Small Bus Econ (2013) 41:241–251
DOI 10.1007/s11187-012-9422-3

Unfair credit allocations

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Accepted: 1 February 2012 / Published online: 28 February 2012

Abstract This article investigates the impact of credit allocation on heterogeneous wealth entrepreneurs. We show that with decreasing risk aversion and unobservable wealth, poorer borrowers exert more effort. As a consequence of endogenous adverse selection, they are either excluded from the market or necessarily subsidize richer borrowers in a pooling equilibrium resulting in a paradoxical and inequitable redistribution. Alternatively, a less likely separating equilibrium may occur, in which poor types bear the entire weight of separation in the form of excess risk taking.

Keywords Collateral · Credit · Cross-subsidization · Decreasing absolute risk aversion · Wealth

JEL Classifications D31 · D82 · G21 · L26

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1 Introduction

From an equity point of view, the option to borrow money for starting a business should be open to all applicants irrespective of their endowment. Applications should be assessed by relevant criteria of responsibility and effort, but instead, imperfect information may force the lender's choice on the basis of observable assets, possibly leading to a wrongful allocation of resources. Starting with the seminal paper by Evans and Jovanovich (1989), a stream of literature has tested the hypothesis of wealth dependence (see among others, Black et al. 1996; Blanchflower and Oswald 1998; Georgellis et al. 2005). The idea that wealth and entrepreneurship are correlated has been empirically confirmed even when accounting for Cressy's (2000) argument about the (endogenous) differential degree of risk aversion being the driver of the decision to become an entrepreneur.[1] In this paradigm low wealth endowment may imply constraints on an individual's ability to make productive investments and to enter contractual arrangements that

[1] Kan and Tsai (2006) test this conjecture and discover a positive effect of wealth on transition into self-employment controlling for the impact of risk aversion. Further, a recent experiment conducted by Elston and Audretsch (2011) finds that capital constraints negatively affect the probability of start-up, although in their case the distribution of risk attitudes is similar between borrowers and non-borrowers.

elicit high effort.[2] These inequality-related incentives are central also to the recent literature on credit market imperfections (see, for example, Gruner 2003). But how exactly do incentives and wealth heterogeneity affect the distribution of credit in terms of equality of opportunity? Are there other possible distributional effects of credit allocation than those arising from the exclusion of poor entrepreneurs?

Our article focuses on these issues and produces some novel results. We propose a model of simultaneous adverse selection and moral hazard in order to investigate the effect of credit allocation among heterogeneous wealth borrowers. Our characterizing assumptions are that individuals' wealth is not publicly observable while agents exhibit decreasing absolute risk aversion (DARA, hereafter).[3] The first assumption requires some justifications. In most of the credit market literature (with the significant exception of Stiglitz and Weiss 1992) wealth is supposed to be observable while entrepreneurial ability is not. We believe that, in reality, personal wealth (particularly financial wealth) is unobservable. In the field of tax evasion, the idea that financial income and wealth positions of individuals are common knowledge would be considered rather odd. When the public authorities are unable to perfectly discover the extent of one's wealth, the assumption that a bank official can discover its size without cost is untenable. Moreover, even if some classes of assets were more observable than others, an individual entrepreneur may still hide the size of his overall wealth in many ways, including shifting formal property to relatives. An indirect signal that wealth is unobservable comes from the widespread phenomenon of multiple banking relationships. An EU Commission survey on small and medium enterprises (European Commission 2003) found that 35% of SMEs (44% of those with any credit lines) in the EU have multiple banking relationships. There may be several reasons for multiple banking relationships, but it seems unlikely that all banks involved know the overall wealth position of the entrepreneur. In most papers the assumption of common knowledge on wealth seems to proxy for the implicit belief that there are no reasons to conceal one's wealth. In this article we explain that this is not the case when decreasing risk aversion turns wealth into a bad signal.

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 implies that the agents behave in a less risk averse fashion the larger is their wealth. This gives personal endowment a new role in providing incentives that can mitigate or exacerbate information problems. More wealth and less risk aversion worsen the moral hazard problem (see Newman 2007). Adverse selection on wealth types is therefore endogenously generated by different optimal levels of effort along the distribution of wealth [models with endogenous adverse selection were recently developed in the same field, although in different manners, by Ghatak et al. (2007) and Jamovich (2011)]. As a consequence poor individuals may end up as hard-working agents.

We consider a contract space in terms of collateral and interest rate. Risk aversion and effort choice interact to determine the willingness to post collateral and therefore decide whether the equilibrium is pooling versus separating. 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, a separating equilibrium is theoretically possible using collateral as a screening device. The net cost of separation is shouldered by poor individuals in the form of excess risk taking. Instead, when the direct effect of risk aversion prevails, pooling is the only possible adverse-selection equilibrium. This is the more interesting case and the one we investigate with greater detail. Cross-subsidization occurs in the pooling equilibrium with the poor hard-working borrowers subsidizing rich borrowers. The rich are therefore charged a low rate of interest (relative to their risk) while the poor borrowers are charged too high of an interest rate. The possibility remains that the poor's participation constraint is not satisfied at the pooling contract. In this pure lemons case, the poor entrepreneurs are crowded out and only rich entrepreneurs get credit at a fair contract.

Our contribution lies within the literature on inefficiencies in the credit market (de Meza and Webb 1987; Stiglitz and Weiss 1981). Inefficient levels of investments may also occur notwithstanding collateral

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

[3] For the empirical evidence in favor of the DARA assumption, see among others, Black (1996); Rosenzweig and Binswanger (1993); Ogaki and Zhang (2001).

(Bester 1985, 1987; 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), 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. Coco and Pignataro (2010) instead show that when entrepreneurs' heterogeneity concerns both wealth and unobservable aversion to effort, wider cross subsidization in high wealth classes may lead to a violation of the equality of opportunity principle. Finally, Gruner (2003) considers a setting similar to our paper 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 in Section 3 we characterize the agents' preference map. Section 4 investigates the potential equilibria in the market. Conclusions follow in Section 5.

2 The model

2.1 The projects

We consider a one-period competitive credit market where each project requires an amount of capital K. It yields a gross return Y in case of success with probability $p(e)$ or zero revenue in case of failure with probability $1 - p(e)$, where $e \in [0, \bar{e}]$ is the amount of effort and its utility cost. Returns to effort are positive and diminishing as usual, i.e. $p'(e) > 0$ and $p''(e) < 0$. In more general terms, higher levels of effort e result in a project whose returns first-order stochastically dominates (FOSD) the return of projects with lower levels of effort.

2.2 Entrepreneurs

There is a finite number of would-be borrowers each endowed with a project described above. Borrowers are risk averse. The individual's expected utility is a concave increasing function that exhibits decreasing absolute risk aversion, 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, $w_i < (1 + r)K$, $\forall\ i$. As a consequence they need to borrow the whole amount of capital, K, in order to undertake the investment projects and we denote $X = (1 + r)K$ the total repayment, where r is the interest rate required by the bank for an amount of collateral c, such that $c \leq w_i$. A fraction λ of these entrepreneurs belongs to rich type while $(1 - \lambda)$ is the proportion of the poor. The borrower's wealth w_i and her actual effort choice e_i are assumed to be private information. In the two-state case, the expected utility of a borrower i is:

$$U_i = p(e_i)U(Y - X + w_i) + (1 - p(e_i))U(w_i - c) - e_i \tag{1}$$

2.3 Banks

A fixed amount of capital K is financed by risk-neutral lenders. Bertrand competition in the credit market implies that banks earn zero expected profit in equilibrium and so Eq. 2 is equal to zero. Under ex-ante asymmetric information lenders know the wealth distribution of borrowers, but cannot observe 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. Under these conditions 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, the representative bank's profit in a competitive market is:

$$\pi_i = p(e_i)X + (1 - p(e_i))c - K \tag{2}$$

2.4 Equilibrium

We impose that the contracts offered by the bank result in a Wilson 'anticipatory' equilibrium (Wilson 1977).

Accordingly, an equilibrium is defined as a set of contracts such that: (i) all contracts make nonnegative profits and (ii) no new contract (or set of contracts) could be offered that makes positive profits after all contracts that would make negative profits as a result of its offer were withdrawn. The adoption of this equilibrium concept is one way to obtain pure strategy equilibrium, refining the simple 'Nash' equilibrium concept proposed by Rothschild and Stiglitz (1976), in order to rule out the potential nonexistence issue. Intuitively, the idea is that any representative lender who considers the possibility of offering a new contract should check whether the new contract would remain profitable once other existing contracts are withdrawn. Thus banks take into account the effects of their actions on the actions of the other banks according to a non-myopic rationality benchmark.

3 Agents' preference map

If a lender can observe a borrower's level of effort and can write an effort-contingent contract, there is no moral hazard and first-best outcomes will potentially emerge. Instead when effort is unobservable, the bank must infer $e^*(w, X, c)$, borrower's optimal level of effort as a function of wealth and repayment of the project.

Using Eq. 1, the first order condition for the borrower's optimal choice of effort $e^*(w, X, c)$ is given by:

$$\frac{\partial U_i}{\partial e_i} = p'(e_i)U(Y - X + w_i) - p'(e_i)U(w_i - c) = 1 \tag{3}$$

Equation 3 shows that the borrower supplies effort until the expected value of marginal effort equals the marginal cost of effort. The maximization conditions are satisfied since the probability of success $p(e)$ is concave. Rearranging Eq. 3, the optimal choice of effort $e_i^*(w, Y, X, c)$ is described by:

$$p'(e_i^*) = \frac{1}{U(Y - X + w_i) - U(w_i - c)} \tag{4}$$

From straightforward comparative statistics it follows that $\frac{de^*}{dY} > 0; \frac{de^*}{dc} > 0; \frac{de^*}{dX} < 0$ 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 apply effort. With a similar argument, one can show that there exists a negative relation between effort and wealth, i.e., the marginal effort is lower, the higher the wealth of individuals:

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

For the proof, see the Appendix.

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

$$\frac{dX}{dc} < 0 \tag{6}$$

For the proof, see the Appendix.

The crucial element to establish the possibility of separating equilibria is the slope of the indifference curves in the (X, c) space in relation to the wealth of borrowers. In this respect we may separate the direct effect of risk preferences from the impact of moral hazard. We can therefore rewrite the slope of the indifference curve in Eq. 6 as:

$$\frac{dX}{dc} = M(w)R(w)$$

where $M(w) = -\frac{(1 - p(e_i))}{p(e_i)}$ while $R(w) = \frac{U'(W^F)}{U'(W^S)}$. The curvature of the indifference curve with respect to changes in wealth is then:

$$\frac{\partial}{\partial w}\left(\frac{dX}{dc}\right) = M(w)R'(w) + M'(w)R(w) \gtrless 0 \tag{7}$$

For the proof, see the Appendix.

Here $M(w)R'(w)$ captures the risk preference effect while $M'(w)R(w)$ captures the impact of moral hazard. Not surprisingly Eq. 7 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. 8, 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 that of poor people, notwithstanding their lower risk aversion:

$$\frac{\partial e}{\partial w} > p(e_i)(1 - p(e_i))(A(W^S) - A(W^F)) \tag{8}$$

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

$$\frac{dX}{dc}\Big|_{\bar{\pi}_i} = -\frac{(1 - p(e_i)) + (dp(e_i)/dc)(X - c)}{p(e_i) + (dp(e_i)/dX)(X - c)} \tag{9}$$

where $\bar{\pi}_i$ is the bank's expected profit from the borrower of class i. Since $dp(e_i)/dX$ is negative, Eq. 9 could in principle be positive. Note that this becomes more likely for high values of X and lower values of $p(e_i)$ and 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, e.g., on line O_P in Fig. 1, due to decreasing risk aversion.

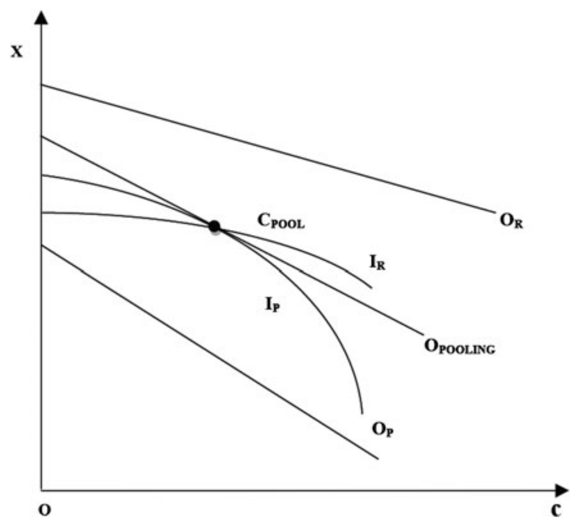

Fig. 1 Pooling equilibrium

4 Unfair cross-subsidization

Under hidden information lenders just know the distribution of classes of wealth and shares of the subgroups of population. Figure 1 describes the main elements of the model and the contract which allows the bank to break even. Two indifference curves for the rich and poor individuals are labeled, respectively, I_R and I_P, while the isoprofit lines for poor, pooling and rich individuals are defined as O_P, O_{POOLING}, O_R.

From Eq. 7, individuals with lower wealth (and thus with higher risk aversion) may have steeper or flatter indifference curves in different portions of the $(X, c) -$ space, while considering Eq. 5, they are also the 'hard-working' agents at any given contract. We will discuss in this section two polar 'well behaved' cases arising when Eq. 7 is always positive or negative and the single crossing property holds one way or the other. In the first case, where rich entrepreneurs display a relative preference for posting collateral, screening is impossible. The only possible equilibria include first a lemon case, where due to the excessive burden of cross subsidization, poor entrepreneurs are excluded from credit, and second, a pooling case where they subsidize rich types. In the second case a separating equilibrium is in principle possible, though unlikely. Poor borrowers bear the cost of separation through excess risk taking.

Consider first the hypothesis that the direct impact of decreasing risk aversion exceeds the effect of moral hazard, hence $\frac{\partial}{\partial w}\left(\frac{dX}{dc}\right) > 0$. In this case, rich individuals display a relative preference for posting more collateral compared to the poor at any point in the space (X, c), notwithstanding their lower success probabilities. Under these conditions separation is not possible as there exists no contract on O_P that can attract low wealth/low risk borrower while deterring the wealthier ones. The relative slope of the indifference curves of the two types is inconsistent with the use of collateral as a signal (as in Coco 1999). This case is described in Fig. 1. Two possibilities arise under this assumption.

Proposition 1 *When rich entrepreneurs display a larger relative willingness to post collateral, the equilibrium may entail: (i) a fair contract only for rich entrepreneurs excluding the poor ones from credit, and (ii) a pooling contract where poor borrowers subsidize richer ones.*

Consider a possible pooling contract, C_{POOL}, that results in a competitive return for the bank when chosen by both types of borrowers and maximizes on O_{POOLING}, the utility of low wealth/low risk borrowers[4]. In this contract, poor types necessarily subsidize rich types and, as a consequence, their participation constraint can be satisfied or not. If poor types do not participate in C_{POOL}, no feasible contract can be offered to poor types at all. Rich types will get credit through a fair contract on O_R and poor types are excluded from credit altogether. This is a pure 'lemon' case where adverse selection causes good hard-working types to be excluded. Note that this case is in accordance with the evidence presented in the introduction on wealth dependence. Poor entrepreneurs are excluded as a consequence of endogenous adverse selection and the necessity to subsidize rich types in equilibrium.

When the participation constraint is satisfied at C_{POOL} then this contract is the only possible Wilson equilibrium. To convince yourself note that any other contract on the pooling zero profit line, O_{POOLING}, can be dominated by C_{POOL}. Separation is thereby ruled out by the borrowers' preference pattern. Any contract lying below the indifference curve of poor borrowers but above that of the rich borrowers could, in principle, steal away the better risk. But once the pooling contract, C_{POOL}, is withdrawn, the new contract will deliver negative profits. Cross-subsidization occurs in this pooling equilibrium. Poor types put in more effort and their projects deliver a larger surplus.

Let's turn now to the second case. When the moral hazard effect prevails with respect to the direct impact of risk aversion, the slope of the indifference curve of rich borrowers is steeper than that of poor ones (see Fig. 2). In this case asymmetric information may be overcome by the use of collateral as a sorting device.

Proposition 2 *When poor entrepreneurs display a relative preference for posting collateral, both a pooling and a separating equilibria are in principle possible. When separation occurs the poor borrowers bear the cost in terms of excessive risk taking.*

Consider a menu of contracts $C_i = (X_i, c_i), \forall i \in [R, P]$ that can be offered by the representative lender who maximizes her expected profit. According to the revelation principle the bank needs to restrict attention to contract profiles ensuring that (i) each entrepreneur would get the contract designed for her type (incentive compatibility) and (ii) the two agent types would be willing to accept their respective contracts under individual rationality:

$$p(e_R)U(Y - X_R + w_R) + (1 - p(e_R))U(w_R - c_R) - e_R \geq p(e_R)U(Y - X_P + w_R) + (1 - p(e_R)) \times U(w_R - c_P) - e_R \tag{10a}$$

$$p(e_P)U(Y - X_P + w_P) + (1 - p(e_P))U(w_P - c_P) - e_P \geq p(e_P)U(Y - X_R + w_P) + (1 - p(e_P)) \times U(w_P - c_R) - e_P \tag{10b}$$

$$p(e_i)U(Y - X_i + w_i) + (1 - p(e_i))U(w_i - c_i) - e_i \geq 0 \qquad \forall i = R, P \tag{11}$$

Of course competition results in zero profits at each contract and the chosen contract for poor hard-working agents is the one that minimizes their collateral under incentive compatibility. As described in Fig. 2, rich individuals are indifferent between the two contracts, while poor ones strictly prefer C_P. Considering that each contract is on the bank's break-even line, two cases arise in relation to the preferences of poor borrowers. When $U_P(C_P) < U_P(C_{\mathrm{POOL}})$, where C_{POOL} here denotes the contract on the pooling line O_{POOLING}, that maximizes the poor's welfare, then C_{POOL} is again the equilibrium contract. This equilibrium is similar to that proposed in proposition 1 and thus cross subsidization occurs. When $U_P(C_P) > U_P(C_{\mathrm{POOL}})$ (and therefore I_P lies entirely below O_{POOLING} as in Fig. 2), then separation is viable and no other contract making positive expected profits can attract any bundle of the two entrepreneurs. Note that this equilibrium requires a zero collateral contract for rich borrowers only. The collateral posted in C_P is the minimum amount required to avoid cross-subsidization among classes of borrowers. Of course separation occurs at a cost, a deadweight loss which in this case is borne by the poor good-quality borrowers. An inefficient amount of collateral is posted to signal their quality type.

[4] Notwithstanding the fact that borrowers are risk averse and the bank risk neutral, posting collateral (and a lower interest rate) increases the surplus from the project. The additional surplus, in equilibrium, accrues entirely to borrowers and may compensate, especially for low values of collateral where the incentive effect is supposed to be larger and risk aversion lower, the additional risk for borrowers. This explains why the optimal contract, C_{POOL}, is not necessarily a zero-collateral one.

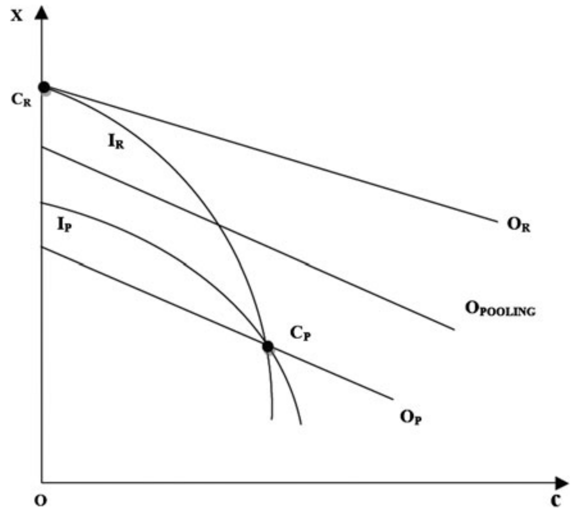

Fig. 2 Separating equilibrium

Although this equilibrium is in principle possible there are several reasons to believe that it will never occur. On one hand it is paradoxical that poor entrepreneurs are the only ones posting collateral. On the other hand the available empirical evidence rejects the hypothesis that ex-ante and ex-post project risk (loan quality) is positively correlated with the amount of collateral posted (see Berger and Udell 1990).

Outside these two cases, the indifference curves do not fulfil the single crossing property and, as a general rule, separation is impossible. Pooling equilibria are possible but only depending on the relative slope of the indifference curves at the candidate zero-profit contract. In case of pooling, cross subsidization is bound to occur just as in the first case described above (Fig. 1). Hence, outside the possible, but unlikely, case where conditions in Eqs. 10a,b and 11 and the additional condition $U_P(C_P) > U_P(C_{\mathrm{POOL}})$ are satisfied, a pooling equilibrium is the only feasible one.

5 Concluding remarks

In this paper we have shown that credit market equilibria may entail adverse distributive effects. A new result is that, besides the possibility of exclusion, unfair cross-subsidization from poor to rich agents is possible. This follows from a model where otherwise identical borrowers choose to put effort in a project based on their heterogeneous unobservable wealth. In particular we studied the interplay between the impact of wealth through decreasing absolute risk aversion on incentives to spend effort and the willingness to post collateral. We find in equilibrium an endogenous adverse selection problem stemming from underlying moral hazard under DARA. The previous literature has analyzed some elements of our model separately. On one hand the interplay between risk taking and adverse selection has been studied by Jaimovich (2010) in an overlapping generations model of the credit market. On the other hand, Newman (2007) has shown how moral hazard may interact unpredictably with DARA to deliver unexpected (and implausible) result on risk taking between poor and rich borrowers. Poor entrepreneurs need to bear less risk to remain incentive compatible and therefore may be surprisingly more willing to bear risk in equilibrium. Our paper combines these features.

Newman's (2007) argument in particular is our starting point. Because of decreasing risk aversion, moral hazard has a heavier impact on wealthier entrepreneurs. This is very plausible in our opinion as failure in the project is certainly a more dramatic event for a poor entrepreneur. Willingness to post collateral is hence ambiguously correlated with wealth. On one side wealthier entrepreneurs are less risk adverse and therefore, other things equal, more willing to post collateral. On the other side they are riskier because of moral hazard and therefore less willing to post collateral. When the direct risk aversion effect is higher than the negative indirect effect (through moral hazard), it becomes impossible to separate borrowers in equilibrium because the potential signal (collateral) is useless. In this case two outcomes are possible depending on participation of poor entrepreneurs at the potential pooling contract. They may be excluded from credit or accept a pooling contract where they cross subsidize rich types. The striking feature of this equilibrium is the direction of the cross-subsidization. Poor hard-working borrowers subsidize rich 'lazy' borrowers. As usual, cross-subsidization implies an output loss due to lower effort of the good risk types caused by higher than necessary interest rates. But the overall output consequences of cross subsidization relative to a separating equilibrium are unclear, because bad risk types benefit from lower interest rates.

Whenever the impact of moral hazard prevails in the whole contract space, separation through the use of the screening device is, in principle, possible. Collateral requirement in this case is a net cost paid by the poor individuals. As a consequence, their net welfare will be again lower than it would be under full information.

In all possible cases poor borrowers lose out from asymmetric information and the presence of rich borrowers. Asymmetric information worsens the distribution of resources in society. Up to now, the belief that credit market imperfections could worsen inequality was widespread, but in the conventional wisdom this effect came from credit availability. While we believe this channel to be relevant, we discover an additional reason to believe that there are adverse distributional effects from credit market imperfections.

These results imply that State programs promoting entrepreneurship need to be accurately targeted. In recent decades, a conjecture about the welfare costs of exclusion has led to widespread government intervention in the banking sector, particularly of low income countries (Burgess et al. 2005). Instances of such interventions range from interest rate ceilings on lending to the small entrepreneurs to a mix of taxes (for the inframarginals) and subsidies (for the rationed marginals). Whether such interventions actually improve the access of the more efficient firms to banks' credit remains widely debated. Shane (2009) discusses this issue. Rather than developing policies to simply increase the number of start-ups in the market, policy-makers should concentrate on a subset of business which is more productive than existing companies. Our research particularly confirms that such programs concentrated on specific wealth-target groups may help unwind undesirable cross subsidization between classes of borrowers. An appropriate design of State programs therefore requires that they should focus mainly on personal characteristics of potential entrepreneurs in the opportunity egalitarian perspectives.

A promising avenue for further research in this area is the exploration of the interaction between subsidization and exclusion (or alternatively with participation and entry as in Parker 2003 and Gruner 2003). Our model, for instance, excludes the possibility of rationing. In a richer setting with an upward sloping supply of funds, poorer borrowers may be crowded out by richer entrepreneurs in a two-contract partially separating equilibrium (as in Coco 1997; Arnold and Riley 2009).

Acknowledgments We are indebted to David de Meza, Alberto Bennardo, Emma Carter, Daniel Kraus, Alireza Naghavi and Alberto Zazzaro for useful comments. The suggestions of the associate editor and an anonymous referee helped to improve considerably the paper. We are also grateful to the participants at the SIE conference (October, 2010), the Meeting of ECINEQ in Catania (July, 2011), the conference of the European Economics and Finance Society in London (June, 2011) and the European Economic Association Conference in Oslo (August, 2011). Responsibility for mistakes remains entirely ours. Giuseppe Coco gratefully acknowledges the financial support of the MIUR Prin Grant No. 2007RR7HCN.

Appendix

Proof of Eq. 5

Starting with Eq. 3:

$$\frac{\partial U_i}{\partial e_i} = p'(e_i)\big(U(W^S) - U(W^F)\big) - 1$$

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

$$\begin{aligned}&\big[p''(e_i)\big(U(W^S) - U(W^F)\big)\big]de\\ &\quad + \big[p'(e_i)\big(U'(W^S) - U'(W^F)\big)\big]dw = 0\\ &\big[p''(e_i)\big(U(W^S) - U(W^F)\big)\big]de\\ &\quad = -\big[p'(e_i)\big(U'(W^S) - U'(W^F)\big)\big]dw\end{aligned}$$

which implies that:

$$\frac{de}{dw} = -\frac{p'(e_i)(U'(W^S) - U'(W^F))}{p''(e_i)(U(W^S) - U(W^F))} < 0$$

Proof of Eq. 6:

Starting with Eq. 1:

$$U_i = p(e_i)U(Y - X + w_i) + (1 - p(e_i))U(w_i - c) - e_i$$

Let us assume that $W^S = Y - X + w_i$ and $W^F = w_i - c$, we can simply rewrite that:

$$U_i = p(e_i)U(W^S) + (1 - p(e_i))U(W^F) - e_i$$

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

$$\begin{aligned}&\big[-p(e_i)U'(W^S)\big]dX - \big[(1 - p(e_i))U'(W^F)\big]dc = 0\\ &\big[-p(e_i)U'(W^S)\big]dX = \big[(1 - p(e_i))U'(W^F)\big]dc\end{aligned}$$

which implies that:

$$\frac{dX}{dc} = -\frac{(1 - p(e_i))U'(W^F)}{p(e_i)U'(W^S)} = s < 0$$

Second order condition $\left(\frac{d^2X}{dc^2}\right)$

Let us define as s the slope of the indifference curve. The curvature of the indifference curve can be studied after differentiating Eq. 6 with respect to c:

$$\frac{\partial}{\partial w}\left(\frac{dX}{dc}\right) = M(w)R'(w) + M'(w)R(w)$$

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 $M(w)R'(w)$:

$$\begin{aligned}
\frac{d^2X}{dc^2} &= -\left\{\frac{\left[-(1-p(e_i))U''(W^F)-p'(e_i)\frac{\partial e}{\partial c}U'(W^F)\right]\left(p(e_i)U'(W^S)\right)}{[p(e_i)U'(W^S)]^2} - \frac{[(1-p(e_i))U'(W^F)]\left[-p(e_i)U''(W^S)\frac{\partial X}{\partial c}+p'(e_i)\frac{\partial e}{\partial c}U'(W^S)\right]}{[p(e_i)U'(W^S)]^2}\right\} \\
&= -\left\{-\frac{(1-p(e_i))U''(W^F)}{[p(e_i)U'(W^S)]} - \frac{p'(e_i)\frac{\partial e}{\partial c}U'(W^F)}{[p(e_i)U'(W^S)]} + \frac{p(e)(1-p(e))U'(W^F)U''(W^S)\frac{\partial X}{\partial c}}{[p(e_i)U'(W^S)]^2} - \frac{p'(e_i)\frac{\partial e}{\partial c}U'(W^S)(1-p(e_i))U'(W^F)}{[p(e_i)U'(W^S)]^2}\right\} \\
&= \left\{\frac{(1-p(e_i))U''(W^F)}{p(e_i)U'(W^S)} - s\,\frac{(1-p(e_i))U''(W^S)U'(W^F)}{p(e_i)(U'(W^S))^2} + \frac{p'(e_i)\frac{\partial e}{\partial c}U'(W^F)}{p(e_i)U'(W^S)} + \frac{p'(e_i)\frac{\partial e}{\partial c}(1-p(e_i))U'(W^F)}{p(e_i)^2U'(W^S)}\right\} \\
&= \left\{\frac{(1-p(e_i))}{p(e_i)}\frac{U'(W^F)}{U'(W^S)}\left(\frac{U''(W^F)}{U'(W^F)} - s\,\frac{U''(W^S)}{U'(W^S)}\right) + \left[\frac{p'(e_i)\frac{\partial e}{\partial c}U'(W^F)}{p(e_i)U'(W^S)}\left(1 + \frac{(1-p(e_i))}{p(e_i)}\right)\right]\right\} \\
&= \left\{-s\left[-A(W^F) + sA(W^S)\right] + \frac{p'(e_i)\frac{\partial e}{\partial c}U'(W^F)}{p(e_i)U'(W^S)}\left(\frac{1}{p(e_i)}\right)\right\} \\
&= \left\{-s\left[sA(W^S) - A(W^F)\right] + \left[\frac{\partial e}{\partial c}\frac{p'(e_i)}{(p(e_i))^2}\frac{U'(W^F)}{U'(W^S)}\right]\right\} \lesseqgtr 0
\end{aligned}$$

The first expression in curly brackets gives the negative risk aversion effect which makes the indifference curve more concave while the second positive term is the effort disincentive effect which renders the indifference curve more convex. The former is larger, thus the higher the degree of risk aversion, the more sensitive is the probability of success to the amount of collateral provided. However, to simplify in Figs. 1 and 2, we design the indifference curves with a negative second derivative because convexity due to the dominance of the moral hazard impacts does not have significant implications for the existence and nature of equilibrium.

Proof of Eq. 7:

We can again rewrite the slope of the indifference curve as:

$$\frac{dX}{dc} = M(w)R(w)$$

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

$$\begin{aligned}
M(w)R'(w) &= -\frac{(1-p(e_i))}{p(e_i)}\left[\frac{U''(W^F)U'(W^S)-U''(W^S)U'(W^F)}{(U'(W^S))^2}\right] \\
&= -\frac{(1-p(e_i))}{p(e_i)}\left[\frac{U''(W^F)}{U'(W^S)} - \frac{U''(W^S)U'(W^F)}{(U'(W^S))^2}\right] \\
&= -\frac{(1-p(e_i))}{p(e_i)}\frac{1}{U'(W^S)}\left[U''(W^F) - \frac{U''(W^S)U'(W^F)}{U'(W^S)}\right] \\
&= -\frac{(1-p(e_i))}{p(e_i)}\frac{U'(W^F)}{U'(W^S)}\left[\frac{U''(W^F)}{U'(W^F)} - \frac{U''(W^S)}{U'(W^S)}\right]
\end{aligned}$$

Let us define $A(W)$ as the coefficient of decreasing absolute risk aversion, we can then rewrite $M(w)R'(w)$ as:

$$\begin{aligned}
M(w)R'(w) &= -\frac{(1-p(e_i))}{p(e_i)}\frac{U'(W^F)}{U'(W^S)}\left(A(W^S)-A(W^F)\right) \\
&= \frac{dX}{dc}\left(A(W^S)-A(W^F)\right) > 0
\end{aligned}$$

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

Then we can solve $M'(w)R(w)$:

$$
\begin{aligned}
&M'(w)R(w)\\
&= \left[-\frac{-p'(e_i)\frac{\partial e}{\partial w}p(e_i) - (1-p(e_i))p'(e_i)\frac{\partial e}{\partial w}}{(p(e_i))^2} \right] \frac{U'(W^F)}{U'(W^S)}\\
&= \left[\frac{p'(e_i)\frac{\partial e}{\partial w}}{(p(e_i))} + \frac{(1-p(e_i))p'(e_i)\frac{\partial e}{\partial w}}{(p(e_i))^2} \right] \frac{U'(W^F)}{U'(W^S)}\\
&= \frac{p'(e_i)}{p(e_i)}\frac{\partial e}{\partial w}\left[1 + \frac{(1-p(e_i))}{p(e_i)} \right] \frac{U'(W^F)}{U'(W^S)}\\
&= \frac{p'(e_i)}{p(e_i)}\frac{\partial e}{\partial w}\left[\frac{U'(W^F)}{U'(W^S)} - \frac{dX}{dc} \right]\\
&= -\frac{p'(e_i)}{p(e_i)}\frac{\partial e}{\partial w}\left[\frac{dX}{dc} - \frac{U'(W^F)}{U'(W^S)} \right] < 0
\end{aligned}
$$

Therefore,

$$
\begin{aligned}
\frac{\partial}{\partial w}\left(\frac{dX}{dc}\right) &= \frac{dX}{dc}\big(A(W^S) - A(W^F)\big)\\
&\quad - \frac{p'(e_i)}{p(e_i)}\frac{\partial e}{\partial w}\left(\frac{dX}{dc} - \frac{U'(W^F)}{U'(W^S)}\right) \lesseqgtr 0
\end{aligned}
$$

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

Proof of Eq. 8:

After some algebraic manipulations,

$$
\begin{aligned}
\frac{\partial}{\partial w}\left(\frac{dX}{dc}\right) &= s\big(A(W^S) - A(W^F)\big) - \frac{\partial e}{\partial w}\frac{p'(e_i)}{p(e_i)}\left(s - \frac{U'(W^F)}{U'(W^S)}\right)\\
&= s(1-p(e_i))\big(A(W^S) - A(W^F)\big)\\
&\quad - \frac{\partial e}{\partial w}p'(e_i)\frac{(1-p(e_i))}{p(e_i)}\left(s - \frac{U'(W^F)}{U'(W^S)}\right)\\
&= s(1-p(e_i))\big(A(W^S) - A(W^F)\big)\\
&\quad - \frac{\partial e}{\partial w}p'(e_i)\left(\left(\frac{(1-p(e_i))}{p(e_i)}\right)s + s\right)\\
&= s(1-p(e_i))\big(A(W^S) - A(W^F)\big)\\
&\quad - \frac{\partial e}{\partial w}p'(e_i)\frac{s}{p(e_i)}\\
&= s\big((1-p(e_i))\big(A(W^S) - A(W^F)\big)\\
&\quad - \frac{\partial e}{\partial w}\frac{1}{p(e_i)(U(W^S) - U(W^F))}\big)\\
&= \frac{s}{p(e_i)(U(W^S) - U(W^F))}\\
&\quad \times \left(p(e_i)(1-p(e_i))\big(A(W^S) - A(W^F)\big) - \frac{\partial e}{\partial w}\right)
\end{aligned}
$$

The impact of moral hazard prevails if and only if:

$$
\frac{\partial e}{\partial w} > p(e_i)(1-p(e_i))\big(A(W^S) - A(W^F)\big)
$$

References

Arnold, L. G., & Riley J. G. (2009). On the possibility of rationing in the Stiglitz–Weiss model. *American Economic Review, 99*(5), 2012–2021.

Benabou, R. (1996). Inequality and growth. In B. S. Bernanke, & J. J. Rotemberg (Eds.), *NBER macro-economics annual* (pp. 11–74). Cambridge: The MIT Press.

Berger, A. N., & Udell, G. F. (1990). Collateral, loan quality and bank risk. *Journal of Monetary Economics, 25*, 21–42.

Besanko, D., & Thakor, A. (1987). Collateral and rationing: Sorting equilibria in monopolistic and competitive credit market. *International Economic Review, 28*, 671–689.

Bester, H. (1985). Screening vs. rationing in credit market with imperfect information. *American Economic Review, 75*(4), 850–855.

Bester, H. (1987). The role of collateral in credit markets with imperfect information. *European Economic Review, 31*(4), 887–899.

Black, J., & de Meza, D. (1997). Everyone may benefit from subsidising entry to risky occupations. *Journal of Public Economics, 66*(3), 409–424.

Black, J., de Meza, D., & Jeffrey, D. (1996). House prices, the supply of collateral and the enterprise economy. *Economic Journal, 106*, 60–75.

Blake, D. (1996). Efficiency, risk aversion and portfolio insurance: An analysis of financial asset portfolios held by investors in the United Kingdom. *Economic Journal, 106*, 1175–1192.

Blanchflower, D., & Oswald, A. (1998). What makes an entrepreneur? *Journal of Labour Economics, 16*, 26–60.

Burgess, R., Pande, R., & Wong, G. (2005). Banking from the poor: Evidence from India. *Journal of the European Economic Association, 3*, 268–278.

Coco, G. (1997). Credit rationing and the welfare gains from usury laws. Discussion Paper in Economics. Exeter: University of Exeter, N 97/15.

Coco, G. (1999). Collateral, heterogeneity in risk attitude and the credit market equilibrium. *European Economic Review, 43*, 559–574.

Coco, G. (2000). On the use of collateral. *Journal of Economic Surveys, 14*(2), 191–214.

Coco, G., & Pignataro, G. (2010). Inequality of opportunity in the credit market. *SERIES working paper*, n 0026.

Cressy, R. (2000). Credit rationing or entrepreneurial risk aversion? An alternative explanation for the Evans and Jovanovic finding. *Economics Letters, 66*(2), 235–240.

de Meza, D. (2002). Overlending? *Economic Journal, 112*, 17–31.

de Meza, D., & Webb, D. (1987). Too much investment: A problem of asymmetric information. *Quarterly Journal of Economics, 102*(2), 281–292.

de Meza, D., & Webb, D. (1999). Wealth, enterprise and credit policy. *Economic Journal, 109*(455), 153–163.
de Meza, D., & Webb, D. (2000). Does credit rationing imply insufficient lending? *Journal of Public Economics, 78*(3), 215–234.
Elston, J. A., & Audretsch, D. B. (2011). Financing the entrepreneurial decision: an empirical approach using experimental data on risk attitudes. *Small Business Economics, 36*, 209–222.
European Commission (2003). SMEs and access to finance. Observatory of European SMEs, Enterprise Publications, 2003/2.
Evans, S., & Jovanovic, B. (1989). An estimated model of entrepreneurial choice under liquidity constraints. *Journal of Political Economy, 97*, 808–827.
Georgellis, Y., Sessions, J., & Tsitsianis, N. (2005). Windfalls, wealth, and the transition to self-employment. *Small Business Economics, 25*, 407–428.
Ghatak, M., Morelli, M. & Sjostrom, T. (2007). Entrepreneurial talent, occupational choice, and trickle up policies. *Journal of Economic Theory, 137*(1), 27–48.
Gruner, H. (2003). Redistribution as a selection device. *Journal of Economic Theory, 108*, 194–216.
Jaimovich, E. (2010). Adverse selection and entrepreneurship in a model of development. *Scandinavian Journal of Economics, 112*(1), 77–100.
Jaimovich, E. (2011). Sectoral differentiation, allocation of talent, and financial development. *Journal of Development Economics, 96*(1), 47–60.
Kan, K., & Tsai, W.-D. (2006). Entrepreneurship and risk aversion. *Small Business Economics, 26*, 465–474.
Newman, A. (2007). Risk-bearing and entrepreneurship. *Journal of Economic Theory, 137*(1), 11–26.
Ogaki, M., & Zhang, Q. (2001). Decreasing relative risk aversion and tests of risk sharing. *Econometrica, 69*, 515–526.
Parker, S. (2003). Asymmetric information, occupational choice and government policy. *Economic Journal, 113*(490), 861–882.
Rothshild, M., & Stiglitz, J. (1976). Equilibrium in competitive insurance markets: An essay on the economics of imperfect information. *Quarterly Journal of Economics, 90*, 629–649.
Rosenzweig, M., & Binswanger, H. (1993). Wealth, weather risk and the composition and profitability of agricultural investments. *Economic Journal, 103*, 56–78.
Shane, S. (2009). Why encouraging more people to become entrepreneurs is bad public policy. *Small Business Economics, 33*, 141–149.
Stiglitz, J., & Weiss, A. (1981). Credit rationing in market with imperfect information. *American Economic Review, 71*(3), 393–410.
Stiglitz, J., & Weiss, A. (1992). Asymmetric information in credit markets and its implications for macro-economics. *Oxford Economic Papers, 44*, 694–724.
Wilson, C. (1977). A model of insurance markets with incomplete information. *Journal of Economic Theory, 16*, 167–207.