

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. These market failures have been shown to arise endogenously in a framework with complete information when individual borrowers can default on debt. In contrast, when students are assumed to hold private information on their ability, adverse selection yields over-investment in education. In this paper, we retrieve the role of information asymmetries in explaining failures in the credit and insurance markets for students. To do that, we propose a model that combines adverse selection and ex-post moral hazard.

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

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1 Introduction

In the education literature, it is generally acknowledged that credit for students is rationed. Moreover, access to insurance is also limited. Governments all over the world recognize the existence of both these failures. Indeed, not only private student loans are usually heavily subsidized (Shen & Ziderman (2007)) but, also, an increasing number of countries is directly opting for the provision of public loans whose repayment is made contingent on income earned. In other words, public loans which are insured. This is the case in countries such as Australia, New Zealand, Sweden, Canada, the UK, Thailand, Canada and, more recently, Spain.¹

These credit market failures have been shown to arise endogenously in the education market when individual borrowers can default on debt (Zeira (1991) and Kehoe & Levine (1993)). In contrast, the well-known argument of Stiglitz & Weiss (1981), according to which credit rationing results from the asymmetric information regarding the investor's probability of success, does not work when the investors are students and the projects are careers. In this paper, we argue that the role of information asymmetries should however not be ruled out when searching for the reasons why student credit and/or insurance markets fail. But, before explaining our contribution, let us take some time to understand why adverse selection à la Stiglitz and Weiss is not a satisfactory explanation for the lack of credit in education markets.

In Stiglitz & Weiss (1981), projects have the same expected return but risks differ in the sense of a Mean Preserving Spread (MPS). In this setting, with MPS and borrowers' limited liability, the riskier investor is willing to pay a higher interest than the less risky investor. In the case of unsatisfied demand, the standard market mechanism relies on an increase of the price to clear the market. In the Stiglitz and Weiss setting however, an increase of the price of credit - the interest rate - may fail 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.

A different setting based on the First Order Stochastic Dominance (FOSD) concept is

¹See Chapman (2005) and Chapman & Greenaway (2006) for an international overview of ICL's. The US Department of Education also has developed an "Income Contingent Repayment Plan", whereby the monthly payments are pegged to the borrower's income, family size and total amount borrowed. The idea of making repayment contingent on income is generally attributed to Friedman & Kuznets (1945).

used by de Meza & Webb (1987): 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. When the investment with the lower expected return is inefficient, pooling implies that too many projects are financed. Thus, a market imperfection in de Meza & Webb (1987) is characterized by overinvestment rather than credit rationing.

In the economics of education literature, it is usually assumed that high ability students face larger expected returns from investing in education. Moreover, their probability of success is also larger. Hence, of the two models discussed above, de Meza & Webb (1987), with its First Order Stochastic Dominance concept, seems more adequate than Stiglitz & Weiss (1981) to describe the conditions of the market for student loans.² In this paper, we show that, when combined with default as a strategic decision of the agent (ex-post moral hazard), the de Meza & Webb (1987) framework can also generate a credit rationing result. The model also explains the lack of insurance for certain values of the parameters.

We then consider a model where agents differ in ability, or probability of success, which is private information.³ They are risk averse and need to borrow in order to invest in education. Banks are perfectly competitive and offer menus of loan contracts that may include insurance against the eventuality of failure. As we have already mentioned, the main feature of our model is that it accounts for default as a strategic decision of the agent. This allows to consider the role of ex-post moral hazard in combination with asymmetric information on the agent's type. Ex-post moral hazard may occur when the outcome of the investment is realized, and borrowers have incentives to default. Such incentives are conditional on the design

²Despite its obvious flaws in the context of student loans, the conclusions of Stiglitz & Weiss (1981) are sometimes appealed to explain the absence of purely private student loans when students hold private information on their ability. This is the case, for example, in Canton & Blom (2004) and Jacobs & van Wijnbergen (2007). Barr (2001) also resorts to adverse selection as an explanation of credit market failure but, in order to comply with Stiglitz & Weiss (1981)'s setting, he assumes that students hold private information on their career choice (p. 177).

³Sometimes, the ability of students can be inferred from previous examinations, reference letters and interviews. Other times, individual records are difficult to compare and reference letters are not all that informative. Finally, students can lie at interviews. One has to admit that there is at least some scope, in some cases, for students knowing more about themselves than banks.

of default penalties, for which some heterogeneity is observed at the international level. For instance, La Porta et al. (1998) establish a difference in credit market development depending on whether the country is influenced by common law or by French law tradition. The difference among the two is precisely the legal protection of entrepreneurs, stronger in common-law countries. Ionescu (2007) studies the implications of the change in the bankruptcy rule for student loans in the US, and shows that the choice of rule affects the default behavior of borrowers, who may default for strategic reasons under some institutional arrangements. Salmi (1999) attributes high default levels in student loans partly to "poor management of the loan recovery function". Bertola et al. (2006) recall that "Equilibrium models of default recognize that all debt *could* be repaid if the punishment were sufficiently large. In reality, punishment is even less severe than permanent exclusion from further consumption smoothing opportunities". In this paper, default penalties are modelled as the proportion of the wage that banks can garnish when the agent defaults. In reality, the effective size of default penalties depends upon several other things such as bankruptcy norms, enforcement costs or social and psychological penalties. Our modelling strategy allows us to provide a rationale for the above mentioned observations of credit rationing and lack of insurance in the student loan market. In addition, it shows that market failure can result in over-investment, for some combinations of the parameters.

In particular, we obtain the following results. The interaction of ex-post moral hazard and adverse selection proves fundamental in explaining credit rationing in the student loan market. More precisely, an absence of private student loans results when default penalties are relatively soft. When default penalties are intermediate, and the degree of risk aversion of agents is sufficiently low, banks offer pooling contracts at equilibrium. Since we assume that the investment in education by the low ability types is inefficient, this result implies over-investment in education. However, at this equilibrium, banks offer no insurance. Finally, if penalties for default and/or the risk aversion of agents are large, banks are able to provide loans that are only attractive to the good types and include limited contractual insurance.

The model provides a framework for the analysis of student loan policy and can also be used to explain other stylized facts. For example, it can be shown that private loans are the more likely to be offered the higher the return to education in case of success (Lochner & Monge-Naranjo (2008)) and that the introduction of subsidies improves the case for private lending (Shen & 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, 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 a set, or menu of contracts. When facing the menu of contracts offered by banks, 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 & 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 bank cannot expropriate those who default. However, as Lochner & 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. 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 (FFEL), in the USA, the garnishment rate is set at a maximum of 15%. In other countries, such as Spain, the scheme of default penalties is more complex, following a graduated scale and with exemptions. On the other hand, personal bankruptcy laws sometimes allow to escape the penalty, further protecting defaulters.

All in all, the legal system provides the borrower with some insurance against failure, even if the contract designed by the bank does not include such insurance. Later, we will refer to a non-insuring contract when the bank does not provide any level of insurance that is above the one guaranteed by law.

Agents are risk averse and, prior to making their decision to invest in higher education, care for 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 $U(\cdot) : \mathbb{R}_+^2 \rightarrow \mathbb{R}^+$. 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 agent have negative slopes and satisfy the single-crossing condition. Indeed, for all $(c_f, c_s) \in \mathbb{R}_+^2$, $\frac{dc_s}{dc_f} \Big|_{EU_a(C)=\bar{U}} = -\frac{1-p_a}{p_a} \frac{U'(c_f)}{U'(c_s)}$, where \bar{U} is constant. Since $-\frac{1-p_a}{p_a}$ is increasing in p_a , $\frac{dc_s}{dc_f} \Big|_{EU_h(C)=\bar{U}} > \frac{dc_s}{dc_f} \Big|_{EU_l(C)=\bar{U}}$

for all $\bar{U}, \bar{U}' \in \mathbb{R}^+$.

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 the agent.
3. The agent 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. If banks offer no contract, the agent remains unskilled and the game ends.
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 agent 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.⁴ 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 $R_\sigma F > gw_\sigma$.

⁴Even 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 et al. (1995) Chapter 13.

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

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

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

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* 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

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

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

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

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 ???. 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 highest possible interest rate in case of success. Indeed, if starting from this type of contract banks increased marginally the interest rate in case of success, successful agents would default. 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 lowest interest rate 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 a borrower has the lowest possible level of consumption in this state of the world: $c_f = (1 - g)w_f$.*

Note that a non-insuring contract can be viewed as a pure loan contract, with $R = R_f = R_s$, where banks, anticipating that borrowers default in case of failure, adjust the interest rate in order to avoid losses. However, although banks do not offer any private insurance,

borrowers are still legally insured. Indeed, thanks to the legal system, an unsuccessful agent cannot end up with a lower consumption level than $(1 - g)w_f$. In other words, a student is totally deprived of any insurance only if $g = 1$.

Figure 1 about here

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

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

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:

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

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 ??, 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 ?? 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.⁵

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 a complete market failure, where no loans are offered. 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.

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. This is the intuition behind credit rationing in our model. 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.

We thus start from $g = 0$ and gradually increase it. 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

⁵The more general case is treated in Del Rey and Verheyden (2008), of which an updated version is available upon request.

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.

As g reaches g_0^h , which is defined as the lowest g such that $Z\Pi(p_h, g)$ is non-empty, banks can now 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.⁶ Therefore, expected profits would still be negative, and banks would still refuse to offer loan contracts.

Definition 4 *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 default-proof space $DP(g_2)$.

Figure 2 about here

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 4, 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.⁷ Then, banks might want to look for other options rather than trying to specifically target high ability agents. For instance, even though 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 5 *Let g_0^p be the minimum g such that $Z\Pi(p_p, g)$ is non-empty. It is such that $Z\Pi(p_p, g_0^p) = P_0 \equiv Z\Pi(p_p) \cap G$*

⁶This is always true given the following assumption, which, although not necessary proves useful for the presentation of results. Let (\bar{c}_f, \bar{c}_s) be the point where I_l intersects $Z\Pi(p_h)$. We assume $\bar{c}_s \geq (w_s/w_f)\bar{c}_f$, 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.

⁷This 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 .

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 $0 \leq g < \min\{g_0^p, g_2\}$.*

The preceding discussion actually proved Proposition 1. Indeed, we have shown in the first part of the discussion that low values of $g < \min\{g_0^p, g_2\}$ imply that banks do not offer loans at equilibrium since such an offer would incur losses. The other implication, that credit rationing exists at equilibrium only if $g < \min\{g_0^p, g_2\}$, was proven by showing that for $g \geq \min\{g_0^p, g_2\}$, there exists a deviation from credit rationing, so that the latter cannot be an equilibrium.

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 ($DP(g)$ moves down). In this subsection, we explore the possibility that a pooling equilibrium exists and show that, when it does, it involves minimum insurance on the part of banks.

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 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.*

Figure 3 about here

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 $P_I \equiv (c_f^i, c_s^i)$. 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 $P_{NI}(g) \equiv (c_f^{ni}, c_s^{ni})$. Lemma 1 provides an explanation for the lack of insurance in student loans offered by private banks, which is one of the stylized facts 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).⁸

Definition 6 *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, $g_1 = g_0^p$.*

⁸Note 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 about here

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. This can happen if banks are able to find a contract that is attractive to all agents 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 $(\tilde{c}_f, \tilde{c}_s) \equiv A'$ be the point on $Z\Pi(p_p)$ that is most preferred by a high ability type (see Figure 4).

Definition 7 *The threshold g'_1 is such that*

- if $\tilde{c}_s \geq (w_s/w_f)\tilde{c}_f$, $g'_1 = \min g$ such that $(\tilde{c}_s, \tilde{c}_f) \in DP(g)$
- if $\tilde{c}_s < (w_s/w_f)\tilde{c}_f$, $g'_1 = g_0^p$.

Again, we need $g < g'_1$ for a pooling equilibrium to exist. Also note that by definition $g'_1 \geq g_0^p$.

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) $g_1 > g_0^p$.
- 1.b) $g'_1 > g_0^p$.

Note that Condition 1 limits the degree of risk aversion of agents of low and high ability. This is sensible since the unique pooling equilibrium candidate does not involve any contractual insurance. 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 $g_0^p < \min\{g_1, g'_1\}$.*

The proof of Lemma 2 is straightforward. 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 $g_0^p \leq g < \min\{g_1, g'_1\}$. 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, $\min\{g_0^p, g_2\}$, always equals g_0^p when a pooling equilibrium exists. Indeed, by Proposition 2, Condition 1 must apply for a pooling equilibrium to exist, and Condition 1 implies that $g_2 > g_0^p$. In Figure 4, the pooling equilibrium thus emerges for values of g that define default proof spaces whose origin lie on the lighter part of G , i.e., $g_0^p \leq g < g_1$. 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, $(1 - g)w_f$.

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 $IF > g_1w_f > gw_f$ 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, to wit 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 a separating equilibrium does not exist either.

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 $\min\{g_1, g'_1\} \geq g_2$. If $\min\{g_1, g'_1\} = g_1 \geq g_2$ which is impossible by the curvature of I_l . If $\min\{g_1, g'_1\} = g'_1 \geq g_2$, since $g_2 > g_1$, implies that $g'_1 \geq g_1$ 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 if $\min\{g_1, g'_1\} \leq g < g_2$.*

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., $g \geq g_2$, 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.

Figure 5 about here

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 $g > g_2$.*

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 provided this exists. That is, provided that individuals show low risk aversion levels.

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 ability is private information of the students, this moderate level of insurance is the most we can get without dragging low ability individuals into investing in education, which is inefficient by assumption.⁹

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 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

⁹When the investment in education by both types is efficient, the market also works fine 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.

$g'_1 = g_0^p$. 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, $g_2 < IF/w_f \leq g$. From Proposition 5, a separating equilibrium arises when $g_2 \leq g$.

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 & 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 subsidised by governments (Shen & 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 insuring loans provided they prohibit competition or lend at lower interest rates than the market, so that the program shows a budget deficit. This practice leads however to over-participation in education, which, together with the costs of financing the budget deficit, questions the pertinence of this type of programs.

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, with everything else equal.

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.

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.

We thus 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 agents' ability. They offer menus 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.

In the first place, if default penalties are sufficiently low, banks do not offer student loans at equilibrium. This market failure is commonly known as credit rationing, and in our model, it results from the combination of ex post moral hazard and adverse selection. In the second place, higher default penalties can yield a pooling equilibrium. Banks offer a single contract that is non-insuring. Because agents are risk averse, this equilibrium corresponds to a second type of market failure, to wit lack of insurance. Moreover, given our assumption that the investment in education by low ability individuals is inefficient, the pooling equilibrium involves over-investment, which can be seen as a third type of market failure. If risk aversion is high, the pooling equilibrium may not exist. Finally, if penalties for default and/or the risk aversion of agents are sufficiently large, the equilibrium is separating and involves some insurance.

How large is, in reality, the penalty for default? It is difficult to say. 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, the student loan market is in general heavily intervened. 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.

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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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 $P_{NI}(g) = ((1 - g)w_f, (p_p w_s - IF + (1 - p_p)gw_f)/p_p)$ 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 $c_s^i < (p_p w_s - IF + (1 - p_p)gw_f)/p_p$, 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.

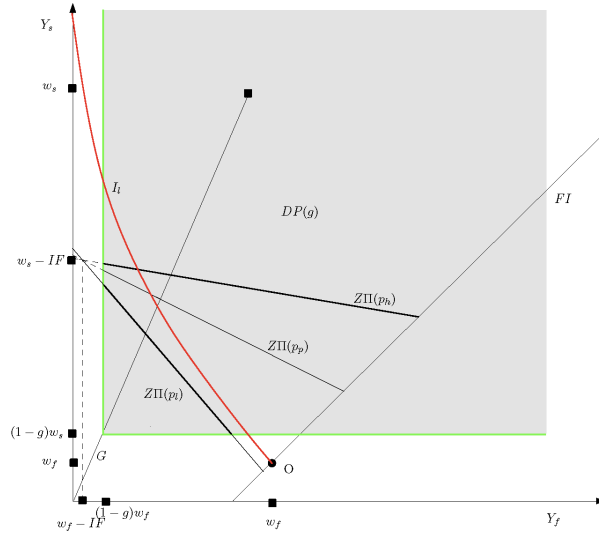


Figure 1: Basic elements of the model

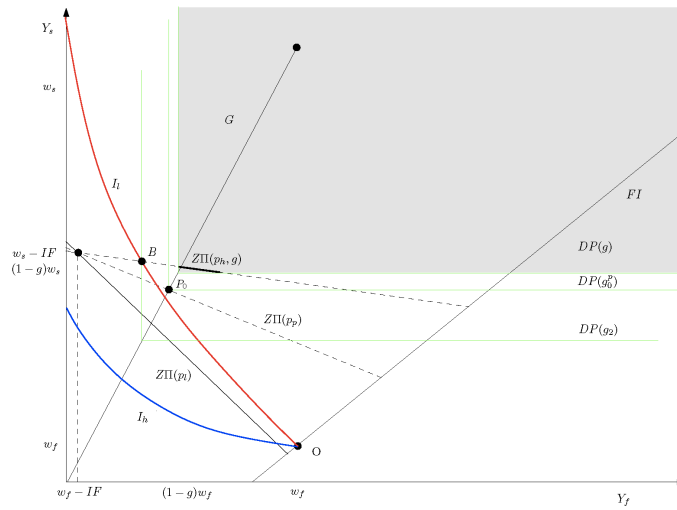


Figure 2: Credit rationing equilibrium

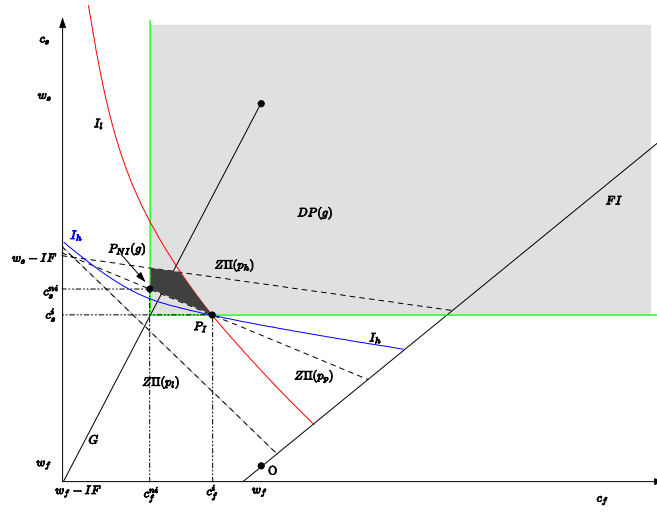


Figure 3: No insurance at the pooling equilibrium