bank in the different states:

$$rB_0 = -k + \phi p(\phi)[B_1 - B_0 - T - C], \tag{15}$$

$$rB_1 = \theta q(\theta)[B_2 - B_1], \tag{16}$$

$$rB_2 = \rho + s[B_1 - B_2]. \tag{17}$$

(15) determines the value of a bank that has just entered the credit market B_0 and starts to search for a student. The bank has to pay flow searching costs k for its employees and for holding the money for the loans in short term investments with low returns. The bank is matched to a student with probability $\phi p(\phi)$ and

then bargains for the credit contract ρ. Afterwards, it pays the tuition fees T to the university and the transfer to the student C. Then the bank enters phase 1 and has to wait until the worker finds a job. While the worker is unemployed the bank does not experience any direct cash flows. However, the longer the worker stays unemployed, the longer the bank has to wait for the repayment of its loan. Once the worker is matched to a firm the bank enters phase 2 and receives the flow repayment ρ. Whenever the worker goes through a spell of unemployment the credit rates are interrupted (and the bank drops to phase 1) until the worker finds a new job.

We can use these Bellman equations to compute the value of a loan B_1 by solving (15) with free entry of banks, $B_0 = 0$. On the other hand, a bank that has just paid for the education of a student can estimate the present value of all cash flows from this worker by substitution of B_2 from (17) into (16).

$$B_1 = \frac{k}{\phi p(\phi)} + T + C, \tag{18}$$

$$B_1 = \rho[1 - d(\theta)]/r. \tag{19}$$

The free entry condition for banks (18) shows that the expected costs of a loan are composed of the expected searching costs on the credit market, the students' tuition fees T, and the transfer for consumption C to the student that is covered by the bank. The profits (19) correspond to the net present value of the expected repayments. For a given repayment size ρ the present value of these profits is increasing in θ, that is, decreasing in unemployment: higher unemployment extends the time until the worker finds his first job as well as all future unemployment spells. In both situations the worker interrupts her repayments.

2.6 Firms

With free entry, firms open a vacancy to search for a worker if the expected present value of a vacancy is positive. Each firm can employ either one worker with high education or employ one unskilled worker. A firm with a filled vacancy produces one unit of an intermediate good, either with high (skilled worker) or low (unskilled worker) quality. The competitive final goods sector uses both intermediate goods as inputs to produce a homogeneous final good, following the CES production function $Y(q_s, q_u) = A[a_s q_s^\delta + (1 - a_s) q_u^\delta]^{1/\delta}$ where q_s (q_u) denotes the amount of high (low)

quality intermediate goods used. Competition between all of the small intermediate goods-producing firms drives prices of these intermediate goods down to their marginal productivity. The production function exhibits constant returns to scale, so the marginal productivity of an intermediate good depends only on the relative amount of high and low quality inputs, and thus on the (endogenous) fraction of workers with higher education α. A firm with a skilled (unskilled) worker can sell its output for $p^s(\alpha) = \partial Y/\partial q_s$ ($p^u(\alpha) = \partial Y/\partial q_u$).

Consider the following Bellman equations that determine the value of a firm with a free vacancy V and the value of a position that is filled with a worker of productivity i, S^i:

$$rV = -f + q(\theta)[\alpha(S^s - V) + (1-\alpha)(S^u - V)], \quad (20)$$

$$rS^i = p^i(\alpha) - w^i + s(V - S^i). \quad (21)$$

Firms cannot direct their search towards a specific type of worker and pay flow costs f for capital costs and their human resources department while they search. Once matched to a worker, which happens with flow probability $q(\theta)$, the firm observes the productivity of this worker. The worker has high productivity with probability α. Then the firm and the worker bargain on the wage, they start producing, the firm sells the output for $p^i(\alpha)$ and pays the wage w^i until the match is destroyed exogenously with flow-probability s.

Free market entry gives rise to $V = 0$. If we substitute S^s and S^u from (21) into (20), we obtain the job-creation condition (conditional on wages)

$$\frac{f}{q(\theta)} = \frac{1}{r+s}[\alpha(p^s(\alpha) - w^s) + (1-\alpha)(p^u(\alpha) - w^u)]. \quad (22)$$

The left-hand-side of (22) shows the expected costs to fill a vacancy, while the right-hand-side illustrates the expected profits of a filled vacancy: with probability α the firm hires a skilled applicant, who produces $p^s(\alpha)$ and earns the wage w^s, with the counter probability the employee is unskilled, produces $p^u(\alpha)$ and earns w^u. The firm can earn this cash-flow until the match is exogenously destroyed with probability s and discounts profits with r.

2.7 Wage Bargaining

A skilled worker is involved in two negotiations that are separated in time: first, when she is matched to a bank she bargains for the credit rate ρ. Later, when she meets a firm, she bargains for her wage w^s. The credit contract determines the cash flows from workers to banks during employment and therefore has an effect on the surplus of a worker-firm match later: the more money flows from workers to banks as repayment ρ, the less is left for workers and firms to split. The credit contract is fixed when workers and firms bargain on the wage, and skilled workers cannot discharge the loan even in bankruptcy. Therefore, workers and firms treat the credit rates ρ as given. The wage maximises the generalised Nash Product with $0 < \gamma < 1$ as bargaining power of a firm, so

$$w^s = \arg\max(W_2^s - W_1^s)^{1-\gamma}(V - S^s)^{\gamma} \text{ and} \tag{23}$$

$$w^u = \arg\max(W_1^u - W_0^u)^{1-\gamma}(V - S^u)^{\gamma}. \tag{24}$$

This gives rise to the standard surplus-splitting first order conditions

$$\gamma[W_2^s - W_1^s] = (1-\gamma)[S^s - V] \text{ and} \tag{25}$$

$$\gamma[W_1^u - W_0^u] = (1-\gamma)[S^u - V]. \tag{26}$$

After substitution from the Bellman equations we obtain the wages of unskilled and skilled workers, the latter conditional on the credit contract ρ:

$$w^u(\theta, \alpha) = \overline{\gamma}(\theta)b + (1 - \overline{\gamma}(\theta))p^u(\alpha) \text{ and} \tag{27}$$

$$w^s(\rho, \theta, \alpha) = \overline{\gamma}(\theta)(b + \rho) + (1 - \overline{\gamma}(\theta))p^s(\alpha) \quad \text{with} \tag{28}$$

$$\overline{\gamma}(\theta) = \frac{\gamma d(\theta)}{\gamma d(\theta) + 1 - \gamma}, \frac{\partial \overline{\gamma}}{\partial \theta} < 0.$$

The wage is a weighted average of the productivity and the worker's opportunity cost of working, including the repayment ρ for skilled workers. However, the extent to which the firm can push wages towards the worker's opportunity costs is not identical to the firm's bargaining power γ, but the effective bargaining power $\overline{\gamma}(\theta)$, with $0 < \overline{\gamma}(\theta) < \gamma$. This effective bargaining power of firms converges to γ if unemployment becomes extremely large (θ converges to 0) and decreases with θ until it reaches 0 when θ approaches infinity, that is, the worker could find another

firm in no time and is therefore able to capture all of the surplus.[6]

Proposition 1: A unit increase in the repayment rate ρ raises the wage by $\overline{\gamma}(\theta)$.

Proof: $\dfrac{\partial w^s}{\partial \rho} = \overline{\gamma}(\theta)$.

According to proposition 1, a marginal increase in the student's credit rate is compensated by a wage increase equivalent to the effective bargaining power of the firm $\overline{\gamma}(\theta)$. While she is employed, the student loses ρ in every period just like she forgoes the value of leisure and unemployment benefits b. Thus, the credit rate, and, implicitly, the loan size, are part of the opportunity costs of working and raise the wage of the high-skilled worker.

As usual, unemployment puts downward pressure on the unskilled wages, that is, $\partial w^u/\partial\theta > 0$ given that $p^u(\alpha) > b$ (note that $d'(\theta) < 0$). The positive effect of θ on wages is well known and is caused by the improvement of the worker's outside option as the unemployment rate decreases with θ: the higher θ, the easier it becomes for a worker to find a job. Therefore, the worker's threat point improves and the worker can sustain a larger share of the matching surplus, that is, establish a higher wage. However, the effect on skilled wages $\partial w^s/\partial\theta$ is not obvious at this point. While unemployment weakens the skilled worker's bargaining position, it also has an effect on the surplus of a bank-worker match and thus on the credit rate ρ. Thus, we next take a look at the credit contract between students and banks.

2.8 Credit Bargaining

Banks and workers anticipate that firms compensate workers for the fraction $\overline{\gamma}(\theta)$ of the credit repayments. Thus, banks and workers internalise this effect when they bargain on the credit contract: The surplus of a bank-worker match is increasing in the credit rate ρ as a third party, the firms, pays $\overline{\gamma}(\theta)$ of the credit rate to workers, while the credit rate is only a transfer from workers to banks.

The credit contract ρ is the outcome of Nash-Bargaining, satisfying

$$\rho \;=\; \arg\max (B_1 - B_0 - T - C)^{\beta} (W_1^s + C - W_0^s)^{1-\beta} \tag{29}$$

[6] A similar effect can be found in Wasmer and Weil (2004).

where $0 < \beta < 1$ represents the bargaining power of the bank. The surplus of this match is split according to the first order condition

$$\beta(W_1^s + C - W_0^s) = (1-\beta)(1-\overline{\gamma}(\theta))(B_1 - B_0 - T - C). \tag{30}$$

The multiplier $(1-\overline{\gamma}(\theta))$ on the right-hand-side captures the effect of ρ on w^s. Next, we substitute B_1 from (19), W_1^s from (14) and the free entry condition $B_0 = 0$. These values do not depend on ϕ, but contain the cash flows workers and banks can expect once they have been matched and enter the labour market. In an interior equilibrium, workers are indifferent between studying and following a career as unskilled worker, thus $W_0^s = W_0^u$, which can be substituted from (9). This gives rise to

$$\beta[[w^s - w^u - \rho](1-d(\theta))/r + C] \;=\; (1-\beta)(1-\overline{\gamma}(\theta))[\rho(1-d(\theta))/r - T - C]. \tag{31}$$

Substituting the wages (27) and (28) into (31) and solving for ρ yields

$$\begin{aligned} \rho \;&=\; \beta[p^s(\alpha) - p^u(\alpha)] + \frac{(1-\beta)(T+C)}{(1-d(\theta))/r} + \frac{\beta C}{(1-\overline{\gamma}(\theta))[(1-d(\theta))/r]} \\ \text{with} \qquad & \frac{\partial \rho}{\partial \theta} < 0, \, \frac{\partial \rho}{\partial \alpha} < 0. \end{aligned} \tag{32}$$

Proposition 2:
If students cannot finance consumption with a student loan ($C = 0$), the credit contract ρ is a convex combination of the productivity gain of education and the costs of education T. Other things equal, a marginal increase in consumption, financed by a student loan C, increases the credit rate ρ by more than a marginal increase in tuition fees T.

After considering the effect of ρ on w^s, the credit rates are a convex combination of the effect of education on productivity and the costs of education from a banks point of view. These costs consist of the tuition fee T and the transfer to the student C. The last term captures that students and banks internalise the effect of this transfer on the student's wages.
The credit rate in (32) does not (directly) depend on the bargaining power of firms. The reasoning is as follows: on the one hand, higher effective bargaining power of firms shifts the wage towards the opportunity costs of working that include the

credit rates, giving workers and banks incentives for higher credit rates. On the other hand, a higher bargaining power of firms reduces the overall surplus of a bank-worker match, as the firms capture a larger share of the workers' productivity, making workers and banks worse off and reducing the absolute size of ρ. These two effects offset each other, giving rise to (32).
Moreover, the credit rates decrease in θ and in α: lower unemployment reduces the time between investments and returns to education, and the skill premium decreases in the share of skilled workers α.

2.9 The Incentives to Accept a Job

So far we have implicitly assumed that agents always prefer to proceed to the next phase. However, if the costs of education are very high it could be optimal for skilled workers to stay unemployed instead of accepting a job offer, that is, they prefer to receive b instead of earning w^s and paying ρ. Banks will only offer credits to prospective students if skilled workers will accept job offers and repay the loan, $W_2^s \geq W_1^s$. The skilled worker's Bellman equations show that this is the case if $w^s \geq \rho + b$. By substituting w^s from (28) we see that the worker has an incentive to accept a job if $p^s(\alpha) - \rho - b \geq 0$. After paying the bank and compensating the worker for forgoing his unemployment benefits there still must be some surplus left to be distributed between the firm and the worker. However, workers always have the option to abstain from studying and to follow a career as an unskilled worker. Thus, instead of becoming skilled, declining all job offers, and receiving b forever she could also refrain from education, save the costs of searching for a bank, earn the same b during unemployment and have the opportunity to find a job as an unskilled worker (given that $p^u(\alpha) > b$). Of course, the latter is a strictly dominant strategy. So in any interior equilibrium where some workers are unskilled, the workers who opt for education always have an incentive to repay their loans.
A similar argument holds for the incentives of firms to accept skilled workers: a situation where firms decline skilled workers can never be a long run equilibrium, as then no worker would acquire an education. Also note that surplus splitting implies that a match is either beneficial for all involved agents or for none.

3 The Equilibrium

3.1 Equilibrium Credit Market Tightness

We substitute the banks' and the workers' expected costs of finding a matching partner on the credit market, (18) and (13), into the surplus splitting rule (30) and obtain the credit market tightness, conditional on W_0^s,

$$\phi^* = \frac{(1-\beta)(1-\overline{\gamma}(\theta))}{\beta}\frac{k}{rW_0^s - b}. \tag{33}$$

In equilibrium, workers are indifferent with respect to their career, $W_0^s = W_0^u$. We substitute W_0^u from (9) with the wages from (27) into (33) and obtain as equilibrium credit market tightness

$$\phi^*(\theta,\alpha) = \frac{1-\beta}{\beta}\frac{k}{[p^u(\alpha)-b](1-d(\theta))}, \frac{\partial\phi^*}{\partial\alpha} < 0, \frac{\partial\phi^*}{\partial\theta} < 0. \tag{34}$$

ϕ^* is decreasing in α because the higher the fraction of skilled workers workers, the higher are the wages of the unskilled, so the opportunity costs of searching on the credit market rW_0^u are larger. Lower unemployment (higher θ) increases the opportunity costs of searching on the credit market: workers could instead search for an unskilled job, which is more promising due to low unemployment. This gives rise to a positive link between unemployment and credit market tightness.

3.2 Credit Creation and Investment in Human Capital

There are two ways to obtain B_1, the value of a bank that just has paid for a student's education: We can either consider the expected costs to reach this stage (18) or the present value of cash flows that a bank can expect from the student (19). We combine both equations and substitute ρ from (32) to obtain the banks' credit creation condition conditional on θ and α,

$$\frac{k}{\phi^* p(\phi^*)} + \beta T = \beta[p^s(\alpha) - p^u(\alpha)][1-d(\theta)]/r + \beta\left[\frac{\overline{\gamma}(\theta)}{1-\overline{\gamma}(\theta)}\right]\cdot C. \tag{35}$$

The expected costs of finding a worker plus the fraction of the education costs that is effectively paid by the bank on the LHS are equal to the expected profit of a credit: the fraction β of the productivity improvement generated by the worker's education plus the firms effective share of the additional consumption C for the student. Here

we clearly see the different effects of a loan to pay for tuition fees T and one to pay for consumption of the student C. For a bank-student-match, the tuition fees T are actual costs this match has to cover. After considering the credit bargaining and the wage-response of the firms, the bank has to effectively pay the share β of these costs.[7] In contrast, the student's additional consumption C offers a "free lunch" for the bank-student match: C is only a transfer within the match, but the firms nevertheless compensate workers for their increased loans by higher wages. Thus, the surplus of the bank-student match is actually increasing in C.

Next, we determine the worker's education decision as a function of θ and α in a similar way. The expected costs of finding a bank (reaching W_1^s via (13)) must be equal to the present value of all cash flows the worker can expect from this point in time onwards (computing W_1^s via (14)). Indifference of workers with respect to their career implies that the costs of searching the credit market for a bank also incorporate the opportunity costs of not being able to search the labour market as an unskilled worker rW_0^u. After substitution of ρ from (32) we obtain

$$\frac{rW_0^s - b}{p(\phi^*)} + (1-\overline{\gamma})(1-\beta)T \;=\; (1-\overline{\gamma})(1-\beta)[[p^s(\alpha) - p^u(\alpha)][1-d(\theta)]/r] + \overline{\gamma}(1-\beta)C. \tag{36}$$

The worker's opportunity costs of searching the credit market plus the fraction of the tuition fees that the worker effectively has to pay must be equal to the worker's share $(1-\overline{\gamma})(1-\beta)$ of the productivity gains that are generated by this investment. Fraction β of the tuition and the benefits is covered by the banks, fraction $\overline{\gamma}$ of the remainder by firms. Just like for the banks, T and C have different effects: The tuition T is treated as a cost of which the worker has to pay his share, while C increases the match surplus. The following proposition explains the analogy between the bank's credit creation condition (35) and the worker's education decision (36).

Proposition 3: *If the credit market is in the equilibrium determined by* (33)*, then* (35) *and* (36) *are equivalent.*

Proof: *Substitute* (33) *into* (35).

If a bank and a worker meet, they anticipate their effect on the worker's future wages

[7] We will see later that the worker effectively covers $(1-\beta)(1-\overline{\gamma}(\theta))T$ and the firm the residual, $(1-\beta)\overline{\gamma}T$ via higher wages.

and split the surplus of this match, that is, the tuition fees and the expected benefits, according to the surplus splitting rule (30). Both receive a fraction of the effective benefits and costs and act basically as one unit in the labour market. Thus, the effects of θ and α on workers' and banks' incentives are equivalent. If unemployment is higher, both wait longer for their share, and if more workers are skilled, they both suffer in the same way from lower marginal productivity. Thus, (35) describes all combinations of θ and α that satisfy the banks free-entry condition *and* the workers' indifference condition, once we consider the credit market equilibrium (33).

Finally, we substitute the wages from (27) and (28) with the credit rate from (32) into (22) to obtain the firms' job creation condition

$$\begin{aligned} \frac{f}{q(\theta)} &= \frac{\overline{\gamma}(\theta)}{r+s}\{\alpha(1-\beta)[p^s(\alpha)-p^u(\alpha)-(T+C)r/[1-d(\theta)]]-\frac{\alpha\beta Cr}{[1-\overline{\gamma}(\theta)][1-d(\theta)]} \\ &\quad +p^u(\alpha)-b\}. \end{aligned} \tag{37}$$

The expected costs to find a worker on the LHS are equal to the expected profits of having a filled vacancy on the RHS. While $p^u(\alpha)-b$ on the RHS is the baseline surplus of any match between a firm and a worker (of which the firm is able to keep the fraction $\overline{\gamma}(\theta)$), the worker is high-skilled with probability α. In this case, there is an additional profit associated with the higher productivity. Via the credit contract, the bank will keep fraction β of these gains, while the firm can capture the share $\overline{\gamma}(\theta)(1-\beta)$. The remainder goes to the worker. The firm implicitly pays the same share of the costs of tuition T and the transfer to the student C. However, this transfer C has an excess effect on the credit rate (see (32)) and thus on wages. This is captured by the last term in the first line of (37).

3.3 The incentives to overuse student loans

While tuition is exogenous from the student's, bank's and firm's point of view, students have some discretion to expand the student loans beyond the pure necessities of their costs of education, $C > 0$.

A student who has just met a bank would like to choose the level of consumption C such that it maximises her "value" W_C, that is, the expected net present value of all the cash-flows she is going to experience:

$$W_C = W_1^s + C = [bd(\theta)/r + (w^s-\rho)[1-d(\theta)]/r] + C. \tag{38}$$

where w^s and ρ are both increasing in C. The effect of a marginal increase of C on W_C is

$$\frac{\partial W_C}{\partial C} = \left[\frac{\partial w^s}{\partial C} - \frac{\partial \rho}{\partial C}\right] \frac{1 - d(\theta)}{r} + 1. \tag{39}$$

If we substitute the credit contract from (32) and the wages from (27) and (28) we obtain

$$\frac{\partial W_C}{\partial C} = (1 - \beta)\overline{\gamma}(\theta) > 0 \tag{40}$$

A student will find it beneficial to take a loan that exceeds the tuition fees and use the excess amount for consumption. W_C increases in C because the compensation by higher wages exceeds the additional interest paid.

The same effect can also be found on the RHS of (36): A marginal increase of C increases the value of being a student by $\overline{\gamma}(\theta)(1 - \beta)$. The firm compensates the skilled worker for the share $\overline{\gamma}(\theta)$ of her opportunity costs of working, while the bank will receive fraction β of this additional return of the student-bank-match, the students will keep the fraction $(1 - \beta)$ of it. Thus, the bargaining of students and banks gives rise to an externality, as some of the credit costs are covered by firms via higher wages for skilled workers.

4 Simulation

We calibrate this model to the US economy and simulate separately the effects of an increase in tuition fees T and consumption C. The baseline calibration is summarised in table 1. Each period is one year. In general, I follow the calibration by Shimer (2005) whenever this is appropriate for our model. Considering that Shimer (2005) defines one period as one quarter, we adjust the real interest rate to $r = 0.05$ and the job destruction rate to $s = 0.4$. For the CES production function, we choose δ such that it implies an elasticity of substitution between high skilled and low skilled workers of 1.42 (Katz and Murphy, 1992) and a weight of high skilled labour $a_s = 0.5$ to obtain a reasonable fraction of college graduates of $\alpha \approx 0.4$ in the benchmark model.[8] We set TFP to $A = 2$ such that the endogenous average productivity of

[8]The outcome of the calibrated model can be found in table 2.

a worker is very close to unity. This allows us to stay close to Shimer (2005) and Wasmer and Weil (2004) who use a productivity of $y = 1$. Shimer (2005) estimates that the firm's searching costs on the labour market are about 21.3% of a worker's output in the same period of time, giving rise to $f = 0.213$. The unemployment benefits (or value of leisure) of a worker who searches on the credit market or the labour market is set to $b = 0.4$ like in Shimer (2005). We choose $\gamma = 0.5$ as the bargaining power of firms which is in line with Wasmer and Weil (2004). Shimer (2005) uses the equivalent of $\gamma = 0.3$, but argues that this bargaining power of firms is at the lower end of what Petrongolo and Pissarides (2001) find. Analogously, we follow Wasmer and Weil (2004) to set the banks' bargaining power on the credit market to $\beta = 0.5$. We use these bargaining power parameters as elasticities of the matching functions on both markets.[9] This gives rise to the firm's matching probability on the labour market $q(\theta) = 5\theta^{-0.5}$, where we have adjusted the constant from Shimer (2005) for our yearly periods. The matching probability on the credit market is $p(\phi) = p_0\phi^{-\beta} = 4\phi^{-0.5}$. Our constant $p_0 = 4$ is significantly higher than $p_0 = 1$ in Wasmer and Weil (2004). However, their numerical exercise is not calibrated to the United States and generates equilibrium unemployment rates of 9.3% and 16.0%. $p_0 = 4$ is chosen such that we obtain a reasonable expected duration of credit market search for students of about 2 months.

According to the National Center for Education Statistics (2017), only 39.8% of full-time time students who enrolled in 2008 for the first time at a 4-year institution of post-secondary education graduated with a Bachelors degree (or equivalent) within the normal program completion time. These graduation rates only moderately increase to 59.7% (61.9%) if we consider 150% (200%) of the normal program completion time. Thus, we must take into account that studying takes time and that a significant share of students leaves college without a degree and enters the labour market for unskilled workers.

Now consider again the bank's credit creation constraint (35) (which, according to

[9]While the Hosios-Rule (Hosios, 1990) suggests that an elasticity of the matching function equal to the bargaining power gives rise to an efficient decentralised equilibrium, this is not necessarily the case in this model. In particular, investment in human capital might be too high or too low.

parameter	interpretation	calibration	source/target
b	flow income of unemployed workers	0.4	Shimer (2005)
k	credit market searching costs of banks	0.35	Wasmer and Weil (2004)
f	labour market searching costs of firms	0.213	Shimer (2005)
$p(\phi)$	credit market matching function	$4\phi^{-0.5}$	Wasmer and Weil (2004)
$q(\theta)$	labour market matching function	$5\theta^{-0.5}$	Shimer (2005)
γ	bargaining power of firms	0.5	Petrongolo and Pissarides (2001)
β	bargaining power of banks	0.5	Wasmer and Weil (2004)
δ	production function parameter	$1-\frac{1}{1.42}$	$\sigma = 1.42$, Katz and Murphy (1992)
A	TFP production function	2	$\alpha p^s + (1-\alpha)p^u = 1$
a_s	weight of high-skilled in production	0.5	$\alpha \approx 0.4$
r	interest rate	0.05	Wasmer and Weil (2004) / Shimer (2005)
s	job destruction rate	0.4	Shimer (2005)
g	probability to graduate	0.66	U.S. Department of Education
e	years of education	5	U.S. Department of Education

Table 1: List of Parameters

Proposition 3, is also equivalent to the worker's education decision). The benefits of education, that is, the gains in productivity, are weighted by $1-d(\theta)$, where $d(\theta)$ is the share that is effectively lost due to unemployment. Thus, if students have to study for e periods until they obtain their degree and enter the labour market, we must discount these benefits by $(1+r)^e$. Moreover, if only g percent of students graduate (and the other ones forgo the potential benefits of education), we weight these returns by g. Thus, we can rewrite (35) as

$$\frac{k}{\phi^* p(\phi^*)} + \beta T = \beta[p^s(\alpha) - p^u(\alpha)] \cdot \frac{1-d(\theta)}{r} \cdot \frac{g}{(1+r)^e} + \beta \left[\frac{\overline{\gamma}(\theta)}{1-\overline{\gamma}(\theta)}\right] \cdot C \quad (41)$$

If we apply the same approach to the firms' job creation condition (37), we obtain

$$\begin{aligned} \frac{f}{q(\theta)} &= \frac{\overline{\gamma}(\theta)}{r+s}\{\alpha(1-\beta)[p^s(\alpha) - p^u(\alpha) - (T+C)r \cdot (1+r)^e/[(1-d(\theta)) \cdot g]] \\ &- \frac{\alpha\beta C r \cdot (1+r)^e}{[1-\overline{\gamma}(\theta)][(1-d(\theta)) \cdot g]} + p^u(\alpha) - b\}. \end{aligned} \quad (42)$$

In line with the data from the National Center for Education Statistics (2017), we set $g = 0.66$ and $e = 5$.

In the baseline scenario (B) with $T = 2$ and $C = 0$, about 42.1% of the population acquire a college degree. These workers search for about 13.83% of one year (that is,

		Scenario B	**Scenario T**	**Scenario C**
		$T = 2$, $C = 0$	$T = 3$, $C = 0$	$T = 2$, $C = 1$
α	fraction of skilled workers	0.421	0.386	0.423
θ	labour market tightness	2.089	1.903	1.895
ϕ	credit market tightness	0.7497	0.8203	0.7483
u	unemployment rate	0.0525	0.0548	0.0549
$1/[\theta q(\theta)]$	average unemployment spell	0.1384	0.1450	0.1453
$1/[p(\phi)]$	avg. credit search duration	0.2165	0.2264	0.2163
ρ	credit rate	0.2158	0.3189	0.3194
w^s	wage of skilled workers	1.094	1.157	1.096
w^u	wage of unskilled workers	0.8685	0.8283	0.8695
$w^s/w^u - 1$	college premium	0.2597	0.3963	0.2602
$\alpha p^s + (1-\alpha)p^u$	average productivity	0.9911	0.9816	0.9915
W_0	NPV of total income	16.820	16.041	16.814
$W_0 + \alpha A$	NPV income + tuition	17.662	17.200	17.659

Table 2: Simulation Results

almost 2 months) for a bank. After graduating (after 5 years with probability 66%), they earn the wage $w^s \approx 1.094$ and pay the credit rate $\rho = 0.2158$. Low-skilled workers earn considerably less ($w^u \approx 0.8685$), giving rise to a college premium of about 26%. The unemployment rate[10] is 5.25%.

Now consider two different scenarios. In scenario T, the tuition fees increase from $T = 2$ to $T' = 3$. In contrast, in scenario C, the students are able to increase their loans to finance one unit of consumption during their studies. Thus, C increases from $C = 0$ to $C' = 1$. We see that both scenarios have a rather similar effect on unemployment and the credit rate. In scenario T (C), the unemployment rate increases from 5.25% to 5.48% (5.49%). The credit rate rises from $\rho = 0.2158$ to $\rho = 0.3189$ in scenario T and to $\rho = 0.3194$ in scenario C. The stronger effect of an increase in consumption on the credit rate (proposition 2) is present, but rather small.

While the purpose of the loans (T vs C) seems to have only a marginal effect on un-

[10]The stationary unemployment rate must satisfy $s(1-u) = \theta q(\theta)u$ and gives rise to the Beveridge curve $u = s/[s + \theta q(\theta)]$.

employment and the credit rates, the effects on education, credit availability, wage inequality and welfare differ substantially. The additional loan to pay for tuition fees (T) reduces the share of college graduates from 42.1% to 38.6%, whereas a loan to pay for consumption (C) generates a moderate increase in α to 42.3%. The average time to secure funding for college increases in scenario T by about 5%, while it slightly decreases in scenario C. The intuition works as follows: The additional tuition fee T reduces the surplus of a match between a student and a bank. Thus, credit supply of banks declines and fewer people decided to study. In contrast, according to Proposition 2, an increase in C (moderately) increases the surplus of the bank-worker match.

The wages of college graduates increase in both scenarios, but they significantly rise if student fees increase and are virtually unchanged if the additional loan is used to finance consumption. In general, there are three main channels that affect wages: i) w^s increases as firms compensate college graduates for their higher credit rates, ii) higher unemployment weakens the worker's bargaining position and iii) the relative supply of skilled labour affects the skilled workers' productivity. While i) and ii) are very similar in both scenarios, the declined rate of college graduates in scenario T gives rise to a significant increase in w^s, while it is basically constant in scenario C. The increase in unemployment and the change in the skill composition in the labour force also explains the decline in the wage for unskilled workers after the increase in tuition fees T. A combination of the effect on both wages shows that while an increase in student loans that is used to pay for tuition fees significantly raises the college premium from 26% to 40%, wage inequality does not change the loan is used to pay for consumption.

We can also use the worker's Bellman equations to determine the present value of a worker who enters the model in phase 0, W_0. However, a direct comparison of the welfare effects of an increase in tuition fees and an increase in consumption would be misleading, considering that the model assumes that the additional loan is just "burned" in the first and used for consumption in the latter case. This gives obviously rise to a negative effect of tuition fees. We account for this by assuming that the tuition is redistributed to all workers as a lump-sum transfer. But even

under this assumption, the rise in tuition fees in scenario T reduces welfare by about 2.6%. In contrast, the increase in consumption has no significant effect on welfare, even though unemployment and student debt increase. These (moderate) effects are mitigated by the moderate increase in the share of college graduates α.

5 Conclusions

This paper has shown that the "student loan bubble" is not necessarily the result of irrational borrowing by young women and men. The combination of imperfect labour and credit markets allows them to shift a part of the burden of their loans to firms and unskilled workers. While loans for tuition fees and loans to finance consumption have comparable effects on unemployment, tuition fees seem to be significantly more detrimental than borrowing for consumption during college: An increase in tuition fees significantly reduces investment in human capital, increases wage inequality, and welfare declines. In contrast, if students have the option to borrow for consumption, investment in human capital increases and both the college premium and welfare are almost constant. These results suggest that students using their loans for spring break could actually be less of a problem than students who are forced to take on higher loans to pay for increasing tuition fees.

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