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Loans, Insurance and Failures in the Credit Market for Students

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Abstract

In the education literature, it is generally acknowledged that both credit and insurance for students are rationed. In order to provide a rationale for these observations, we present a model with perfectly competitive banks and risk averse students who have private information on their ability to learn and can decide to default on debt. We show that the combination of ex-post moral hazard and adverse selection produces credit market rationing when default penalties are low. When default penalties increase, the level of student risk aversion proves crucial in determining the market outcome. If risk aversion is low, banks offer non-insuring pooling contracts at equilibrium that may result in overinvestment in education. If student risk aversion is high, high ability students are separated and student loan contracts involve a limited amount of insurance.

JEL-Code: D820, I220.

Keywords: ex-post moral hazard, adverse selection, income contingent loans.

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1 Introduction

Public intervention in the student loan market is usually motivated by the general view that the market fails to provide such loans. In other words, student credit is rationed. As a result, in many countries, governments provide banks with subsidies and/or guarantees against the risk of default. Then, banks provide student loans. However, loans offered by banks are always "pure" loans: they do not insure borrowers against the risk of a bad outcome, like dropping out of university, or being unsuccessful in the labor market. This lack of insurance in private loans is in deep contrast with the trend observed in many countries where the repayment of public loans is income contingent. [1] If there is demand for income contingent loans and banks do not provide them, there is a second failure of the student loan market, to wit lack of insurance. In this paper, we propose a model that provides a rationale for these two market failures.

Let us first review the literature on the specificities of the student loan market, and explain how the two failures mentioned above result. Limited access to credit, or credit rationing, has often been attributed to the existence of asymmetric information about the type of investor, following the strand of the literature initiated by Stiglitz and Weiss (1981). In this setting, borrowers have limited liability and face the same expected return, but their risk differs in the sense of a Mean Preserving Spread (MPS). Under these circumstances, the riskier investor is willing to pay a higher interest for the loan than the less risky investor. In the case of unsatisfied demand, the standard market mechanism would rely on an increase of the price to clear the market. In this framework, however, an increase in the price of credit - the interest rate - fails to reach this objective. Indeed, since low risk entrepreneurs drop out before high risk entrepreneurs, the composition of risks changes, and the expected probability of success of an investment decreases. It may then be optimal for profit maximizing banks not to raise the interest rate and to ration credit. This line of argument can explain rationing of student loans when investments in human capital only differ in the spread of returns, not the average expected returns, as it is the case in Barr (2001) and Jacobs and van Wijnbergen (2007).

Nonetheless, in the literature on the economics of education, it is not unusual to find the assumption that high ability students face a larger expected return from investing in

[1] This is the case in countries such as Australia, New Zealand, Sweden, Canada, the UK, Thailand, Canada or Spain. See Chapman (2005) and Chapman and Greenaway (2006) for an inter- national overview of ICLs. The idea of making repayment contingent on income is generally attributed to Friedman and Kuznets (1945).

education, and that their probability of success is larger. These postulates are at odds with the Mean Preserving Spread of returns assumption. Instead, they are more in line with the concept of First Order Stochastic Dominance (FOSD) used in de Meza and Webb (1987), where entrepreneurs differ in terms of probability of success, which results in different expected returns to investment. Entrepreneurs facing higher expected returns are more willing to pay for a loan. If the interest rate rises, entrepreneurs with lower expected returns drop out first. It may occur, however, that separation of types is not possible. Then, banks maximize profits by pooling both types together, and access to credit is unrationed. But this is not the whole story when it comes to investments in education.

Indeed, human capital investments are also characterized by the important peculiarity that credit markets "have no security on the asset" (Glennerster (2009)). In other words, human capital is inalienable, and cannot be used as collateral against loan default. Although human capital investments materialize in higher earnings, which are seizable, the power for creditors to garnish wages is in fact generally limited by law.[2] If the penalty for default is not large, debtors may strategically choose to default. This is known as ex-post moral hazard. As it will be made clearer, accounting for these two main features of human capital investments, FOSD in the returns to the investment and strategic default in absence of collateral, proves useful to analyze in a unified framework both credit rationing and lack of insurance in the student loan market.[3]

We hence consider a model where students differ in ability on the basis of FOSD. This ability, which is captured by the student's probability of graduation, is private information. Individuals are risk averse and need to borrow in order to invest in education. On the student loan market, banks compete à la Bertrand and offer menus of loan contracts that may include insurance against the eventuality of failure.

We obtain the following results. The interaction of ex-post moral hazard and adverse selection proves fundamental in explaining credit rationing in the context of FOSD. More precisely, the absence of credit to students results when default penalties are relatively soft. When default penalties increase, the level of student risk aversion of students is crucial in determining the market outcome. First, if risk aversion is sufficiently low and default penalties are intermediate, banks offer pooling contracts at equilibrium. This pooling equilibrium is characterized by two market failures, namely an absence of contractual insurance from

[2]Creditor protection legislation shows some heterogeneity and this affects credit market development at the international level (see La Porta et al. (1998)).

[3]The argument clearly applies to any investment other than human capital that shares these two features.

banks and overinvestment in education, since agents with low ability obtain loans. Still with low risk aversion, increasing default penalties further allows banks to offer a contract that only high ability agents would accept. Although this contract might contain some contractual insurance from banks, the global insurance, which combines both legal and contractual insurance, is lower than that of the pooling equilibrium. Second, if student risk aversion is high enough, there cannot be pooling (and therefore overinvestment) at equilibrium. Instead, only a separating equilibrium can replace credit rationing when default penalties increase. Interestingly, this equilibrium entails more insurance than the first case's pooling equilibrium, and would actually be preferred by high types even though they are more risk averse in this case. In other words, proper selection and higher levels of insurance -although still far from full insurance- can be obtained if students are sufficiently risk averse.

The model should not be viewed as an attempt to explain one single piece of evidence. It rather provides a general framework for the analysis of student loan markets in many particular instances. Default penalties differ across countries, as so do student levels of risk aversion, and market failure can result in each case from a different combination of parameters.[4] Other parameters, such as expected earnings or the probability of success, not to mention public policy, may differ not only across countries but even across fields of study and also affect the market outcome. In particular, we have used the model to show, as a way of example, that private loans are the more likely to be offered the higher the return to education in case of success (Lochner and Monge-Naranjo (2008)) and that the introduction of subsidies improves the case for private lending (Shen and Ziderman (2007)).

The rest of the paper is organized as follows. In Section 2, we present the model. In Section 3, we characterize the equilibrium outcomes corresponding to different levels of the default penalty that we label *soft*, *intermediate*, *larger* and *largest*. Section 4 provides some additional, comparative static results and Section 5 concludes. More technical details are relegated to the Appendix.

2 The model

There is a population of unskilled agents of measure 1. At the beginning of the period, agents decide whether to invest in higher education or not. This investment is risky and has two possible outcomes $\sigma = \{f, s\}$, where f stands for failure and s for success. In case of success,

[4] Student risk aversion is affected by ...

an agent becomes skilled and obtains an exogenous wage w_s. In case of failure, she remains unskilled and receives the same wage as an agent who chose not to study, w_f. For simplicity, we assume that the outcome of the investment is common knowledge. Agents differ in ability $a \in \{l, h\}$, which affects their probability of success: p_a with $0 < p_l < p_h < 1$. Although this probability is private information, the share of agents of high (h) ability in the population, λ, is common knowledge.

Investments in higher education are costly. We denote these costs, which comprise tuition fees and living expenditures, by F. Agents need to borrow in order to finance F. If they do not accept any loan contract, they remain unskilled and earn with certainty a wage w_f.

The credit market consists of a set of profit maximizing banks offering loans of size F, competing à la Bertrand. A student loan contract is a pair of interest rates $(r_s, r_f) \in \mathbb{R}^2$, where r_s and r_f are the interest rates charged respectively in case of success and failure. The contingency of the interest rate to the state of nature allows the loan contract to provide agents with some insurance, by setting $r_s > r_f$. Note that this is precisely what publicly managed income contingent loan programs do. In particular, it is often the case in these programs that $r_s > 0$ and $r_f = -1$. In order to simplify notations, we will make use of $R_\sigma \equiv 1 + r_\sigma$, so that the total amount of money a borrower has to pay to the bank in state of the world σ is $R_\sigma F$.

Banks may offer more than one contract, or no contract at all. The banks' strategy is thus to offer a set, or menu of contracts. When facing the menu of contracts, unskilled agents decide whether to accept one of them or refuse all of them. However, accepting one contract does not necessarily imply that it will be respected. Indeed, a particularity of our model is that banks are subject to ex-post moral hazard from borrowers: once the outcome of the investment in education is realized, agents decide whether to repay the loan or to default by weighting the gain in resources from non repayment against the punishment for default. In this paper, as Chen (2005) and Lochner and Monge-Naranjo (2008), we model this level of responsibility as a penalty amount incurred by the defaulting borrower. In particular, this penalty is defined as the garnishment by the bank of a share $g \in [0, 1]$ of the wage, w_σ. This is a simplifying assumption that reflects the fact that the law prevents banks from completely expropriating those who default. In other words, the law provides borrowers with some legal insurance in the form of a safety net $(1 - g)\, w_\sigma$. However, as Lochner and Monge-Naranjo (2008) points out, "Even if human capital cannot be directly repossessed by lenders, creditors can punish defaulting borrowers in a number of ways (e.g. lowering credit scores, seizing assets, garnisheeing a fraction of labor earnings), which tend to have a greater impact on debtors with higher post-school earnings." This justifies the assumption that the penalty is proportional to earnings.[5]

All in all, the legal system provides the borrower with some insurance against failure, even if banks do not offer any contractual insurance. Later, we will refer to a non-insuring contract when the bank does not provide any contractual insurance in addition to the legal one.

Agents are risk averse and, prior to making their decision to invest in higher education, care about the set of consumption levels over their productive life in each state of the world $C \equiv (c_f, c_s) \in \mathbb{R}^2_+$, where c_s and c_f are consumption levels contingent respectively on success and failure. The utility function is continuous, strictly increasing and strictly concave and is denoted $U(\cdot) : \mathbb{R}^2_+ \to \mathbb{R}^+$. The expected utility of an individual who invests in education and has probability of success p_a is denoted

$$EU_a(C) = p_a U(c_s) + (1 - p_a) U(c_f),$$

These consumption levels depend both on the accepted loan contract, and on the penalty the borrower endures in case of default. Indifference curves of the two types of agents have negative slopes and satisfy the single-crossing condition. Indeed, for all $(c_f, c_s) \in \mathbb{R}^2_+$, $\frac{dc_s}{dc_f}|_{EU_a(C)=\overline{U}} = -\frac{1-p_a}{p_a}\frac{U'(c_f)}{U'(c_s)}$, where $\overline{U}$ is constant. Since $-\frac{1-p_a}{p_a}$ is increasing in p_a, $\frac{dc_s}{dc_f}|_{EU_h(C)=\overline{U}} > \frac{dc_s}{dc_f}|_{EU_l(C)=\overline{U'}}$ for all $\overline{U}, \overline{U'} \in \mathbb{R}^+$.

Banks get their revenue from loan repayments and/or garnishment of wages, and suffer the costs of borrowing the funds on the international market at the risk-free interest rate i.

The timing of the game is the following:

1. Nature draws the type of an unskilled agent. She will be of high ability (h) with probability λ, otherwise her ability is low (l).

2. Banks offer a menu of student loan contracts to potential students.

3. Each potential student observes the menu of contracts and decides, given her ability, whether to accept one of the loan contracts or refuse all of them and remain unskilled.

[5]Moreover, in many countries, defaulters can indeed be subject to the garnishment of up to a certain proportion of the wage. In the case of the Federal Family Educational Loan, in the USA, the garnishment rate is set at a maximum of 15%. In Portugal, this proportion reaches 30%.

In other countries, such as Spain, the scheme of default penalties follows a non-linear pattern.

If banks offer no contract, the agent remains unskilled.

4. If the agent accepts one contract, the investment in higher education materializes and, accounting for the agent's ability, nature realizes the outcome ($\sigma \in \{f, s\}$) of the investment.

5. The borrower pays the loan or defaults, in which case banks recover the loan up to the legal limit gw_σ.

2.1 Equilibrium

The equilibrium concept is Subgame Perfect Nash Equilibrium (SPNE) in pure strategies.[6] As described in the timing of the game, a strategy profile gathers three strategies: banks' offer of the menu of contracts, agents' acceptance of one of the contracts or refusal of all of them, and, finally, once the outcome is realized and in case agents have subscribed to one contract, agents' compliance with the contract or default. To be an SPNE, a strategy profile must be such that

1. At stage 5, borrowers maximize utility by defaulting if $R_\sigma F > gw_\sigma$.

2. At stage 3, an unskilled agent accepts the contract that provides her with the highest level of utility, provided the latter is higher than the one obtained by remaining unskilled. Otherwise, she refuses all contracts.

3. At stage 2, banks offer a menu of student loan contracts that maximize expected profits. Because of Bertrand competition, the highest value for expected profits is zero, so that at equilibrium, every contract (R_f, R_s) in the menu must be such that

$$\begin{aligned} E\Pi(q, R_f, R_s) &= q \min(R_s F, gw_s) + (1-q) \min(R_f F, gw_f) - IF \\ &= 0, \end{aligned}$$

where $q \in [0; 1]$ is the expected probability of success of the agents for whom the contract is intended.

[6] Even though there are two types and information is asymmetric, the equilibrium concept does not need to rely on Bayesian expectations. Indeed, the uninformed players - banks - do not need to formulate beliefs about which type will take a contract. Because they play first, the contracts they design allow them to anticipate with certainty what type(s) they are going to face for each contract offered. For further discussion of this issue, see Mas-Colell (1995) Chapter 13.

The menu of contracts will be empty at equilibrium if all possible loan contracts provide the bank with strictly negative profits.

If the menu is composed of two contracts, and banks anticipate that each of them will be selected by a different type of agent, the equilibrium is *separating* and $q = p_h$ for the contract selected by high ability agents, while $q = p_l$ for the contract selected by low ability agents.

Finally, the menu may be a singleton, and two scenarios emerge. Either banks anticipate that both types will accept the contract, and $q = p_p \equiv \lambda h + (1 - \lambda)l$ (the equilibrium involves *pooling of* both types). Or, alternatively, banks anticipate that only one type will accept it. If this is the case, since the expected gain from investing in higher education is higher for the high ability agent, she will be the one who takes such a contract.

At equilibrium, then, student consumption levels in outcome $\sigma \in \{f, s\}$ are

$$c_\sigma = \max\{w_\sigma - R_\sigma F, (1 - g)w_\sigma\}, \tag{1}$$

for $R_\sigma \equiv 1 + r_\sigma$. Conversely, banks' profits under outcome $\sigma \in \{f, s\}$ write

$$\Pi_\sigma = \min\{R_\sigma F, g w_\sigma\} - IF, \tag{2}$$

where $I \equiv 1 + i$.

2.2 Graphical analysis

In order to analyze under which conditions the various types of equilibria will emerge, it will prove convenient to represent all players' strategies in the space of consumption levels of agents in case of failure and success (c_f, c_s), as illustrated in Figure 1. Such a space can be divided into two subspaces relative to the two strategies that agents can play at stage 5: repay or default. Let us define in this space the set of allocations such that default does not occur:

Definition 1 *The default-proof space, $DP(g)$ is the set of consumption bundles (c_f, c_s) such that for all $\sigma \in \{f, s\}$, $w_\sigma - R_\sigma F \geq (1 - g)w_\sigma$.*

In $DP(g)$, $c_\sigma = w_\sigma - R_\sigma F \geq (1-g)w_\sigma$ for all $\sigma \in \{f, s\}$, while outside $DP(g)$, there exists at least one outcome $\sigma \in \{f, s\}$ such that $c_\sigma = (1-g)w_\sigma > w_\sigma - R_\sigma F$. This implies that, in the space of consumption levels, one can establish a one to one relation between loan contracts (r_f, r_s) and consumption levels (c_f, c_s) only inside $DP(g)$. In other words, students can credibly commit to pay interest rates (r_f, r_s) inside $DP(g)$. Out of $DP(g)$, a contract is not respected, in which case banks are legally allowed to garnish gw_σ and consumption is in fact $c_\sigma = (1-g)w_\sigma$. Such consumption bundles are located on the boundaries of $DP(g)$.

Two relevant types of contracts are to be considered on the boundaries of $DP(g)$. First, contracts such that $c_s = (1-g)w_s$. In this case, borrowers face the lowest possible consumption in case of success. Since zero profits imply a balance between interest rates in cases of failure and success, contracts on this (horizontal) boundary are those which provide borrowers with the highest consumption in case of failure, i.e. the greatest level of insurance. Second, contracts such that $c_f = (1-g)w_f$. We call this type the "non-insuring contracts":

Definition 2 *A non-insuring contract is a contract such that, in case of failure, $R_f F > gw_f$ so that the borrower's consumption level is limited to the legal safety net: $c_f = (1-g)w_f$.*

Note that a pure loan contract with $R = R_f = R_s > I$ can be viewed as a non-insuring contract where banks, anticipating that borrowers default in case of failure, adjust the interest rate in order to avoid losses. However, as we have mentioned before, borrowers are still legally insured even though banks do not offer any contractual insurance.

Let us now represent, in the space (c_f, c_s), the set of loan contracts that provide, for a given expected probability of success q, zero expected profits. Since $c_\sigma + \Pi_\sigma = w_\sigma - IF$, $E\Pi(q, r_f, r_s)$ can be rewritten as

$$E\Pi(q, c_f, c_s) = q(w_s - c_s) + (1-q)(w_f - c_f) - IF. \tag{3}$$

Equation (3) allows us to define the zero profit locus in terms of combinations of consumption bundles in case of failure and success (c_f, c_s).

Definition 3 *$Z\Pi(q, g)$ is the set of consumption bundles (c_f, c_s) in $DP(g)$ such that, for a probability of success q, banks make zero expected profits:*

$$c_s = \left[w_s - w_f + \frac{w_f - IF}{q}\right] - \frac{1-q}{q} c_f. \tag{4}$$

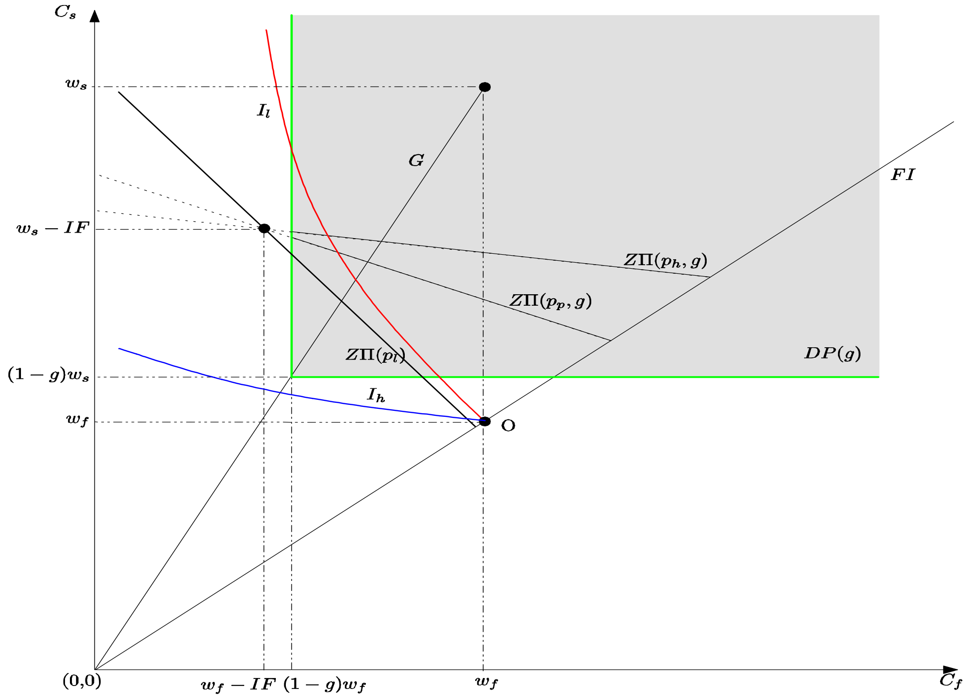

Figure 1: Basic elements of the model

For convenience, we will often refer to $Z\Pi(q) \equiv Z\Pi(q, 1)$, the zero-profit locus when all contracts are immune to ex-post moral hazard. This will allow us to discuss and compare these loci in the largest possible set of consumption bundles. Indeed, when $g = 1$, $c_\sigma = \max\{w_\sigma - R_\sigma F, 0\}$, so that the default proof space is $\mathbb{R}^2_+$. In Figure 1, as g decreases (penalties become softer) the default-proof space shrinks, its origin moving along G - the set of consumption bundles (c_f, c_s) such that $c_s = (w_s/w_f)\, c_f$ - towards (w_f, w_s). Figure 1 also depicts, in the (c_f, c_s) space, the default-proof space and the zero profit loci: $Z\Pi(p_l)$, when contracts are accepted only by low ability agents; $Z\Pi(p_p)$, for contracts that pool together high and low ability agents; and $Z\Pi(p_h)$, for contracts that separate high ability agents. Clearly, the slope of a zero profit locus is given by $-(1-q)/q$. Thus, since $p_l < p_p < p_h$, $Z\Pi(p_h)$ is the flattest of these loci, followed by $Z\Pi(p_p)$ and, finally, $Z\Pi(p_l)$, the steepest one. Also, zero profit loci cross at $(c_f, c_s) = (w_f - IF, w_s - IF)$. Finally, note that bundles below [above] $Z\Pi(\cdot)$ yield positive [negative] profits. Still in this figure, FI is the certainty or full insurance line, characterized by the set of consumption bundles (c_f, c_s) such that $c_f = c_s$.

Finally, point O in Figure 1 represents the outside option of refusing all contracts and remaining unskilled (w_f, w_f). For simplicity of presentation, we assume that it is inefficient for low ability individuals to invest in education:[7]

Assumption 1 $p_l(w_s - w_f) < IF$.

As a result, point O is above $Z\Pi(p_l)$. Also, I_l $[I_h]$ is the set of consumption bundles C such that $EU_l(C) = U(w_f)$ $[EU_h(C) = U(w_f)]$, i.e., the low [high] ability agent's indifference curve for the utility level obtained at the outside option.

3 Characterization of the equilibria

In this section, we solve the game for all values of g. The first subsection deals with "soft" default penalties (low g). We show that the interaction between ex-post moral hazard and adverse selection yields complete credit rationing, i.e., no loans are offered at equilibrium. The second subsection studies intermediate default penalties (intermediate g). In such a case, the market equilibrium is characterized by pooling contracts where no insurance takes place. The third subsection presents the conditions under which no equilibrium exists. The last subsection discusses the case where default penalties are largest, which results in a separating equilibrium where only the more able invest in education. It also provides a final proposition that collects all the results and highlights the role of student risk aversion in determining the market outcome. In particular, if risk aversion is too high, the interval of intermediate default penalties becomes empty, which implies in this case that pooling never occurs at equilibrium.

3.1 Low default penalties

When default penalties are sufficiently low, the best strategy at the last stage is for agents to default. Yet, since penalties are low, banks' revenues yield negative profits, so they will not offer any contract. As default penalties g increase, a market will eventually emerge because garnishments in case of default start generating sufficient revenues to allow the funding of some projects at low interest rates. We discuss here the upper bound on default penalties such that credit rationing exists. The main intuition in this subsection is that credit rationing will prevail as long two conditions are met. First, the garsnishment rate has to be low enough so that banks will not be able to provide high ability agents with separating contracts which

[7]The more general case is treated in Del Rey and Verheyden (2008), of which an updated version is available upon request.

these agents can credibly commit to repay. Second, the garsnishment rate needs also be low enough for banks to be able to provide both types with default-proof pooling contracts that yield non negative profits.

We thus start from $g = 0$ and gradually increase it. Graphically, increasing g will make the default proof space move downwards, its origin shifting along G towards (0,0). Trivially, if $g = 0$, the borrower has the choice between repaying her loan or default and suffer no penalty at all. In turn, the bank does not receive any payments and makes losses. As g increases, some contracts become exempt of default, but they involve very small interest rates since penalties are still very low and agents prefer otherwise to default. Those interest rates are so small that, even if loans were taken by high ability agents alone, they would not allow to cover the risk-free interest rate i, and thus would still yield negative profits. Hence, the market does not exist.

Definition 4 *Let g_0^h be the lowest g such that $Z\Pi(p_h, g)$ is non-empty.*

When g reaches g_0^h, banks can offer contracts that are exempt of default and that would, if only high ability agents took them, yield non-negative profits. However, a contract corresponding to the singleton $Z\Pi(p_h, g_0^h)$, i.e. $Z\Pi(p_h) \cap G$ would also be preferred by low ability agents to the outside option.[8] Therefore, expected profits would still be negative, and banks would still refuse to offer loan contracts.

Definition 5 *Let g_2 be the minimum g such that $I_l \cap Z\Pi(p_h, g)$ is non-empty.*

Figure 2 depicts $B \equiv I_l \cap Z\Pi(p_h)$ and the corresponding default-proof space $DP(g_2)$.

When g reaches g_2, banks are able to offer a contract on $Z\Pi(p_h, g_2)$ that only high ability agents will pick, since, as stated in Definition 5, this contract, which corresponds to point B, provides low ability agents with the same utility level as the outside option. Banks are therefore no longer making losses and a market for student loans emerges.

The threshold g_2 may however be very large.[9] Then, banks might want to look for other options rather than trying to specifically target high ability agents. For instance, even though

[8]This is always true given the following assumption, which, although not necessary proves useful for the presentation of results. Let $(\bar{\bar{c}}_f, \bar{\bar{c}}_s)$ be the point where I_l intersects $Z\Pi(p_h)$. We assume $\bar{\bar{c}}_s \geq (w_s/w_f)\bar{\bar{c}}_f$, i.e. $I_l \cap Z\Pi(p_h)$ lies to the left of G. The implications of relaxing this assumption are available upon request.

[9]This is more likely, on the one hand, the lower the level of risk aversion and on the other, the higher the probability of success of high ability agents. To see why, keep in mind that the slope of $Z\Pi(p)$ equals $-(1-p)/p$, which is increasing in p.

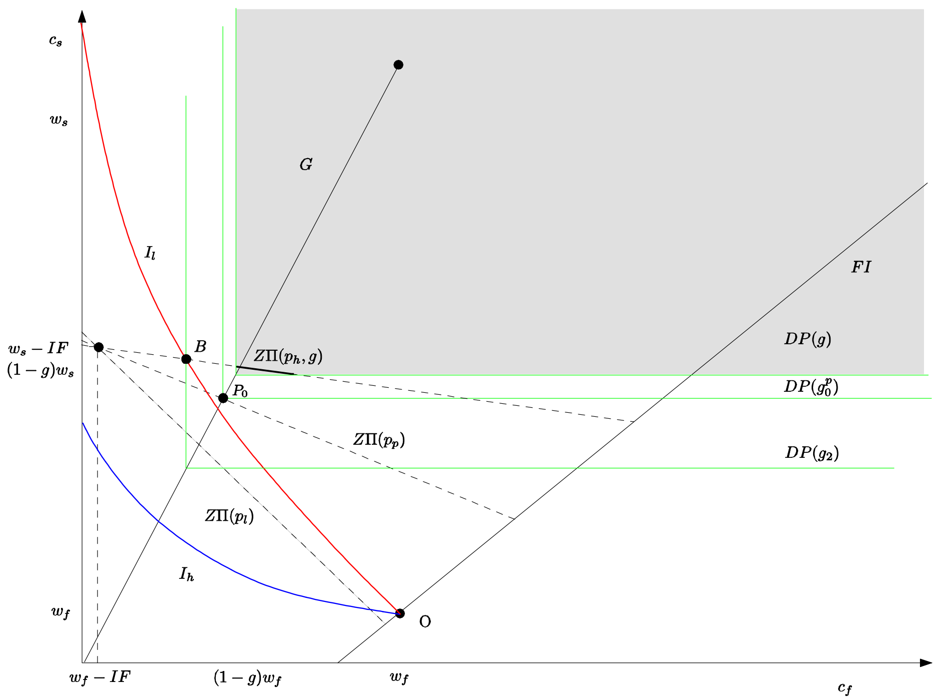

Figure 2: Credit rationing equilibrium

g were lower than g_2, it might be sufficiently high so that contracts that yield zero profits when both types accept them become default-proof: $Z\Pi(p_p, g)$ is non-empty. The level of g that is just sufficient to allow banks to offer a default-proof contract that yields non-negative profits when both types pick it (P_0 in Figure 2) is noted g_0^p:

Definition 6 *Let g_0^p be the minimum g such that $Z\Pi(p_p, g)$ is non-empty. It is such that $Z\Pi(p_p, g_0^p) = P_0 \equiv Z\Pi(p_p) \cap G$*

Summing up, credit rationing exists as long as banks are unable to offer loans that borrowers can credibly commit to repay. More precisely, credit rationing exists as long as default penalties are not sufficient to allow banks either to screen borrowers ($g < g_2$) or to pool them ($g < g_0^p$). This result is stated formally in the following proposition.

Proposition 1 *Credit rationing exists at equilibrium if and only if $0 \leq g < min\{g_0^p, g_2\}$.*

Figure 2 depicts the credit rationing equilibrium when $\min\{g_0^p, g_2\} = g_0^p$. This market failure can be solved rather trivially if we can provide the information that allows to identify high ability individuals provided that g is large enough to rule out default by these individuals. This shows that banks refrain from offering loan contracts when default penalties are low because of the interaction between ex-post moral hazard and adverse selection. In the following subsection we explore the consequences of increasing g on the equilibrium.

3.2 Intermediate default penalties

As default penalties increase further, more contracts become default-proof ($DP(g)$ continues to move down). In this subsection, we explore the possibility that a pooling equilibrium exists and show that, when it does, banks do not offer any market insurance beyond the legal safety net $(1-g)\,w_\sigma$. Therefore, the main conditions for pooling to exist are that default penalties should be high enough to avoid credit rationing, but at the same time not too high, otherwise the legal safety net would be too low for low ability agents -who are most likely to fail- to accept the pooling contract. One gets the intuition from this reasoning that pooling may not always exist. We show that low student risk aversion is crucial to determine the non-emptiness of the interval of default penalties that is compatible with pooling.

A first condition that must be met is that $g \geq g_0^p$. This ensures that there exists at least one potential pooling contract (P_0 in Figure 2). For the moment, assume all necessary conditions are satisfied and a pooling equilibrium exists. Lemma 1 shows that this equilibrium is always unique and non-insuring, i.e., the equilibrium contract does not contain any market insurance and leaves unsuccessful students with the lowest consumption level legally tolerated, $(1-g)w_f$.

Lemma 1 *If a pooling equilibrium exists, it is unique and it is such that the contract offered by banks is non-insuring.*

The formal proof of this lemma is provided in Appendix 1. Figure 3 depicts a pooling equilibrium candidate with insurance, where both types of students accept a contract that provides them with the consumption bundle $P_I \equiv \left(c_f^i, c_s^i\right)$. The dark shaded area represents a set of consumption bundles that have two important characteristics. On the one hand, these bundles are preferred by high ability agents to P_I, while they provide low ability agents with lower utility. On the other hand, this set of bundles lies below $Z\Pi(p_h, g)$. A bank offering a contract corresponding to any of these bundles will thus attract only high types and make positive profits. Since a profitable deviation exists, this candidate is not an equilibrium. In fact, the only contract on $Z\Pi(p_h, g)$ for which there is no profitable deviation is the non-insuring pooling contract, which corresponds to the consumption bundle $P_{NI}(g) \equiv \left(c_f^{ni}, c_s^{ni}\right)$.

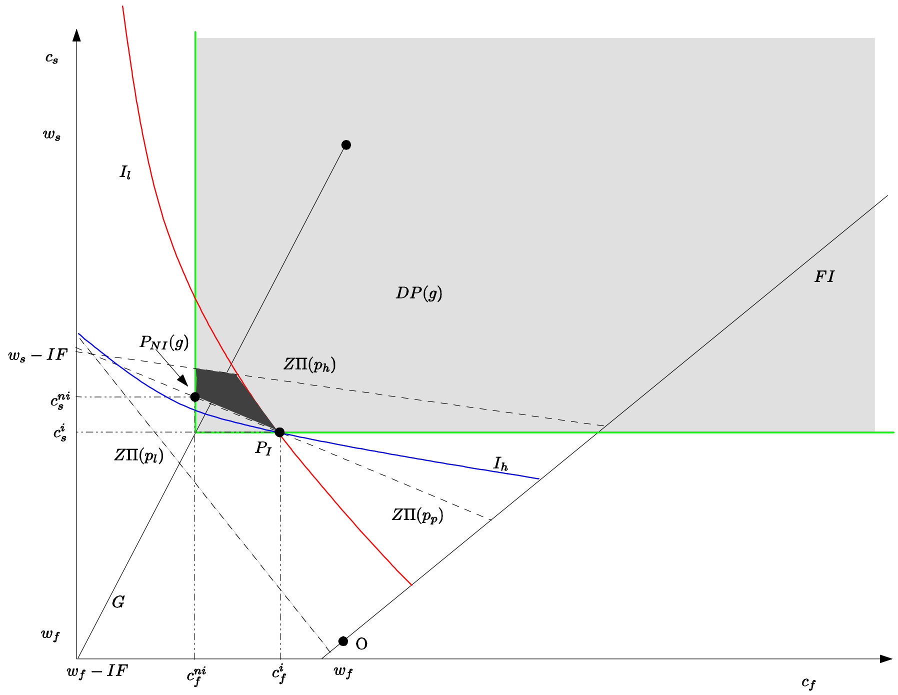

Figure 3: No insurance at the pooling equilibrium

Lemma 1 provides an explanation for the lack of insurance in student loans offered by private banks, which is one of the market failures that we wanted to analyze. Also keep in mind that even though banks do not provide any private insurance and may apply the same interest rate in every state of the world, borrowers are insured by the legal system against the risk of failure as long as $g < 1$. As default penalties increase, the non-insuring contract becomes less attractive because legal insurance is reduced. Then, a pooling equilibrium is less likely. Let us thus now study the exact conditions under which pooling non-insuring contracts are not offered at equilibrium.

First, as we have just mentioned, as the law on default gets tougher, the "safety net" consumption level in case of failure $(1-g)w_f$ eventually becomes so low that the pooling contract is no longer preferred by low ability agents to the outside option. The threshold g_1 formally defines the level of g at which a low ability agent is indifferent between the outside option and the non-insuring, pooling contract. Let $A \equiv (\bar{c}_f, \bar{c}_s)$ be the point where I_l intersects $Z\Pi(p_p)$ (see Figure 4).[10]

[10]Note that $(\bar{c}_f, \bar{c}_s)$ may not exist because the outside option may provide higher consumption levels in both states of the world than the potential full insurance pooling contract. Since the slope of I_l is strictly larger than that of $Z\Pi(p_p)$, these two loci can never cross in this case.

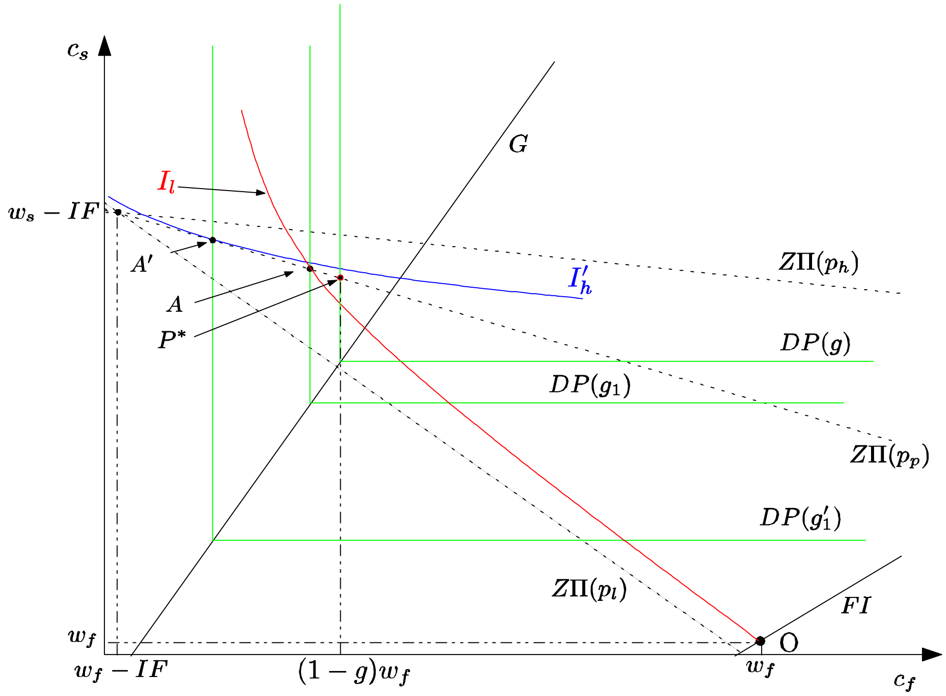

Figure 4: Existence of the pooling equilibrium

Definition 7 *The threshold* g_1 *is such that*

- *if* $(\bar{c}_f, \bar{c}_s)$ *exists and* $\bar{c}_s \geq (w_s/w_f)\,\bar{c}_f$, $g_1 = \min g$ *such that* $(\bar{c}_f, \bar{c}_s) \in DP(g)$,
- *if* $(\bar{c}_f, \bar{c}_s)$ *exists and* $\bar{c}_s < (w_s/w_f)\,\bar{c}_f$, $g_1 = g_0^p$
- *if* $(\bar{c}_f, \bar{c}_s)$ *does not exist,* $g_1 = g_0^p$.

From the discussion above, $g < g_1$ is necessary for a pooling equilibrium. Note that $g_1 \geq g_0^p$ in any case, which will prove useful in the discussion of Proposition 2.

A second reason why pooling may not exist is that banks might find it profitable to deviate from the pooling non-insuring contract to offer another pooling contract that provides more insurance and yields positive profits. Graphically, this can only be the case if the high ability agents' indifference curve that goes through the pooling non-insuring contract is steeper than $Z\Pi(p_p)$. Let now $(\widetilde{c}_f, \widetilde{c}_s) \equiv A'$ be the point on $Z\Pi(p_p)$ that is most preferred by a high ability type (see Figure 4).

Definition 8 *The threshold* g'_1 *is such that*

- *if* $\widetilde{c}_s \geqslant (w_s/w_f)\widetilde{c}_f$, $g'_1 = \min g$ *such that* $(\widetilde{c}_s, \widetilde{c}_f) \in DP(g)$
- *if* $\widetilde{c}_s < (w_s/w_f)\widetilde{c}_f$, $g'_1 = g^p_0$.

Again, we need $g < g'_1$ for a pooling equilibrium to exist. Also note that, by definition, $g'_1 \geq g^p_0$.

Given the constraints on g for the existence of a pooling equilibrium and the fact that apart from strict concavity, we do not impose any assumption on preferences, it may be the case that a pooling equilibrium does not exist for any g. However, we have isolated one condition on the ordering of thresholds, Condition 1, that is both necessary and sufficient for the non-emptiness of the interval of g that is compatible with a pooling equilibrium.

Condition 1

1.a) $g_1 > g^p_0$.

1.b) $g'_1 > g^p_0$.

Note that Condition 1 limits the degree of risk aversion of agents of low and high ability. Later, we will refer to *low risk aversion* to describe a situation where Condition 1 holds.

Lemma 2 *Condition 1 is necessary and sufficient for* $g^p_0 < \min\{g_1, g'_1\}$.

The proof of Lemma 2 is straightforward given the definitions of the thresholds. Proposition 2 provides a formal statement of the interval of g which supports a pooling equilibrium.

Proposition 2 *If Condition 1 is met, a pooling equilibrium exists if and only if* $g^p_0 \leq g < \min\{g_1, g'_1\}$. *Otherwise, a pooling equilibrium does not exist for any* $g \in [0; 1]$.

The proof of Proposition 2 is in Appendix 2. Figure 4 depicts a pooling equilibrium where the upper bound on g for a pooling equilibrium to exist, $\min\{g_1, g'_1\}$, equals g_1. It is important to note that the upper bound on g for credit rationing to be an equilibrium, $\min\{g^p_0, g_2\}$, always equals g^p_0 when a pooling equilibrium exists. Indeed, by Proposition 2, Condition 1 must apply for a pooling equilibrium to exist, and Condition 1 implies that $g_2 > g^p_0$. In Figure 4, the pooling equilibrium thus emerges for values of g comprised between g^p_0 and g_1. For the level of default penalty g represented in Figure 4, the pooling contract is represented by P^*. This leaves unsuccessful agents with the lowest possible level of consumption, $(1 - g)w_f$. Finally, note that the pooling equilibrium is inefficient by assumption.[11]

[11] Clearly, when the assumption that the investment in education by low ability individuals is inefficient is relaxed, the pooling equilibrium is no longer characterized by overinvestment (see Del Rey and Verheyden (2008) for a treatment of this case).

Summing up, we have seen in this subsection that the market can exist when the default penalty g is not too low, and provided two conditions limiting the degree of risk aversion of agents are met. Banks will then offer a single pooling contract that involves no insurance. Of course, the legal system does provide some insurance, by limiting the amount banks can garnish in the eventuality of default. This amount that banks can garnish is not enough for banks to cover the costs of lending to those who fail, i.e., $gw_f < IF$. This is due to the fact that point A in Figure 4 lies necessarily to the right of $w_f - IF$ (since I_l is tangent to $E\Pi(p_l)$ on the Full Insurance line and agents are risk averse). Then, $w_f - IF < (1 - g_1)w_f$ or $IF > g_1 w_f > gw_f$ when $g < g_1$. If $g_1' < g_1$, then A' lies to the right of A and a similar argument applies. In spite of the fact that banks make losses on those who fail, they are able to break even when pooling both individual types together.

3.3 Larger default penalties

In this model, there are three types of equilibrium: credit rationing, pooling and separating. So far, we have identified the necessary conditions for a credit rationing equilibrium and a pooling, non-insuring equilibrium to exist. Thus, if the conditions we have provided are not met, such types of equilibria do not exist. In this subsection, we identify the conditions under which neither does a separating equilibrium exist. Then, there will be no equilibrium in pure strategies.

A separating contract may exist if, as stated in Subsection 3.1, $g \geq g_2$. In this case, banks offer a unique contract which only high ability individuals accept. This contract entails so little legal insurance that it deters low ability agents from taking it, so that these agents remain unskilled. Conversely, if $g < g_2$, default penalties are lower, or equivalently, the degree of legal insurance is higher. This prevents banks from offering a contract that only high ability agents would pick.

In the previous subsection, we defined necessary and sufficient conditions under which a pooling equilibrium may exist. In this subsection, we also describe the necessary and sufficient condition under which, for some levels of g, no equilibrium exists.

Condition 2 : $g_2 > g_0^p$.

Note that Condition 1 implies Condition 2, but not the other way around. Thus, Condition 2 also limits the degree of risk aversion of a low ability individual, but less so than Condition 1. For this reason, we will later refer to *moderate risk aversion* to describe a situation where Condition 1 does not hold but Condition 2 does. If Condition 2 does not hold either we will refer to *large risk aversion*.

Lemma 3 *Condition 2 is necessary and sufficient for* $\min\{g_1, g_1'\} < g_2$*.*

To prove Lemma 3, let us first show that Condition 2 implies $\min\{g_1, g_1'\} < g_2$. On the one hand, Condition 2 implies $g_2 > g_1$, and $g_1 \geq \min\{g_1, g_1'\}$. Therefore, g_2 is greater than each element in $\min\{g_1, g_1'\}$. Let us now prove the other implication, that $\min\{g_1, g_1'\} < g_2$ implies Condition 2. Assume not, then $\min\{g_1, g_1'\} \geqslant g_2$. If $\min\{g_1, g_1'\} = g_1 \geqslant g_2$ which is impossible by the curvature of I_l. If $\min\{g_1, g_1'\} = g_1' \geqslant g_2$, since $g_2 > g_1$, then $g_1' \geqslant g_1$ and hence it is not the smaller of the two, leading to a contradiction.

Proposition 3 *If Condition 2 applies, the game has no equilibrium in pure strategies when* $\min\{g_1, g_1'\} \leq g < g_2$*.*

The absence of equilibrium in pure strategies is illustrated in Figure 4, where $\min\{g_1, g_1'\} = g_1$. No equilibrium thus exists for $g_1 < g < g_2$ in this case.

To prove Proposition 3, let us simply gather the information already available, keeping in mind that there are only three types of equilibrium candidates, namely credit rationing, pooling and separation. First, we know that if $g \geq \min\{g_1, g_1'\}$, neither pooling nor credit rationing can be equilibria. Second, we have shown that if $g < g_2$, a separating equilibrium cannot exist, Q.E.D..

Let us finish the characterization of the equilibria by the case where default penalties are largest, which can result in the separating equilibrium.

3.4 Largest default penalties

Once default penalties attain the largest levels, i.e., $g \geqslant g_2$, banks can offer contracts that leave low ability individuals indifferent between them and the outside option, while high ability agents strictly prefer them to the pooling option. A separating equilibrium arises and it is efficient, since only high ability individuals invest in education. This case is illustrated in Figure 5.

Proposition 4 *A unique separating equilibrium exists for* $g_2 \leq g \leq 1$*. Banks offer a unique contract which attracts only high ability agents and entails some market insurance as long as* $g > g_2$*.*

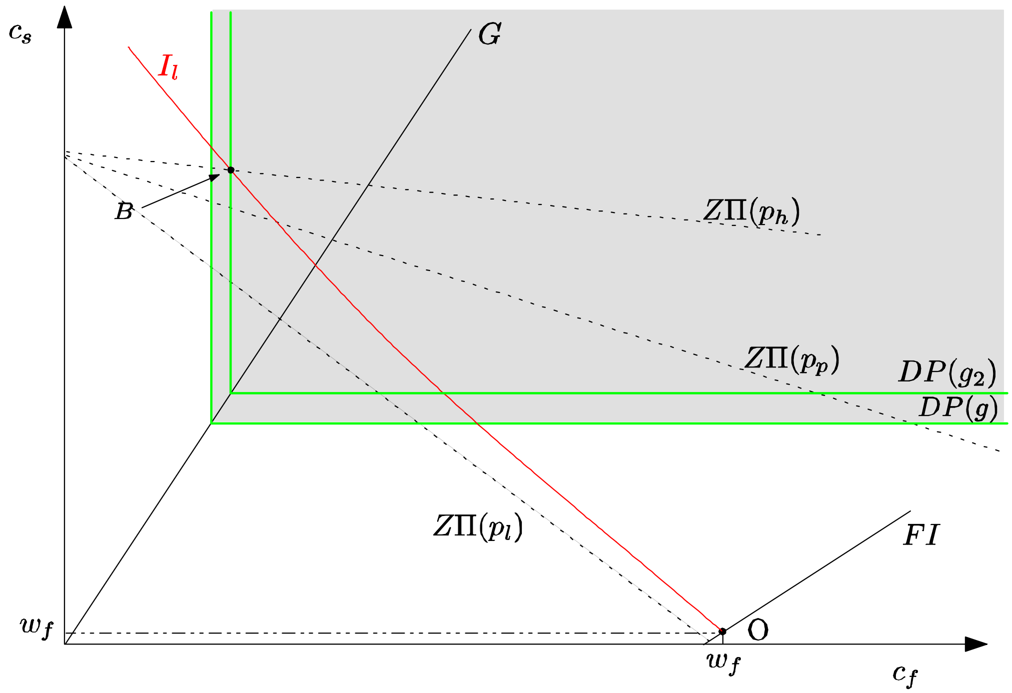

Figure 5: Separating equilibrium

This separating contract is represented by point B. Note that, in spite of the fact that banks may offer some insurance, because legal protection of the borrower is now lower, the individual ends up less insured than at the pooling equilibrium when this exists. That is, provided that individuals show low risk aversion levels (i.e., under Condition 1).

The level of insurance granted to the high ability type is limited in this case by the self-selection constraint of the low ability individual. In a sense, we can then argue that the credit market for students does not fail when default penalties are sufficiently large: high ability individuals are able to borrow and insure their loans to a certain extent. When students hold private information about their ability, it is impossible to provide high ability students with more insurance without dragging low ability individuals into investing in education, which is inefficient by assumption.[12]

Summing up our findings, we have characterized the outcome corresponding to each possible level of default penalty. Indeed, the intervals stated in Propositions 1 to 4 provide a proper partition of the domain of g, i.e. $[0, 1]$. By gathering Propositions 1 to 4, one can

[12]When the investment in education by both types is efficient, the market failures are limited for sufficiently large default penalties. However, in that case, banks use different insurance levels to separate students. Participation is, again, efficient, and low ability students, with a higher probability of failure, enjoy larger levels of insurance. *(See Del Rey and Verheyden (2008).)*

conclude that each type of equilibrium, as well as the case in which there is no equilibrium, may emerge for mutually exclusive intervals of g. In other words, when an equilibrium emerges, it is unique. Note that, if Condition 1 does not apply, then either $g_1 = g_0^p$ or $g_1' = g_0^p$. Also if Condition 2 does not apply, $g_2 < g_0^p$. Since this also implies that Condition 1 is not satisfied, $g_1 = g_0^p (> g_2)$. Then, we can write Proposition 5 to summarize our results:

Proposition 5 *Gathering Propositions 1 to 4, the game entails three possible scenarios:*

1. *Low Risk Aversion: Condition 1 (hence Condition 2) apply. The relevant intervals and their corresponding equilibria are then:*

    - $[0; g_0^p[$, *unique credit rationing equilibrium*
    - $[g_0^p; \min\{g_1, g_1'\}[$, *unique pooling non-insuring equilibrium*
    - $[\min\{g_1, g_1'\}; g_2[$, *no equilibrium in pure strategies*
    - $[g_2; 1]$, *unique separating equilibrium*

2. *Moderate Risk Aversion: Condition 1 does not apply, but Condition 2 does. The relevant intervals and their corresponding equilibria are then:*

    - $[0; g_0^p[$, *unique credit rationing equilibrium*
    - $[g_0^p; g_2[$, *no equilibrium in pure strategies*
    - $[g_2; 1]$, *unique separating equilibrium*

3. *Large Risk Aversion: Condition 2 (hence Condition 1) do not apply. The relevant intervals and their corresponding equilibria are then:*

    - $[0; g_2[$, *unique credit rationing equilibrium*
    - $[g_2; 1]$, *unique separating equilibrium.*

Credit rationing results under each possible scenario for low values of g. For the existence of a market that however fails to provide insurance, we need to impose the necessary and sufficient Condition 1, which, as previously mentioned, limits the degree of risk aversion of both types of agents. Conversely, a unique separating equilibrium results under each possible scenario for sufficiently large values of the default penalty, g. When individuals show large degrees of risk aversion (Condition 2 is not satisfied), this is the only feasible market solution.

To conclude the analysis, let us consider the possibility that a contract involving the riskless interest rate i in both states of the world is default-proof. This implies that $g \geq IF/w_f$, i.e. banks manage to recover the investment in case of failure of either type. There is no reason, then, for the market to fail. Indeed, arguing as before, point B must necessarily lie to the right of $w_f - IF$. Then, $g_2 < IF/w_f \leqslant g$. From Proposition 5, a separating equilibrium arises when $g \geq g_2$.

The next section is devoted to providing some additional applications of the model.

4 Comparative statics

The model can be also used to explain some additional and distinct stylized facts. First, according to Lochner and Monge-Naranjo (2008), the rising returns to higher education in the United States provide an explanation for the dramatic increase in private lending. Interestingly, our model can be used to show that private loans are more likely to be offered the higher the return to education in case of success. Second, it is observed that most private student loans are actually subsidized by governments (Shen and Ziderman (2007)). Our model allows us to show that the introduction of such subsidies does indeed improve the case for private lending. Third, the model also allows us to discuss the case for public income contingent loans. We show that governments can offer pooling loans comprising substantial insurance either if they enforce the exclusive use of public finance schemes or if they face competition and lend at lower interest rates than the market (in which case the program would show a budget deficit).

We start by analyzing the impact of exogenous changes in the wage in case of success. Then we study the role of an exogenous cash inflow used to subsidize the interest rate i. Finally, we refer to the case for public income contingent student loans.

4.1 Role of the wage in case of success

Changes in w_s affect the location of the zero profit loci (4). They also change the slope of G (w_s/w_f) and thus the location of the default proof space $DP(g)$.

If w_s increases, income after default in case of success $(1-g)w_s$ increases and $DP(g)$ becomes smaller (G becomes steeper while $(1-g)w_f$ does not change). For a unit increase in w_s, $DP(g)$ moves upwards by $(1-g)$. Yet, the zero profit loci move up by 1 unit, so that (additional) zero-profit contracts become available inside $DP(g)$. The reason is that the bank is able to offer better conditions in case of success compared to the default option, $(1-g)w_s$. Indeed, a borrower who repays her loan benefits from the whole wage increase, whereas a defaulter would only increase her consumption by a fraction $(1-g)$ of that increase. Individuals will be less prone to default and this makes it more likely for the market to exist. Thus, higher wages in case of success improve the case for private student loans, ceteris paribus.

4.2 Role of a subsidy on the interest rate

Suppose that the government benefits from an exogenous inflow of cash that it uses to subsidize banks' costs of borrowing i. Because of Bertrand competition, this lower cost will immediately be transferred to the borrower: interest rates will be lower and allow higher consumption bundles in case of failure and success. Lower interest rates, on the other hand, make it less profitable to default. Thus the existence of the market is compatible with lower levels of the penalty g when banks are subsidized. In other words, subsidies of this kind can take the economy from a credit rationing equilibrium to a pooling equilibrium (when risk aversion is *low*, or Condition 1 holds) or to a separating equilibrium (when risk aversion is *large*, or Condition 2 does not apply).

Graphically, the reduction in i translates into an upward shift of the zero profit loci, while their slope remains unaltered (see Equation (4)). Given g, the fall in i thus incites banks to offer contracts, as some of those contracts now generate non-negative profits despite asymmetric information and ex-post moral hazard. If risk aversion is large, the separating equilibrium, which involves the provision of some insurance by banks, is easier to obtain. Whether the benefits exceed the costs attached to obtaining the resources required to provide this subsidies remains a subject for future research.

4.3 Public income contingent loans

Unlike private banks, it is observed that governments offer pooling contracts with insurance, such as point P_I on Figure 3. According to the model, there are two reasons why this can be done. On the one hand, governments, unlike banks, can act alone on this market. By forcing students to participate in the public program (forbidding private lenders to offer student loans), governments can prevent deviations that would attract high ability agents out of the pooling insuring contract, and thus maintain the sustainability of the system. On the other hand, if private banks are allowed to offer student loans, the government can use budget revenues in order to lend at lower interest rates. According to the analysis undertaken in the previous subsection, this will shift the pooling zero-profit locus of the government upwards, improving the case for public (and not private) loans. As we have mentioned before, pooling contracts with insurance may lead to over-participation, i.e., some individuals will invest in education in spite of the fact that their expected earnings are below the cost of this investment.[13]

5 Conclusion

In this paper we have proposed a model to analyze the student loan market and explain its potential failures, along with other important stylized facts. We have considered risk averse agents who need to borrow in order to invest in education and who are heterogeneous in the probability of success. A particularity of our model is that it combines adverse selection with the possibility for agents to repay their loan only if this is less costly than incurring default. This allows us to retrieve the role of information asymmetries in explaining failures in the credit and insurance markets for students. Default penalties are determined by law and are defined here as the share of the wage that banks are allowed to garnish. Banks are perfectly competitive and are unable to observe *the ability of students*. They offer a menu of loan contracts that may include insurance against the eventuality of failure. In this framework, we have characterized the outcome corresponding to each possible level of default penalty and we have shown that when an equilibrium exists, it is unique.

When default penalties are sufficiently low, banks do not offer student loans. This first market failure results in our model from the combination of ex post moral hazard and adverse selection. The effect of raising default penalties on the market outcome depends on the degree of risk aversion of students. If risk aversion is low, intermediate default penalties generate a pooling equilibrium characterised by the strict absence of market insurance, yielding a second type of market failure. If risk aversion is high, pooling does not occur at equilibrium. Instead, banks are able to offer loan contracts characterized by limited levels of market

[13]Even if participation of lower ability students was efficient, the superiority of pooling contracts with insurance over separating contracts would only be guaranteed for sufficiently subsidized interest rates. The opportunity costs of the resulting deficit and, in particular, its relative efficacity if devoted to bank subsidies instead, should also be considered if we were to find the best policy. We leave these issues for further research.

insurance which only attract students of high ability, allowing efficient participation.

To assess the actual severity of default penalties in reality is a difficult exercise. Effective default penalties depend not only on the law, but also the cost of law enforcement and the regulation of personal bankruptcy. There are also cultural and psychological factors that affect the perceived size of the penalty. The fact that, when we observe the existence of a market of student loans, these are of the pooling-non-insuring type, may be interpreted as evidence that default penalties are of intermediate size. However, public interventions on the student loan market are in general substantial. Thus, what we generally observe is not a pure market outcome and, as we have seen, the level of default penalties that accompany a subsidized market are likely to be lower than those of an unsubsidized market.

Our model provides a framework for the analysis of student loan policy. As a way of example, we have used it to show how an exogenous increase in the wage in case of success can improve the case for private student loans for any given level of default penalties. Also, we have shown how subsidies can bring about private loans and how governments can implement income contingent schemes.

The model is certainly simple and leaves out of the scope of the analysis important aspects of credit markets such as market power, legal costs associated to collecting penalties, other costs associated to default or the role of collateral, among others. Yet, the model provides a useful benchmark and can be extended to account for some of these issues, that we leave for future research.

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Barcelona, Universitat de Girona, Facultés universitaires Notre Dame de la Paix (Namur), and Universitat Pompeu Fabra. We retain responsability for any remaining errors.

References

Barr, N. (2001). *The welfare state as piggy bank : information, risk, uncertainty, and the role of the state.* Oxford: Oxford University Press.

Chapman, B. (2005). Income contingent loans for higher education: International reform. *Discussion Papers of the Research School of Social Sciences, Australian National University, CEPR*, (491).

Chapman, B. and Greenaway, D. (2006). Learning to live with loans? international policy transfer and the funding of higher education. *The World Economy*, 29(8):1057–1075.

Chen, H.-j. (2005). Educational systems, growth and income distribution: a quantitative study. *Journal of Development Economics*, 76(2):325–353.

de Meza, D. and Webb, D. C. (1987). Too much investment: A problem of asymmetric information. *The Quarterly Journal of Economics*, 102(2):281–92.

Friedman, M. and Kuznets, S. (1945). Income from independent professional practice. *New York: National Bureau of Economic Research.*

Glennerster, H. (2009). *Understanding the finance of welfare: what welfare costs and how to pay for it.* Policy Press in association with the Social Policy Association, Bristol, UK.

Jacobs, B. and van Wijnbergen, S. J. G. (2007). Capital-market failure, adverse selection, and equity financing of higher education. *FinanzArchiv: Public Finance Analysis*, 63(1):1–32.

La Porta, R., Lopez-de Silanes, F., Shleifer, A., and Vishny, R. (1998). Law and finance. *Journal of Political Economy*, 106(6):1113–1155.

Lochner, L. J. and Monge-Naranjo, A. (2008). The nature of credit constraints and human capital. *NBER Working Papers Series*, (13912).

Mas-Colell, Andreu, M. D. W. e. J. R. G. (1995). *Microeconomic Theory.* Oxford University Press.

Shen, H. and Ziderman, A. (2007). Student loans repayment and recovery - international comparisons. Paper presented at the "Funding, Equity and Efficiency of Higher Education" Conference in Portoroz, 2007.

Stiglitz, J. E. and Weiss, A. (1981). Credit rationing in markets with imperfect information. *American Economic Review*, 71(3):393–410.

Appendix 1: Proof of Lemma 1

For a pooling equilibrium to exist, $Z\Pi(p_p, g)$ must be non-empty. Lemma 1 claims that, among all contracts that are pooling equilibrium candidates, or equivalently, among all corresponding consumption bundles $(c_f, c_s) \in Z\Pi(p_p, g)$, only the non-insured bundle $P_{NI}(g) = ((1-g)w_f, (p_p w_s - IF + (1-p_p)\, g w_f)/p_p)$ emerges at the pooling equilibrium. To see why, let us consider any other bundle providing some degree of insurance $(c_f^i, c_s^i) \in Z\Pi(p_p, g)$ with $c_f^i > (1-g)w_f$ and $c_s^i < (p_p w_s - IF + (1-p_p)\, g w_f)/p_p$, and show that there exists a profitable deviation from (c_f^i, c_s^i), so that the latter cannot be an equilibrium. By single crossing of the two types' indifference curves, there always exists some other bundle $(c_f^d, c_s^d) \in DP(g)$ such that $EU_l(c_f^d, c_s^d) < EU_l(c_f^i, c_s^i)$ but $EU_h(w_f, w_f) > EU_h(c_f^i, c_s^i)$ and such that $E\Pi(p_h, c_f^d, c_s^d) > 0$. In other words, if banks offer a pooling contract that implies a consumption bundle (c_f^i, c_s^i), there always exists a profitable deviation, which consists in offering a contract they know that only high types would accept, and that would yield strictly positive expected profits. The dark shade area in Figure 3 represents such profitable deviations from (c_f^i, c_s^i). Finally, note that $P_{NI}(g)$ is the only bundle in $Z\Pi(p_p, g)$ such that such a profitable deviation does not exist.

Appendix 2: Proof of Proposition 2

The proof has 3 steps. First, let us start by showing that when Condition 1 is not met, pooling does not exist for any $g \in [0; 1]$ then. By Lemma 2, if Condition 1 is not met, the interval $[g_0^p; \min\{g_1, g_1'\}[$ is empty. We have shown before Proposition 2 that pooling could only exist within this interval. Therefore, a pooling equilibrium cannot exist for any $g \in [0; 1]$.

The second step of the proof consists in showing that when Condition 1 is met, or equivalently $[g_0^p; \min\{g_1, g_1'\}[$ is non-empty, the existence of the pooling equilibrium implies that

$g_0^p \leq g < \min\{g_1, g_1'\}$. We have actually proved this in the discussion prior to the proposition. Indeed, we have shown that for values of g that are outside this interval, a pooling equilibrium cannot exist. Hence, if a pooling equilibrium exists, it has to be the case that $g_0^p \leq g < \min\{g_1, g_1'\}$.

The third and final step of the proof consists in showing that when Condition 1 is satisfied ($[g_0^p; \min\{g_1, g_1'\}[$ is non-empty), $g_0^p \leq g < \min\{g_1, g_1'\}$ implies the existence of a pooling equilibrium. Let us thus show that under these conditions, there exist no profitable deviations from the pooling non-insuring equilibrium candidate. In order to do that, it will prove useful to refer to I_h^* as the indifference curve of high ability agents at the equilibrium candidate. First, low (and a fortiori high) ability agents do not want to deviate from the non-insuring contract to the outside option because $g < g_1$. Consider now all contracts on I_h^* or below. Since $g < g_1'$, I_h^* is above $Z\Pi(p_p, g)$, so that any other contract strictly between I_h^* and $Z\Pi(p_l, g)$ will make losses, as it will be accepted by low ability types alone. Finally, contracts above I_h^* are preferred by both types, but since $g < g_1'$, those contracts are above $Z\Pi(p_p, g)$ and thus, make losses. As a result, there is no profitable deviation from the pooling non-insuring equilibrium candidate. This concludes the proof of Proposition 2.