Inequality of credit opportunities*

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Abstract

This paper investigates the impact of credit allocation on heterogeneous wealth entrepreneurs from an egalitarian opportuntiy point of view. We show that in a model with hidden information about both entrepreneurial wealth and effort aversion, and moral hazard, collateral proves ineffective in sorting good entrepreneurs from bad ones. Due to DARA, poor entrepreneurs, other things equal realize better projects. This notwithstanding, they may be rationed out or obtain a loan only at the cost of cross subsidizing bad projects realized by rich entrepreneurs.

Keywords: Collateral, Credit, Cross-subsidization, Decreasing absolute risk aversion, Equality of Opportunity

JEL classification: D31; D82; G21

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1 Introduction

The ideal of a society in which people do not suffer disadvantage from discrimination on grounds of unequal opportunities is widely upheld as desirable in itself. The requirement extends far beyond the vague injunction to eschew public sphere discrimination but it implies a central normative investigation for deciding on what grounds one might justify responsibility-sensitive policy interventions. The idea of competing on equal terms was formalized in the equality of opportunity principle which requires the distinction between unchosen circumstances and individual choices (see among egalitarian philosophers, Rawls (1971), Sen (1973), Cohen (1989) and Arneson (1989)). The former are matters imposed on an individual in ways that she could not have influenced or controlled; these matters are just given. The latter, instead, constitute the personal responsibility of individuals. Main circumstances for instance include the wealth inherited and early environment provided by parents and in general all the features of the world in which one finds oneself prior to any opportunity for responsible choice. Measuring opportunity profiles is also required to discover whether the gap between the top rung of society and the bottom rung should be large or small taking into account their possible influences on economic performance (Roemer, 1998). In the last 20 years the opportunity egalitarian literature has entirely extended on the measurement of inequality of opportunity as a crucial way to guarantee or favor a proper redistribution in terms of social fairness. A variety of measures was adopted with the aim of separating 'inequality of opportunity' or 'responsibility sensitive inequality' and applied mainly in the context of income inequality but also in taxation, education, health (e.g. Bourguignon *et al.* (2007), Checchi and Peragine (2010))[1].

Intuitively the principle of equality of opportunity should require that jobs and options to borrow money for investment purposes such as starting a business should be open to all applicants. However a strong evidence demonstrate unequivocally that entry in the credit market is heavily wealth dependent (Berger and Udell, 1990; Black *et al.*,1996; Blanchflower and Oswald, 1998)[2][3]. What in general would be hoped is that applications be assessed

[1] For a recent survey, see Pignataro (2011).

[2] Most contributions lie in the field of development economics; for a survey, see Benabou (1996).

[3] Wealth dependence can in turn be the product of many factors, among which endogenous risk preferences (Cressy, 2000).

by relevant criteria of responsibility while the presumption typically is that the criteria is usually related to profitability. Instead, for instance imperfect information may force the principal to choose on the basis of collateral provision, leading a wrongful allocation of resources. When hard working poor individuals are excluded from credit lines, markets function less efficiently, and potential output may not be realized.

This paper allows us to deal with this fundamental concern trying to understand how potential moral hazard and adverse selection shape contractual relationships of this kind. More specifically, we investigate what are the interactions among them and whether they involve the violation of the equality of opportunity principle. We propose a responsibility variable in the form of a parameter denoting effort aversion for different individuals. Effort aversion affects the individual willingness to supply effort and therefore measures (inversely), other things equal, the propensity of individual to work hard.

At a high level of generality, equality of opportunity in the credit market can be interpreted as the equal access to credit for would-be entrepreneurs with the same effort aversion. Thus inequality of opportunity is realized in this case when poor people with the same effort aversion are excluded from the market. We will also find that adverse redistribution may occur in equilibria where poor entrepreneurs cross-subsidize rich ones determining unfair credit allocations (see Coco and Pignataro, 2012). Further we try also to understand whether inequality of opportunity and perverse redistribution prospect is associated to an inefficiency determined by the heterogeneity on effort aversion.

In order to make this possible, we propose a model with bidimensional heterogeneity among individuals where adverse selection and moral hazard simultaneously coexist. Potential entrepreneurs differ for both circumstances and personal responsibility. Circumstances of borrowers are perfectly represented by the ex-ante endowed wealth while the individuals' responsibility variable is codified as effort aversion (an indicator of preferences) affecting the measure of the chosen actions (effort) the individual takes. We want to investigate the implication for the existence and properties of equilibrium in a framework where both features are unobservable by competitive lenders.

Thus one characterizing assumption is that individuals' wealth is not publicly observable, while agents exhibit decreasing absolute risk aversion

($DARA$, hereafter)[4]. This assumption requires some justifications[5]. In most of the credit market literature (with the significant exceptions of Stiglitz and Weiss, 1992 and Coco and Pignataro, 2012) wealth is supposed to be observable while entrepreneurial ability is not. However in other fields (for example tax evasion), the idea that financial income and wealth positions of individuals are common knowledge would be considered rather odd. The idea that a bank official can assess the extent of one individual's wealth is even stranger. In most papers the assumption of common knowledge on wealth possibly proxies for the belief that there are no reasons to conceal one's wealth. In this paper this is not the case because decreasing risk aversion may turn wealth into a bad signal. Relative to our former paper however here we assume asymmetric information on the responsibility variable as well.

This bidimensional symmetric information and the moral hazard ensuing complicates considerably the game. In a situation where individuals are risk averse, their willingness to bear risk is an important additional channel through which the distribution of wealth determines the contract form and the efficiency and equity properties of the equilibrium. In particular $DARA$ gives personal endowment a new role in providing incentives that can mitigate or exacerbate information problems. More wealth (and less risk aversion) negatively impact on effort provision (see Newman, 2007). Adverse selection on wealth types is therefore endogenously generated by different optimal levels of effort along the distribution of wealth. As a consequence poor individuals may end up as hard-working agents, other things equal. Moreover for each wealth class, preferences on effort aversion affect effort provision as well and the two dimension interact in a complex manner.

We consider a contract space in terms of collateral and interest rate. Risk aversion and effort aversion (through their consequent effort choice) determine the willingness to post collateral and therefore the existence and form of the equilibrium. Risk aversion influences the willingness to post collateral both directly and through effort choice (moral hazard) in different directions. When the moral hazard channel dominates, no equilibrium exists. Instead when the direct effect of risk aversion prevails, we discover a unique pure strategy subgame perfect equilibrium in the screening game. For some preferences, only some poor entrepreneurs are excluded from the market.

[4]For the empirical evidence in favor of the DARA assumption, see among others, Black (1996); Ogaki and Zhang (2001).

[5]For a fuller discussion of this assumption see our previous paper Coco and Pignataro (2012) where it was first introduced.

Different risk classes (rich and poor) may be pooled at a single contract in equilibrium, where cross-subsidization occurs not only between wealth classes but also between different effort aversion type. The credit market equilibrium is then characterized by inequality of opportunity and inefficiency in contrast with the traditional trade-off. The rich are therefore charged a low rate of interest (relative to their risk) even if they are characterized by high level of effort aversion while the poor borrowers (with low effort aversion) are charged too high an interest rate.

Our contribution lies within the literature on inefficiencies in the credit market (de Meza and Webb, 1987; Stiglitz and Weiss, 1981) and in particular the theory of collateral use. Inefficient levels of investments may also occur notwithstanding collateral (Bester, 1985; Besanko and Thakor, 1987; Coco, 2000) serving as a screening device.

The issue of cross-subsidization has been highly debated in the theoretical literature (e.g., Black and de Meza, 1997; de Meza and Webb, 1999, 2000; de Meza, 2002; Parker, 2003), although not from the equity point of view. Most related to our work are the papers by Stiglitz and Weiss (1992) and Coco (1999). These papers demonstrate the impossibility of screening by collateral in the credit market with two classes of borrowers with different risk attitudes. Risk preferences and project quality interact through moral hazard in conflicting ways, so that collateral is not a meaningful signal of project quality. In Stiglitz and Weiss (1992) in particular, differences in risk attitude arise due to decreasing risk aversion, an idea we adopt in this paper as well. Finally, our paper is related to Gruner (2003) who considers a setting where rich borrowers crowd out productive poor ones. He suggests that an ex-ante complete redistribution of endowments, by inducing the substitution of rich entrepreneurs with poor ones, may lead to a Pareto-improvement due to a rise in the risk-free interest rate.

The structure of the paper is as follows. Section 2 introduces the baseline model while section 3 discuss the characterization of the loan contracts. The inequality of opportunity equilibrium is instead investigated in section 4. Concluding remarks follow in section 5.

2 The model

Consider a one period competitive credit market populated by entrepreneurs owning projects with risky income streams. Each project requires both (fixed) investment capital K and effort supplied by the entrepreneur. Specifically the uncertain revenue from an investment can take one of the two values, Y in the event of successful state with a certain level of probability $p(e)$ and zero in case of failure with probability $(1 - p(e))$ where $e \in [0, \bar{e}]$ denotes the amount of effort. Returns to effort are positive and diminishing as usual, i.e., $p'(e) > 0$ and $p''(e) < 0$. In more general terms, a higher level of effort e results in a project whose returns first-order stochastically dominates ($FOSD$) the project returns with lower levels of effort (De Meza and Webb, 1987). Utility for the would-be borrowers is a concave increasing function that exhibits decreasing absolute risk aversion ($DARA$, hereafter), i.e., $d(-U''(w)/U'(w))/dw < 0$ and $U(w = 0) = -\infty$. Each agent has a different amount of illiquid wealth w_i, $i \in [R, P]$ for rich and poor respectively, which are both insufficient to achieve full collateralization, $w_i < (1 + r)K$. This implies the need to borrow the whole amount of capital, K, in order to undertake the investment projects. Moreover let us denote $X = (1 + r)K$ as the total repayment where r is the interest rate required by the bank for an amount of collateral c. Individuals differ also because of a scalar indexed effort aversion μ_j, $j \in [L, H]$ which can be respectively low or high. Futher assume that a project realized by entrepreneurs with a low effort aversion (L) may have a positive net value, while high effort aversion (H) always induces such a low level of effort that its net return is negative[6]. As a consequence projects of types$-H$ should not be undertaken from a social perspective, as they produce less than the resources employed. Moreover an equilibrium with separation of types$-H$ can be ruled out from the outset. While simplifying considerably the picture this assumption is quite realistic in delivering a world in which some potential entreprenuers are basically looters (in the words of Akerlof *et al.*, 2003) and could only realize their projects when obtaining pooling contracts with positive net present value projects/entrepreneurs.

[6]This assumption is introduced to simplify the treatment, but it is not restrictive. As we are going to see in the next sections the contracts designed could be rewritten as contracts in which entrepreneurs at $H-$levels has a positive expected return with a potential separation among wealth classes. We adopt the former characterization because it makes contracts easier to analyze delivering a more tractable framework in the inequality of opportunity perspective.

Besides being characterized by L (low) or H (high) effort aversion, entrepreneurs differ also for their endowement and they may be either of type R (rich) or P (poor). The two feature of the borrowers are distributed independently in the population and therefore if $\lambda_{ij}, \in ij$ $\{R, P\} \times \{L; H\}$, is the proportion of borrowers of class ij where $\lambda_{ij}/\lambda_i = \lambda_{-ij}/\lambda_{-i}$. In other terms the proportion of low and high aversion to effort type is the same in the rich and poor group of the population.[7] The borrower's wealth w_i, her own effort aversion μ_j and her consequent effort choice $e(w_i, \mu_j)$ are known to the individual but not observable by a competitive lender.

The expected utility of a borrower ij equals the expected net revenue from the project minus the cost of effort:

$$U_{ij}(X, c) = p(e_{ij})U(Y - X + w_i) + (1 - p(e_{ij}))U(w_i - c) - \mu_j e_{ij} \quad (1)$$

Intuitively, if a lender can observe a borrower's level of effort and can enforce an effort contingent contract, then there is no moral hazard and a first-best outcome will emerge. If such a contract is not possible then moral hazard persists and the lender must infer $e^*(w_i, \mu_j)$, the participating borrowers' optimal level of effort as a function of wealth w and effort aversion μ. Bertrand competition in the credit market implies that the payment specified by the contract must be such that a competitive lender just expects to break even and so eq. (2) is equal to zero. Now consider the case of ex-ante asymmetric information. Lenders know the wealth distribution of borrowers, but are not able to distinguish the particular borrower's wealth when a loan application is made. We assume zero risk-free interest rate and an infinitely elastic supply of funds in the deposit market. In such a scenario it is known that the standard optimal form of finance would be equity, but assuming unverifiable ex-post returns makes debt the only feasible form of finance (see de Meza and Webb, 2000). For a single borrower, a bank's expected profit from accepting an application for a contract from a type$-ij$ is given by:

$$\pi_{ij} = p(e_{ij})X + (1 - p(e_{ij}))c - K \quad (2)$$

In the successful state entrepreneurs pay back the amount borrowed X with probability $p(e_{ij})$ otherwise the banks keeps the amount of money put up as collateral c. Entrepreneurs and banks sign a contract of the general form

[7] This assumption rules out the possibility that being rich or poor affects inerently your ability/willingness to work hard. We think this is the fairest non-biased assumption but note that it does not have an impact on the equilbrium.

$\{X, c\}$. We seek subgame perfect Nash equilibria of the following two-stage screening game à la Rothschild and Stiglitz (1976)[8]. In the first stage, banks compete for the pool of customers whose type is unknown to them. They may potentially offer applicant borrowers a menu of loan contracts $\{X_{ij}, c_{ij}\} \in ij$ $\{R, P\} \times \{L; H\}$. Then entrepreneurs weight the pros and cons of entering the market and, if so, choose their preferred offer (one) among those offered. Therefore formally a Nash equilibrium here is a set of contracts such that (1) each bank earn nonnegative profits on each contract and (2) there exists no other set of contract that would earn positive profits in aggregate if offered in addition to the original set, with each individual contract in the set earning nonnegative profits. We restrict our attention to pure strategy equilibria.

3 Characterization of loan contracts

3.1 Agents'preference map

In the standard explanation of separation among classes (Bester, 1985), the whole weight of screening is borne by the amount of collateral required on contracts to sort good and bad risk. In the present multidimensional context, instead, the banks' statistical inference problem is more complicated. A borrower signing a contract which requires to post higher level of collateral may belong to rich or poor classes (unless collateral exceeds the poor's wealth) but at the same time she can be relatively highly-averse to supply effort, influencing adversely the performance of the contract.

We start by looking at the effect of moral hazard. Using eq. (1), the first order condition for the borrower's optimal choice of effort $e^*(w_i, \mu_j)$ is given by:

$$p'(e_{ij})U(Y - X + w_i) - p'(e_{ij})U(w_i - c) = \mu_j \tag{3}$$

Eq. (3) shows that the borrower supplies effort until the expected value of marginal effort equals its marginal cost. The maximization conditions are satisfied since the probability of success $p(e_{ij})$ is concave. Rearranging eq. (3), the optimal choice of effort $e^*_{ij}(w_i, \mu_j)$ is described by:

[8]The general structure of our model uses the definition of pure-strategy equilibria proposed by Bester (1985).

$$p'(e_{ij}^*) = \frac{\mu_j}{U(Y - X + w_i) - U(w_i - c)}$$

From straightforward comparative statics it follows that $\frac{de_{ij}^*}{dY} > 0$; $\frac{de_{ij}^*}{dc} > 0$; $\frac{de_{ij}^*}{dX} < 0$ as is customary in moral hazard models. On one side a higher amount of collateral reflects higher penalty in case of failure providing incentives to put in effort. On the other side a higher repayment negatively impacts the borrower's return in case of success, but not in the case of failure. This reduces incentives to supply effort.

As shown in Newman (2007) it may conceivably be argued that more wealth and less risk aversion worsen the moral hazard issue. In particular in our model the adverse selection on wealth types generated as a function of different choices of effort is combined with the role attributed to effort aversion. A multidimensional moral hazard effect changes as a combined function of *DARA* and effort aversion.

We define for any class of wealth, the marginal borrower is defined as the individual who is indifferent to exit or remain active in the credit market. As a direct consequence the marginal set is defined as the set of individuals indifferent between the two options along the wealth distribution. Thus, one can show that there exists a negative relation between effort and wealth, i.e., the marginal effort is lower, the higher is the wealth of individuals:

$$\frac{de_{ij}^*}{dw} < 0 \tag{5}$$

Proof. See the Appendix

while at the same time, a negative correspondence between effort and aversion is established,

$$\frac{de_{ij}^*}{d\mu} < 0 \tag{6}$$

Proof. See the Appendix

which implies that individuals with a higher effort aversion also display a higher probability of default due to moral hazard. Since the marginal individuals capture the lowest share of project expected returns, their choice of effort is farthest from the socially efficient value.

Because of decreasing risk aversion, moral hazard impacts more heavily on wealthier borrowers and of course the effect is heavier for people with larger effort aversion. We can now state the following result:

Lemma 1: Given a certain effort aversion μ_j, marginal poor entrepreneurs are the first to exit from the market:

$$\frac{d\mu}{dw}|_{U_{ij}(.)=0} > 0 \tag{7}$$

Condition (7) is crucial for at least two reasons. First it constitutes a signal about the possibility of inequality of opportunity in the market. The hard-working agents are excluded from the market due to their initial conditions and independently from their level of effort aversion. Second, concerning the role of private information on wealth, Coco and Pignataro (2012) demonstrate that decreasing risk aversion may turn wealth (and availability to post collateral) into a bad signal. In this extended version with multimensional hidden information, another effect occurs because of private information on effort aversion. In order to catch the idea, let us suppose (as proposed in the model) four classes of entrepreneurs $ij \in \{R, P\} \times \{L; H\}$. In this setting rich borrowers (both types) could benefit from not signalling their wealth because of an implicit cross subsidy they would earn in a pooling with hard working poor entrepreneurs.

3.2 Single-crossing preferences

To explore the types of equilibria that may arise in this context, it is useful to draw a diagrammatic representation of the equilibrium. Using (1) and from the Envelope Theorem, we know that the slope of an indifference curve of a borrower in the $(X, c)-$ space is:

$$s_{ij}(X, c) = \frac{dX}{dc} < 0 \tag{8}$$

Proof. See the Appendix

representing the marginal rate of substitution between income in the two states at a certain contract (X, c). The first element in order to establish the possibility of separating equilibria is the slope of the indifference curves

in the (X, c) space with respect to the wealth dimension of borrowers. In this respect we try to distinguish the direct effect of risk preferences from the impact of moral hazard. We rewrite the slope of the indifference curve in (8) as:

$$s_{ij}(X, c) = \frac{dX}{dc} = M_{ij}(w)R_i(w)$$

where $M_{ij}(w) = -\frac{(1-p(e_{ij}))}{p(e_{ij})}$ while $R_i(w) = \frac{U'(W_i^F)}{U'(W_i^S)}$ where $W_i^S = Y - X + w_i$ and $W_i^F = w_i - c$. The curvature of the indifference curve with respect to changes in wealth is then:

$$\frac{\partial}{\partial w}\left(s_{ij}(X, c)\right) = M_{ij}(w)R_i'(w) + M_{ij}'(w)R_i(w) \gtrless 0 \tag{9}$$

Proof. See the Appendix

Here $M_{ij}(w)R_i'(w)$ captures the risk preference effect while $M_{ij}'(w)R_i(w)$ captures the impact of moral hazard. Not surprisingly (9) has an ambiguous sign. On one side, the effect of (decreasing) risk aversion makes the indifference curve flatter as wealth increases. On the other side the negative impact of moral hazard makes it steeper. Indeed, for a given project choice, due to decreasing absolute risk aversion, rich individuals require a smaller reduction in the repayment rate to compensate for an increase in collateral (e.g. they are more willing to post collateral). Whenever the impact of moral hazard prevails as in eq. (10), rich individuals put such a low level of effort, and their probability of success diminishes by so much that their trade-off between collateral and interest rate becomes worse than poor people's one, notwithstanding their lower risk aversion:

$$\frac{\partial e_{ij}}{\partial w} > p(e_{ij})(1 - p(e_{ij}))(A(W_i^S) - A(W_i^F)) \tag{10}$$

Proof. See the Appendix

Note that this ambiguity in general means that the single crossing property of indifference curves which is a necessary condition to ensure the possibility of separation does not hold as a general rule. We can therefore separate these cases in different regions of analysis (see Figures 1 and 2, for details).

Now let us investigate the impact of effort aversion μ_j on the marginal rate of substitution between repayment X and collateral c. Independently by the amount of endowed wealth, entrepreneurs characterized by effort aversion$-L$

display a relative preference for posting more collateral compared to the ones characterized by effort aversion$-H$ at any point in the space (X, c) due to their higher success probability. Thus the impact of effort aversion is always the same and this implies that independently by which one of the two effects prevails the slope of indifference curves with high effort aversion should be steeper than the other ones as in Figure 3.

The heterogeneity between these two unobservable elements identifies four classes of entrepreneurs. When $\frac{\partial}{\partial w}\left(s_{ij}(X,c)\right) > 0$, for instance, the direct impact of decreasing risk aversion exceeds the effect of moral hazard[9]. Thus intuitively the marginal cost of the repayment is globally lower for rich agents or lower effort aversion, holding the other characteristic constant. See Figures 4 and 5 for the possibility of an ordinal ranking among types as a function of risk aversion and moral hazard.

Let us now consider the slope of the isoprofit curve for a bank lending to the borrower of class ij only:

$$\frac{dX}{dc}|_{\bar{\pi}_{ij}} = -\frac{(1-p(e_{ij})) + (dp(e_{ij})/dc)\,(X-c)}{p(e_{ij}) + (dp(e_{ij})/dX)\,(X-c)} \tag{11}$$

where $\bar{\pi}_{ij}$ is the bank's expected profit from the borrower of class i. Since $dp(e_{ij})/dX$ is negative, (11) could in principle be positive. Note that this becomes more likely for high values of X and lower values of c (see Coco, 1999). We may immediately note that, by construction, under this information structure, individuals with a larger wealth (higher risk from the point of view of banks) may prefer contracts that are actuarially fair for poor individuals due to decreasing risk aversion.

4 Inequality of opportunity equilibrium

In the absence of asymmetric information, the equilibrium of economy is trivial. Poor and rich borrowers with low effort aversion take the contract while individuals with higher effort aversion are excluded from the market due to negative expected return. Here instead the search for equilibria is quite complex. Interaction of preferences and feasible contracts in the dimensional

[9]When $\frac{\partial}{\partial w}\left(s_{ij}(X,c)\right) < 0$, the procedure is analogous at least for type$-RH$ and type$-PL$.

space makes it difficult. Our starting point has to be the fact that given the assumptions we have both positive and adverse selection of contract terms (particularly collateral). Hence an increase of collateral for example can lead to exit of high-effort averse types (poor or rich depending on the initial contract) but also more simply of poor entrepreneurs with low effort aversion. What we know for sure is that, given a certain level of effort-aversion, poor entrepreneurs exit first because of decreasing risk aversion. And conversely that, for a given wealth-type, individual with higher effort aversion exits first. An important point concerns the relative slope of the indifference curves of different types. As we observed above the relative slope of poor vs rich types, keeping constant their effort aversion, cannot be ascertained a priori as it depends on the relative strength of the risk aversion versus the incentive effect. Instead we know that within a wealth class less effort-averse types are necessarily more willing to post collateral at any contract (e.g. flatter indifference curves), thus suggesting that separation within wealth classes would be in principle feasible. But separation of wealth types is not feasible given the violation of the single crossing property. The procedure we will use in order to discover potential equilibria is first to distinguish the cases where risk aversion prevails on the incentive effect and viceversa. Second, to analyze the interesting cases in these regions. We will start the analysis of possible equilibria looking at portions of the contract space where all types participate.

As a starting point, let us look at Figure 6 where we can note the participation constraint of poor entrepreneurs with high effort-aversion type$-PH$ denoted PC_{PH} and that of the poor entrepreneurs with low effort aversion PC_{PL} in the contract space.

In area A below the PC_{PH}, every type participates at any contract. However because all types-H participate, it is quite unlikely that a feasible zero-profit pooling contract could be offered. However suppose there exists a potential global pooling zero-profit contract at C_1 (or any point in area A). This contract is not an equilibrium as we know that type$-PL$ can always be attracted by an appropriate higher-collateral contract due to flatter indifference curves and it will definitely deliver higher profits to the bank[10].

Hence a pure pooling equilibrium offered to all types is not feasible. How-

[10] Other types can be attracted as well depending on the relative slope but what really matters is that the additional contract is not preferred by low wealth/high effort aversion types.

ever we know that a separating equilibrium with a contract for the type$-H$ is never feasible by definition (the surplus would be too low due to negative expected return). Hence no contract is feasible in area A.

Now suppose that there is a contract C_2 in area B, above the PC_{PH}, where a bank breaks even with a contract with the 3 remaining types (PL, RH, RL). Again to explore the possibility that this pooling contract is an equilibrium we should analyze the relative slope of indifference curves. We know that for a competitive lender, types$-L$ represent the ones delivering more profits at any given contract and that rich borrowers with low effort aversion types (I_{RL}) have definitely flatter indifference curves than rich borrowers with high effort aversion types (I_{RH}). So it is always possible to offer a contract separating $RL-$types and delivering positive profits. A three-types pooling can be excluded as well by competition.

Some analysis has to be made now about the relative slope of indifference curves of type$-RH$ (I_{RH}) and type$-PL$ (I_{PL}). If the incentive effect prevails $(\frac{\partial}{\partial w}(s_{ij}(X,c)) < 0)$ then the slope of I_{PL} will be flatter than that of I_{RL} and therefore necessarily also of I_{RH}. In this case a contract that steals from the pooling the type$-RL$ also steals the type$-PL$, making it all the more profitable. So the only possible equilibrium contract set in this area would be a contract separating type$-RH$ from the rest. However separating the type$-RH$ is impossible because their projects deliver negative return. In this case no set of contracts in area B of figure 6 can represent an equilibrium, meaning that type$-PL$ will be excluded from the market. In this case a separating contract for the type$-RL$ excluding all other types will be devised by the bank[11]. In this case poor entrepreneurs are systematically excluded from the market due to their inability to distinguish themselves from type$-RH$. Inequality of opportunity is apparent.

If on the other side the risk aversion effect prevails, then indifference curves (I_{PL}) could in principle be steeper. In this case a pooling contract can be offered to two types$-RH$ and $-PL$ (see the contract C_3 in Figure 7 on the zero profit line $(O_{PL/RH})$ for the type$-RH$ and type$-PL$ while freeing the type$-RL$ for a higher collateral 'fair'[12] contract (on the separating contract line O_{RL}), like C_4.

Now let's examine the features of this equilibrium. At a first pooling contract (C_3) types$-PL$ are systematically cross subsidizing types$-RH$. This

[11] This is feasible considering that types$-RH$ exit first.

[12] Meaning with no cross-subsidy.

means that the terms of the contract will be penalizing for poor hard working types. In this case rich types get access to credit both if they are effort averse and if they aren't. By assumption types$-H$ are actually burning some welfare. Therefore inequality of opportunity follows immediately.

5 Concluding remarks

From the normative view the literature has explored different directions in order to justify the equality of opportunity among individuals as a primary objective of the theory of justice. These claims do not focus on equality of outcomes but essentially on equality of means to realize those outcomes, that is, they place some responsibilities on individuals to decide how much effort to spend in order to exploit the opportunity offered to them.

The aim of this article is to investigate whether equality of opportunity actually holds in an asymmetric information credit market with a double unobservable heterogeneity on circumstances and responsibility, respectively wealth and effort aversion. Notice that selection among applicants for access to credit market by a random procedure that gives all applicants an identical chance of getting the funds actually violates formal equality of opportunity as well. Only if all applicants are equally qualified (same effort aversion) would this procedure satisfy the ideal of equality of opportunity. In this case instead equality of opportunity requires that individuals with the same level of the responsibility variable be offered the same opportunities.

Relative to existing theoretical models of the credit markets, the addition of a second dimension to informed agents' characteristics in this paper changes the nature of the equilibria in a significant way. Here we show how the impact of moral hazard depends on both wealth and effort aversion of individual borrowers. In particular effort decreases in both variables. Two effects guided by endogenous adverse selection on wealth and effort aversion, due to moral hazard, emerge. First, because of decreasing risk aversion, moral hazard results in rich borrowers supplying less effort to their respective projects compared to the poor ones. Second, for each wealth class, high effort-aversion entrepreneurs are impacted by the moral hazard more severely than low effort-aversion ones. The combination of these features delivers a very complex environment where the search for equilibria is particularly difficult. We demonstrate that any equilibrium entails some form of inequality

of opportunity. In some cases no poor entrepreneur gets credit due to her inability to separate herself from worse (rich) entrepreneurs. Under some restrictions instead a partial separating equilibrium with cross-subsidization between classes exists, where not only equality of opportunity is violated, but poor entrepreneurs with a higher level of responsibility (lower effort aversion) cross-subsidize the rich ones with higher effort aversion. Access to the credit market is thus paid by hard-working poor entrepreneurs with a perverse redistribution 'tax'. The additional consequence of the subsidy is that negative surplus projects are carried out. In this case efficiency and equity violations occur jointly and due to the same causes.

Finally note that in this model wealth heterogeneity is the factor impeding the perfect screeening of types. Effort aversion is correctly (e.g., inversely) correlated with the willingness to post collateral. Therefore when an extreme ex-ante redistribution of wealth is possible, leading to uniform wealth levels in the population of entrepreneurs, willingess to post collateral correctly signals low effort aversion and the project's quality. Perfect screening is in principle possible and only good projects, those carried out by low effort aversion entrepreneurs, are realized in equilibrium. Hence a perfectly egalitarian ex-ante redistribution of resources improves efficiency because it ensures that good projects, and only good projects, are carried out, thus avoiding also waste from realization of negative surplus projects. Contemporaneously, and by defintion, it screens entrepreneurs on the basis of the sole responsibility variable and allows only hard-working individuals to get credit. This intervention would therefore improve final allocations both on distributive grounds, at least under the equality of opportunity benchmark, and on efficiency grounds.

6 Figures

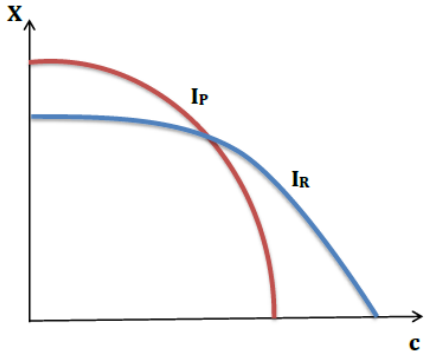

Figure 1: Indifference curves when risk aversion prevails

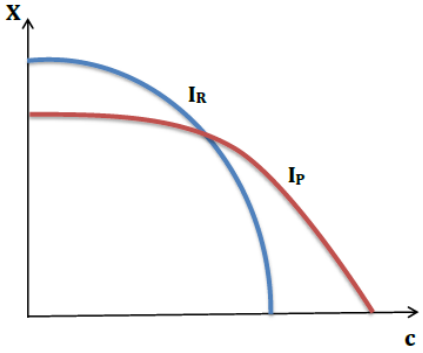

Figure 2: Indifference curves when moral hazard prevails

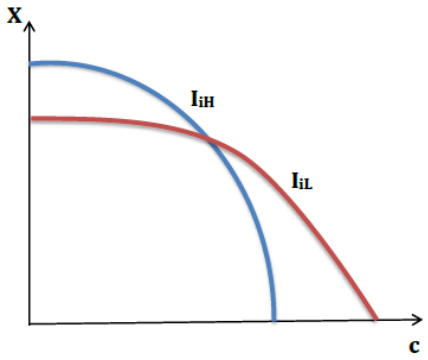

Figure 3: Heterogeneity between effort aversions for a given wealth level

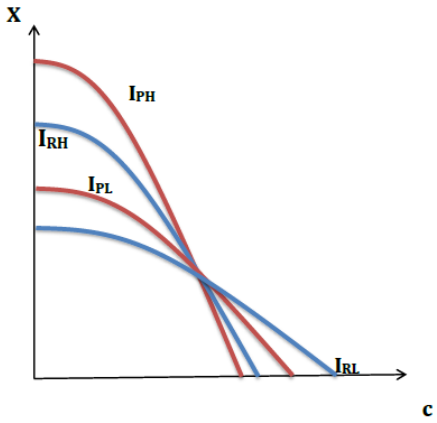

Figure 4: Heterogeneity in effort aversion and wealth when risk aversion prevails

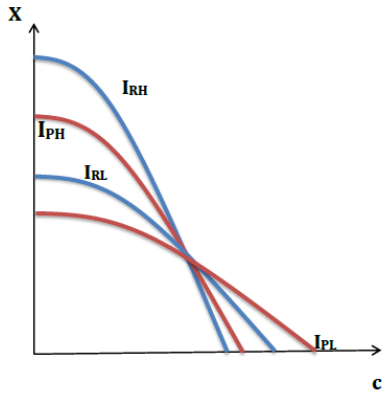

Figure 5: Heterogeneity in effort aversion and wealth when moral hazard prevails

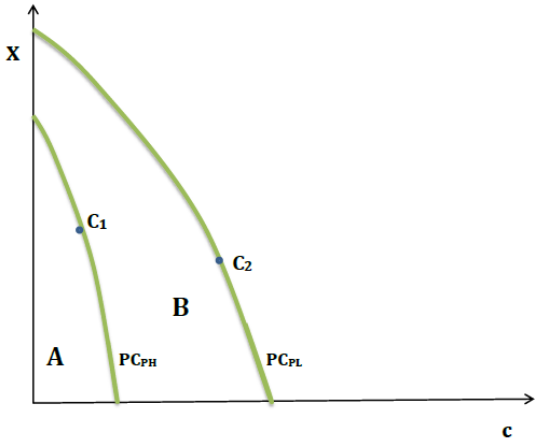

Figure 6: No equilibrium in areas A and B

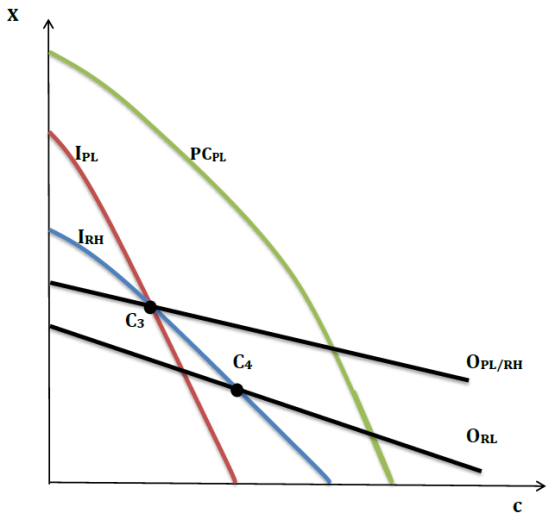

Figure 7: Partial separating equilibrium with cross-subsidization.

7 The appendix

A) Proof of eq. (5):

Starting by eq. (3) and assuming that $W_i^S = Y - X + w_i$ and $W_i^F = w_i - c$, we can simply rewrite that:

$$\frac{\partial U}{\partial e_{ij}} = p'(e_{ij}) \left(U(W_i^S) - U(W_i^F) \right) - \mu_j$$

By the Implicit Function theorem and due to decreasing absolute risk aversion, we simply observe that:

$$\left[p''(e_{ij}) \left(U(W_i^S) - U(W_i^F) \right) \right] de + \left[p'(e_{ij}) \left(U'(W_i^S) - U'(W_i^F) \right) \right] dw = 0$$

$$\left[p''(e_{ij}) \left(U(W_i^S) - U(W_i^F) \right) \right] de = - \left[p'(e_{ij}) \left(U'(W_i^S) - U'(W_i^F) \right) \right] dw$$

which implies:

$$\frac{de_{ij}^*}{dw} = - \frac{p'(e_{ij}) \left(U'(W_i^S) - U'(W_i^F) \right)}{p''(e_{ij}) \left(U(W_i^S) - U(W_i^F) \right)} < 0$$

B) Proof of eq. (6):

With a similar procedure shown in eq. (5), we may write:

$$\left[p''(e_{ij}) \left(U(W_i^S) - U(W_i^F) \right) \right] de - d\mu = 0$$

$$\left[p''(e_{ij}) \left(U(W_i^S) - U(W_i^F) \right) \right] de = d\mu$$

indicating,

$$\frac{de_{ij}^*}{d\mu} = \frac{1}{p''(e_{ij}) \left(U(W_i^S) - U(W_i^F) \right)} < 0$$

C) Proof of eq. (7):

In the marginal set, individuals have utility equal to zero. By the envelope theorem and differentiating equation with respect to μ and w, we observe that:

$$[-e_{ij}] \, d\mu + \left[p(e_{ij}) U'(W_i^S) + (1 - p(e_{ij}) U'(W_i^F) \right] dw =$$

$$[-e_{ij}] \, d\mu = - \left[p(e_{ij}) U'(W_i^S) + (1 - p(e_{ij}) U'(W_i^F) \right] dw$$

which implies that:

$$\frac{d\mu}{dw}|_{U_{ij}(.)=0} = - \frac{\left[p(e_{ij}) U'(W_i^S) + (1 - p(e_{ij}) U'(W_i^F) \right]}{[-e_{ij}]} > 0$$

D) Proof of eq. (8)**:**
Starting by eq. (1):

$$U_{ij} = p(e_{ij})U(W_i^S) + (1 - p(e_{ij}))U(W_i^F) - \mu_j e_i$$

By envelope theorem and differentiating with respect to X and c, it follows that:

$$\left[-p(e_{ij})U'(W_i^S)\right] dX - \left[(1 - p(e_{ij}))U'(W_i^F)\right] dc = 0$$

$$\left[-p(e_{ij})U'(W_i^S)\right] dX = \left[(1 - p(e_{ij}))U'(W_i^F)\right] dc$$

which implies that:

$$s_{ij}(X, c) = \frac{dX}{dc} = -\frac{(1 - p(e_{ij}))U'(W_i^F)}{p(e_{ij})U'(W_i^S)} < 0$$

D) Proof of eq. (**9**)**:**
We can again rewrite the slope of the indifference curve as:

$$s_{ij}(X, c) = \frac{dX}{dc} = M_{ij}(w)R_i(w)$$

where $M(w) = -\frac{(1-p(e_{ij}))}{p(e_{ij})}$ while $R_i(w) = \frac{U'(W_i^F)}{U'(W_i^S)}$. The curvature of the indifference curve with respect to change in wealth is then:

$$\frac{\partial}{\partial w}\left(\frac{dX}{dc}\right) = M_{ij}(w)R_i'(w) + M_{ij}'(w)R_i(w)$$

where $M(w)R'(w)$ captures the effect of risk preference while $M'(w)R(w)$ explains the moral hazard effect. First, let us solve $M(w)R'(w)$:

$$
\begin{aligned}
M_{ij}(w)R_i'(w) &= -\frac{(1-p(e_{ij}))}{p(e_{ij})}\left[\frac{U''(W_i^F)U'(W_i^S)-U''(W_i^S)U'(W_i^F)}{\left(U'(W_i^S)\right)^2}\right] = \\
&= -\frac{(1-p(e_{ij}))}{p(e_{ij})}\left[\frac{U''(W_i^F)}{U'(W_i^S)}-\frac{U''(W_i^S)U'(W_i^F)}{\left(U'(W_i^S)\right)^2}\right] = \\
&= -\frac{(1-p(e_{ij}))}{p(e_{ij})}\frac{1}{U'(W_i^S)}\left[U''(W_i^F)-\frac{U''(W_i^S)U'(W_i^F)}{U'(W_i^S)}\right] = \\
&= -\frac{(1-p(e_{ij}))}{p(e_{ij})}\frac{U'(W_i^F)}{U'(W_i^S)}\left[\frac{U''(W_i^F)}{U'(W_i^F)}-\frac{U''(W_i^S)}{U'(W_i^S)}\right]
\end{aligned}
$$

Let us define $A(W)$ as the coefficient of decreasing absolute risk aversion, we can then rewrite $M_{ij}(w)R_i'(w)$ as:

$$
\begin{aligned}
M_{ij}(w)R_i'(w) &= -\frac{(1-p(e_{ij}))}{p(e_{ij})}\frac{U'(W_i^F)}{U'(W_i^S)}\left(A(W_i^S)-A(W_i^F)\right) \\
&= \frac{dX}{dc}\left(A(W_i^S)-A(W_i^F)\right) > 0
\end{aligned}
$$

Since $W_1 > W_2$ and considering decreasing absolute risk aversion i.e. risk aversion decreases with wealth, $A(W^F) > A\left(W^S\right)$ and that by construction that $\frac{dX}{dc}$ is negative, we can surely say that the effect of risk preferences $M_{ij}(w)R_i'(w)$ is positive.

Then we can solve $M_{ij}'(w)R_i(w)$:

$$
\begin{aligned}
M_{ij}'(w)R_i(w) &= \left[-\frac{-p'(e_{ij})\frac{\partial e_{ij}}{\partial w}p(e_{ij})-(1-p(e_{ij}))p'(e_{ij})\frac{\partial e_{ij}}{\partial w}}{\left(p(e_{ij})\right)^2}\right]\frac{U'(W_i^F)}{U'(W_i^S)} = \\
&= \left[\frac{p'(e_{ij})\frac{\partial e_{ij}}{\partial w}}{\left(p(e_{ij})\right)}+\frac{(1-p(e_{ij}))p'(e_{ij})\frac{\partial e_{ij}}{\partial w}}{\left(p(e_{ij})\right)^2}\right]\frac{U'(W_i^F)}{U'(W_i^S)} = \\
&= \frac{p'(e_{ij})}{p(e_{ij})}\frac{\partial e_{ij}}{\partial w}\left[1+\frac{(1-p(e_{ij}))}{p(e_{ij})}\right]\frac{U'(W_i^F)}{U'(W_i^S)} = \\
&= \frac{p'(e_{ij})}{p(e_{ij})}\frac{\partial e_{ij}}{\partial w}\left[\frac{U'(W_i^F)}{U'(W_i^S)}-\frac{dX}{dc}\right] = \\
&= -\frac{p'(e_{ij})}{p(e_{ij})}\frac{\partial e_{ij}}{\partial w}\left[\frac{dX}{dc}-\frac{U'(W_i^F)}{U'(W_i^S)}\right] < 0
\end{aligned}
$$

Therefore,

$$\frac{\partial}{\partial w}\left(\frac{dX}{dc}\right) = \frac{dX}{dc}\left(A(W_i^S) - A(W_i^F)\right) - \frac{p'(e_{ij})}{p(e_{ij})}\frac{\partial e_{ij}}{\partial w}\left(\frac{dX}{dc} - \frac{U'(W_i^F)}{U'(W_i^S)}\right) \lessgtr 0$$

As shown, the sign of eq. (7) is uncertain due to the combination of the positive effect of risk aversion $\left(\frac{dX}{dc}\left(A(W_i^S) - A(W_i^F)\right)\right)$ and the negative moral hazard impact $-\frac{p'(e_{ij})}{p(e_{ij})}\frac{\partial e_{ij}}{\partial w}\left(\frac{dX}{dc} - \frac{U'(W_i^F)}{U'(W_i^S)}\right)$.

D) Proof of eq. (10):
After some algebraic manipulations,

$$\begin{aligned}
\frac{\partial}{\partial w}\left(\frac{dX}{dc}\right) &= s_{ij}\left(A(W_i^S) - A(W_i^F)\right) - \frac{\partial e_{ij}}{\partial w}\frac{p'(e_{ij})}{p(e_{ij})}\left(s_{ij} - \frac{U'(W_i^F)}{U'(W_i^S)}\right) = \\
&= s_{ij}(1-p(e_{ij}))\left(A(W_i^S) - A(W_i^F)\right) - \frac{\partial e_{ij}}{\partial w}p'(e_{ij})\frac{(1-p(e_{ij}))}{p(e_{ij})}\left(s_{ij} - \frac{U'(W_i^F)}{U'(W_i^S)}\right) = \\
&= s_{ij}(1-p(e_{ij}))\left(A(W_i^S) - A(W_i^F)\right) - \frac{\partial e_{ij}}{\partial w}p'(e_{ij})\left(\left(\frac{(1-p(e_{ij}))}{p(e_{ij})}\right)s_{ij} + s_{ij}\right) = \\
&= s_{ij}(1-p(e_{ij}))\left(A(W_i^S) - A(W_i^F)\right) - \frac{\partial e_{ij}}{\partial w}p'(e_{ij})\frac{s_{ij}}{p(e_{ij})} \\
&= s_{ij}\left((1-p(e_{ij}))\left(A(W_i^S) - A(W_i^F)\right) - \frac{\partial e_{ij}}{\partial w}\frac{1}{p(e_{ij})\left(U(W_i^S) - U(W_i^F)\right)}\right) = \\
&= \frac{s_{ij}}{p(e_{ij})\left(U(W_i^S) - U(W_i^F)\right)}\left(p(e_{ij})(1-p(e_{ij}))\left(A(W_i^S) - A(W_i^F)\right) - \frac{\partial e_{ij}}{\partial w}\right)
\end{aligned}$$

The impact of moral hazard prevails if and only if:

$$\frac{\partial e_{ij}}{\partial w} > p(e_{ij})(1-p(e_{ij}))\left(A(W_i^S) - A(W_i^F)\right)$$

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