“Strategic group lending for banks”

AUTHORS	Marco Spallone https://orcid.org/0000-0003-4990-8872 Pina Murè

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Marco Spallone (Italy), **Pina Murè** (Italy)

STRATEGIC GROUP LENDING FOR BANKS

Abstract

Credit institutions often refuse to lend money to small firms. Usually, this happens because small firms are not able to provide collateral to lenders. Moreover, given the small amount of required loans, the relative cost of full monitoring is too high for lenders. Group lending contracts have been viewed as an effective solution to credit rationing of small firms in both developing and industrialized countries. The aim of this paper is to highlight the potential of group lending contracts in terms of credit risk management. In particular, this paper provides a theoretical explanation of the potential of group lending programs in screening good borrowers from bad ones to reduce the incidence of non-performing-loans (NPL). This paper shows that the success of firms involved in selected group lending programs is due to the fact that co-signature is an effective screening device: more precisely, if lenders make a proper use of co-signature to screen good firms from bad ones, then only firms that are good ex-ante enter group lending contracts. So, the main argument of this paper is that well designed group lending programs induce good firms to become jointly liable, at least partially, with other good firms and discourage other – bad-firms to do the same. Specifically, co-signature is proven to be a screening device only in the case of a perfectly competitive bank sector.

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Marco Spallone, Associate Professor, Department of Economics, DEC, d'Annunzio University of Chieti and Pescara, Italy.

Pina Murè, Associate Professor, La Sapienza University of Rome, Italy.

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INTRODUCTION

Credit institutions often refuse to lend money to small firms[1]. Usually, this happens because small firms are not able to provide collateral to lenders. Moreover, given the small amount of required loans, the relative cost of full monitoring is too high for lenders.

"Group lending" contracts have been viewed as an effective solution to credit rationing of small firms in both developing and industrialized countries. While these contracts have been known in industrialized countries for many years[2], it was the initial success of group lending programs in countries like Bangladesh, Bolivia, Malawi, Thailand and Zimbabwe that caught the attention of many economists.

The common feature of group lending contracts is joint liability in case of default: in fact, the expected returns of each member of a group of borrowers work as collateral in case of default of other members. Small firms choose to enter a group and assume the joint liability in order to obtain better deals from lenders, that is more capital at lower interest rates.

1 In this paper we do not refer to any official definition of "small" firms. In fact, all results can be extended to micro and medium size firms. Generally speaking, they apply to all cases in which either collateral or credit history are lacking.

2 An early example is the Italian institution called Confidi.

However, while in developing countries group lending contracts have often been implemented by specialized banks or NGOs in order to rescue people from poverty, in industrialized countries they could play a different role: in particular, if such contracts are designed in order to allow a partial joint liability, that we name "co-signature", they could work as an effective tool to manage credit risk.

The aim of this paper is to highlight the potential of group lending contracts in terms of credit risk management. In particular, this paper provides a theoretical explanation of the potential of group lending programs in screening good borrowers from bad ones to reduce the incidence of non-performing-loans (NPL).

Scholars followed two alternatives routes to analyze group lending contracts: the first relies on the idea that such contracts provide incentives for similar types to group together (peer selection); the second relies on the idea that such contracts provide incentives for involved agents to choose safe activities (peer monitoring).

In peer selection models group lending contracts are proven to be effectively different for risky types and safe types. In other words, given that risky types will voluntarily team with risky types (which are successful less often and, when they are successful, they are more likely to pay the joint liability payment) and safe types will voluntarily team with safe types, group lending contracts provide a way to price discriminate that is impossible under individual lending contracts.

In peer monitoring models, instead, group lending contracts are proven to be a mechanism that gives borrowers an incentive to choose safe projects: since peer monitoring works as a commitment device, firms involved in group lending contracts usually obtain more capital at lower interest rates.

Many recent papers studied new aspects of group lending contracts. In particular, some of them studied group formation games and some others showed that group lending programs improve the pool of borrowers. However, most of them focused their attention on data retrieved from rural credit markets in developing countries, underestimating the potential of group lending in competitive environments.

This paper shows that the success of firms involved in selected group lending programs is due to the fact that partial joint liability is an effective screening device: more precisely, if lenders make a proper use of joint liability to screen good firms (i.e., firms with less risky investment projects[3]) from bad ones by allowing a partial joint liability (i.e., co-signature), then only firms that are good ex-ante enter group lending contracts. So, the main argument of this paper is that well designed group lending programs induce good firms to become jointly liable (at least partially) with other good firms and discourage other – bad – firms to do the same.

Specifically, co-signature is proven to be a screening device only in the case of a perfectly competitive bank sector; it is not a screening device in the case of a credit market run by a benevolent lender (an NGO, for instance). In other words, while a separating equilibrium with co-signature may arise if the bank sector is competitive, it does not arise if the credit market is run by a planner willing to maximize aggregate surplus. This result also explains why some programs (that is, those run under competitive conditions) were successful in the past while others were not.

A monopolistic bank sector is also considered. If the bank sector is a monopoly, again there is no room for co-signature as a screening device. Such a result confirms the fact that co-signature is effective only in a competitive environment. Moreover, it suggests that the success of group lending programs should increase together with competition among lenders.

3 More precisely, good firms are those willing to undertake investment projects that exhibit a first order stochastic dominance with respect to those undertaken by bad (that is, risky) firms.

The paper is structurized as follows.

The first section describes the role of co-signature in a monopolistic environment: the optimal contract for the monopolistic lender is without co-signature (i.e., there is no optimal contract that screens good firms from bad firms through partial joint liability). The second section takes into account the role of a benevolent lender that resembles a typical NGO: again, there is no room for co-signature. The third section considers a competitive bank sector: if a market equilibrium exists it is a separating equilibrium in which good firms assume partial joint liability and bad firms do not. The last section concludes.

An Appendix contains the derivation of all first order and slackness conditions of the maximization problems.

1. GROUP LENDING CONTRACTS IN A MONOPOLISTIC BANK SECTOR

Consider a market for loans to finance investment projects:

- There is only one risk neutral bank that can supply loans. For simplicity, assume that the cost of one unit of capital for the bank is constant and equal to r.

- There are many risk averse firms that ask for loans to undertake investment projects[4]. They cannot provide any collateral. For simplicity, we assume that all investment projects require one unit of capital. The unique argument of the strictly concave utility function of firms is profit; moreover, we assume that $U(0)=0$.

- There are two types of projects (that is, two types of firms), one good and one bad. An investment project is good if it yields a profit $\Pi>0$ with probability p_g and a profit $\Pi=0$ with probability $1-p_g$. An investment project is bad if it yields a profit $\Pi>0$ with probability p_b and a profit $\Pi=0$ with probability $1-p_b$, where $0<p_b<p_g<1$. We assume that the p_g fraction of bad projects is $\lambda\in(0,1)$.

- Firms know both their type and other firms' type, while banks cannot distinguish a good firm from a bad one[5]. Firms can choose to co-sign a fraction q of each others' loans. For simplicity, we assume that a good firm will co-sign only another good firm's loan and that a bad firm will co-sign only another bad firm's loan[6].

The monopolistic bank offers a set of contracts in order to maximize its expected profit; moreover, by Revelation Principle, all contracts need to be truth telling mechanisms. This implies that the bank has to choose $\{R_b,R_g,q_b,q_g\}$ to maximize the following objective function:

$$\lambda\left[2p_b^2R_b+2p_b\left(1-p_b\right)\left(R_b+q_b\right)-2r\right]+$$
$$+\left(1-\lambda\right)\left[2p_g^2R_g+2p_g\left(1-p_g\right)\left(R_g+q_g\right)-2r\right],$$

such that:

$$p_b^2U\left(\Pi-R_b\right)+p_b\left(1-p_b\right)U\left(\Pi-R_b-q_b\right)\geq\bar{u},\quad(1)$$

$$p_g^2U\left(\Pi-R_g\right)+p_g\left(1-p_g\right)U\left(\Pi-R_g-q_g\right)\geq\bar{u},\quad(2)$$

4 The assumption of risk aversion is consistent with our focus on small firms.

5 This is the typical assumption of all models that deal with asymmetric information on credit markets. Actually, if banks could distinguish good firms from bad ones, they would not need any screening device (not only co-signature, but collaterals as well). In reality, the screening process is costly when credit history is lacking. So, all screening devices are useful as long as they allow lenders to save on all (or some) costs related to credit evaluation.

6 This assumption is consistent with the recent literature, both theoretical and experimental, on peer selection in financial markets. For a detailed explanation of this assumption see Di Cagno et al. (2012). Moreover, it is consistent with all peer monitoring arguments that were made to explain the success of the most popular group lending programs, as for example those implemented by Grameen Bank in Bangladesh, and the long tradition of Italian Confidi, that is associations of homogeneous (same area or same industry) SME, that provide guarantees to lenders by means of partial joint liability of all its members.

$$p_b^2 U(\Pi - R_b) + p_b(1-p_b)U(\Pi - R_b - q_b) \geq \geq p_b^2 U(\Pi - R_g) + p_b(1-p_b)U(\Pi - R_g - q_g), \quad (3)$$

$$p_g^2 U(\Pi - R_g) + p_g(1-p_g)U(\Pi - R_g - q_g) \geq \geq p_g^2 U(\Pi - R_b) + p_g(1-p_g)U(\Pi - R_b - q_b), \quad (4)$$

and:

$$R_b \geq 0, R_g \geq 0, q_b \geq 0, q_g \geq 0,$$

Where R_b and R_g are the gross interest rates for bad and good firms. Constraints (1) and (2) are the participation constraints for bad firms and good firms respectively. Constraints (3) and (4) are the incentive compatibility constraints.

Lemma 1. Constraint (2) can be ignored.

Proof: From constraint (4):

$$p_g^2 U(\Pi - R_g) + p_g(1-p_g)U(\Pi - R_g - q_g) \geq \geq p_g^2 U(\Pi - R_b) + p_g(1-p_g)U(\Pi - R_b - q_b).$$

Moreover,

$$p_g^2 U(\Pi - R_b) + p_g(1-p_g)U(\Pi - R_b - q_b) \geq \geq p_b^2 U(\Pi - R_b) + p_b(1-p_b)U(\Pi - R_b - q_b) \geq \bar{u}.$$

So,

$$p_g^2 U(\Pi - R_g) + p_g(1-p_g)U(\Pi - R_g - q_g) \geq \geq p_b^2 U(\Pi - R_b) + p_b(1-p_b)U(\Pi - R_b - q_b) \geq \bar{u}.$$

Hence, constraint (2) can be ignored.

Lemma 1 says that the participation of bad firms implies the participation of good firms. So, by Lemma 1, the problem of the bank is to choose $\{R_b, R_g, q_b, q_g\}$ to maximize expected profits subject to constraints (1), (3), and (4).

Given the Lagrangian multiplier $\gamma \geq 0, \varphi \geq 0, \theta \geq 0$, it is possible to derive the first order conditions and the complementary slackness conditions[7]. By making use of all conditions it is possible to characterize the optimal contracts through a set of lemmas.

Lemma 2. $\theta > 0$.

Proof: Consider (A2).

Since by assumption:

$$(1-\lambda)2p_g > 0,$$

$$\varphi \begin{bmatrix} p_b^2 U'(\Pi - R_g) + p_b(1-p_b) \times \\ \times U'(\Pi - R_g - q_g) \end{bmatrix} \geq 0.$$

It must be the case that:

$$\theta \begin{bmatrix} p_g^2 U'(\Pi - R_g) + \\ + p_g(1-p_g)U'(\Pi - R_g - q_g) \end{bmatrix} > 0.$$

Given that by assumption:

$$p_g^2 U'(\Pi - R_g) + p_g(1-p_g)U'(\Pi - R_g - q_g) > 0.$$

It follows that $\theta > 0$.

Lemma 2 implies that constraint (4) is always binding. So, in any contract the bank will set:

$$p_g^2 U(\Pi - R_g) + p_g(1-p_g)U(\Pi - R_g - q_g) = \cdot = p_g^2 U(\Pi - R_b) + p_g(1-p_g)U(\Pi - R_b - q_b)$$

In other words, good firms must be indifferent between revealing their type truthfully (i.e., accepting contract $\{R_g, q_g\}$) and cheating (i.e., accepting contract $\{R_b, q_b\}$).

Lemma 3. $\gamma + \varphi > 0$.

Proof: Consider (A1).

Since by assumption:

$$\lambda 2p_b > 0,$$

$$\theta \begin{bmatrix} p_g^2 U'(\Pi - R_b) + \\ + p_g(1-p_g)U'(\Pi - R_b - q_b) \end{bmatrix} > 0.$$

Lemma 2 implies that:

7 All conditions cited in the proofs of the following Lemmas are reported in the Appendix.

$$(\gamma+\varphi)\left[\begin{array}{l} p_b^2U'(\Pi-R_b)+ \\ +p_b(1-p_b)U'(\Pi-R_b-q_b)\end{array}\right]>0$$

Given that by assumption:

$$\begin{array}{l} p_b^2U'(\Pi-R_b)+ \\ +p_b(1-p_b)U'(\Pi-R_b-q_b)>0.\end{array}$$

It follows that $\gamma+\varphi>0$.

Lemma 3 implies that at least one constraint among constraints (1) and (3) is always binding.

Lemma 4. In any contract $q_b=0$.

Proof: Consider (A3).

If $q_b>0$, then:

$$(\gamma+\varphi)=\frac{2\lambda p_b(1-p_b)+\theta p_g(1-p_g)U'(\Pi-R_b-q_b)}{p_b(1-p_b)U'(\Pi-R_b-q_b)}.$$

So, substituting into (A1):

$$\begin{array}{l} 2\lambda p_b\left[2-p_b\left(1-p_b\dfrac{U'(\Pi-R_b)}{U'(\Pi-R_b-q_b)}\right)\right]+ \\ +\theta\left[\dfrac{p_g}{(1-p_g)}U'(\Pi-R_b)+p_g^2U'(\Pi-R_b)\right]+ \\ +2\theta p_g(1-p_g)U'(\Pi-R_b-q_b)>0.\end{array}$$

This is a contradiction.

Lemma 4 states that bad firms are never offered to co-sign each other's loans. The intuition is the following: given both the participation constraints and risk aversion, offering contracts with co-signature is costly for the monopolist. Moreover, offering contracts with co-signature to bad firms is more costly than offering contracts with co-signature to good firms. In other words, it is impossible for lenders to solve the trade-off between participation and incentive compatibility constraints for bad firms[8].

Lemma 5. Hence, $\gamma=0$.

Proof: Consider (S2) and suppose $\varphi>0$.

Case 1: $q_g>0$.

If $\varphi>0$, then it must be the case that:

$$\begin{array}{l} p_b^2U(\Pi-R_b)+p_b(1-p_b)U(\Pi-R_b-q_b)= . \\ =p_b^2U\left(\Pi-R_g\right)-p_b(1-p_b)U\left(\Pi-R_g-q_g\right)\end{array}$$

Since $\theta>0$ (Lemma 2) and $q_b>0$ (Lemma 4), the following must be true:

$$\begin{array}{l} p_bU\left(\Pi-R_g\right)+(1-p_b)U\left(\Pi-R_g-q_g\right)= . \\ =p_gU\left(\Pi-R_g\right)+p_b(1-p_g)U\left(\Pi-R_g-q_g\right)\end{array}$$

This is a contradiction.

Case 2: $q_g=0$.

If $q_g>0$, from (A4) it must be the case that:

$$\theta\geq\frac{2(1-\lambda)}{U'\left(\Pi-R_g\right)}+\varphi\frac{p_b(1-p_b)}{p_g(1-p_g)}.$$

Moreover, from (A2), it must be the case that:

$$\theta=\frac{2(1-\lambda)}{U'\left(\Pi-R_g\right)}+\varphi\frac{p_b}{p_g}\cdot$$

Now, if $\varphi>0$, then the following must be true:

$$\begin{array}{l}\dfrac{2(1-\lambda)}{U'\left(\Pi-R_g\right)}+\varphi\dfrac{p_b(1-p_b)}{p_g(1-p_g)}\leq \\ \leq\dfrac{2(1-\lambda)}{U'\left(\Pi-R_g\right)}+\varphi\dfrac{p_b}{p_g}.\end{array}$$

8 In particular, whenever lenders are willing to screen good firms from bad ones by means of a screening device, they have to solve a trade-off: in order to make profits, they have to allow participation of all types of borrowers by complying with participation constraints, but in order to screen different types, they have to impose an extra cost to firms by complying with incentive compatibility constraints (that is, the risk of being liable for a fraction of the loan of another member of the group). As said, the two types of constraints induce a trade-off, that is not possible to solve for bad firms.

This is a contradiction.

Hence, by Lemma 3, $\gamma > 0$.

Lemma 5 states that bad firms get no more than their reservation utility. So, constraint (1) is always binding.

Lemma 6. In any contract $R_b \geq R_g$.

Proof: Consider (S3).

Suppose that $R_b < R_g$. Since:

$$p_g^2 U\left(\Pi - R_g\right) + p_g\left(1 - p_g\right) U\left(\Pi - R_g - q_g\right) =$$
$$= p_g^2 U\left(\Pi - R_b\right) - p_g\left(1 - p_g\right) U\left(\Pi - R_b - q_b\right),$$

by Lemmas 2 and 3, it must be the case that $q_g < 0$.

This is a contradiction.

Lemma 6 proves that bad firms are never charged a lower interest rate. Given $q_b = 0$, if $R_b < R_g$, it is not possible to enforce truth telling because good firms always find convenient to lie.

Lemma 7. In any contract $q_g = 0$. Hence, $q_b = q_g = 0$ and $R_b = R_g$.

Proof: Suppose $q_g > 0$. From (A2):

$$\theta = \frac{2\left(1-\lambda\right)}{p_g U'\left(\Pi - R_g\right) + \left(1 - p_g\right) U'\left(\Pi - R_g - q_g\right)}.$$

Substituting into (A4), then the following must be true:

$$1 = \frac{U'\left(\Pi - R_g - q_g\right)}{p_g U'\left(\Pi - R_g\right) + \left(1 - p_g\right) U'\left(\Pi - R_g - q_g\right)}.$$

This is a contradiction. Hence, $q_b = q_g = 0$.

Moreover, from Lemma 2 and (S3) it follows that $R_b = R_g$.

Lemma 7 fully characterizes the contract offered by the monopolist. No firm is offered to co-sign and both bad and good firms pay the same interest rate. Moreover, bad firms get an utility $\bar{u}$, while good firms get an utility greater than $\bar{u}$.

There is no room for co-signature.

2. GROUP LENDING PROGRAMS IN A CREDIT MARKET RUN BY A BENEVOLENT LENDER

Now, suppose that the credit market described in the previous section is run by a benevolent lender willing to maximize aggregate surplus. This lender has to choose $\left\{R_b, R_g, q_b, q_g\right\}$ to maximize the following objective function[9]:

$$\lambda p_b^2 U\left(\Pi - R_b\right) + p_b\left(1 - p_b\right) U\left(\Pi - R_b - q_b\right) + $$
$$+\left(1-\lambda\right) p_g^2 U\left(\Pi - R_g\right) +$$
$$+ p_g\left(1 - p_g\right) U\left(\Pi - R_g - q_g\right)$$

such that:

$$\lambda\left[2 p_b^2 R_b + 2 p_b\left(1 - p_b\right)\left(R_b + q_b\right) - 2r\right] + +\left(1-\lambda\right)\left[2 p_g^2 R_g + 2 p_g\left(1 - p_g\right)\times \times\left(R_g + q_g\right) - 2r\right] = 0, \quad (5)$$

$$p_b^2 U\left(\Pi - R_b\right) + p_b\left(1 - p_b\right) U\left(\Pi - R_b - q_b\right) \geq \geq p_b^2 U\left(\Pi - R_g\right) + p_b\left(1 - p_b\right) U\left(\Pi - R_g - q_g\right), \quad (6)$$

$$p_g^2 U\left(\Pi - R_g\right) + p_g\left(1 - p_g\right) U\left(\Pi - R_g - q_g\right) \geq \geq p_g^2 U\left(\Pi - R_b\right) + p_g\left(1 - p_g\right) U\left(\Pi - R_b - q_b\right), \quad (7)$$

and:

$$R_b \geq 0, R_g \geq 0, q_b \geq 0, q_g \geq 0.$$

Constraint (5) is a zero profit condition. Constraints (6) and (7) are the incentive compatibility constraints.

To start, consider the simplified problem of choosing $\left\{R_b, R_g, q_b, q_g\right\}$ to maximize the planner's objective function under the zero profit condition only.

9 The interpretation of aggregate surplus as a social welfare function is in terms of an unborn firm's ex-ante expected utility.

Given the Lagrangian multiplier $\gamma > 0$, it is possible to derive the first order conditions and the complementary slackness conditions[10]. By making use of all conditions, it is possible to characterize the optimal contracts through a set of lemmas.

Lemma 8. The contract

$$\left\{ q_b = 0, q_g = 0, R_b = R_g = \frac{r}{p_g + \lambda\left(p_b - p_g\right)} \right\}$$

is the unique solution to the simplified problem of the benevolent planner.

Proof: Consider (A7).

If $q_b > 0$, then:

$$\gamma = \frac{U'\left(\Pi - R_b - q_b\right)}{2}.$$

So, substituting into (A5), it follows that:

$$-p_b^2 U'\left(\Pi - R_b\right) + p_b^2 U'\left(\Pi - R_b - q_b\right) = 0.$$

Since, by strict concavity of *U* this is a contradiction, it must be the case that $q_b = 0.$ The same proof applies to q_g considering (A6) and (A8).

Now, from (A5) and (A6) it follows that:

$$\gamma = \frac{U'\left(\Pi - R_b\right)}{2},$$

and

$$\gamma = \frac{U'\left(\Pi - R_g\right)}{2}.$$

This implies that $R_b = R_g$. Moreover, $R_b = R_g = r / \left[p_g + \lambda\left(p_b - p_g\right)\right]$ from the zero profit condition.

The contract described in Lemma 8 also satisfies both participation constraints of the benevolent lender problem. So, Lemma 9 follows.

Lemma 9. In any optimal contract

$$\left\{ q_b = 0, q_g = 0, R_b = R_g = \frac{r}{p_g + \lambda\left(p_b - p_g\right)} \right\}.$$

10 All conditions are reported in the Appendix.

Proof: It follows from Lemma 8 and the fact that the contract

$$\left\{ q_b = 0, q_g = 0, R_b = R_g = \frac{r}{p_g + \lambda\left(p_b - p_g\right)} \right\}$$

also satisfies participation constraints.

Again, there is no room for co-signature. A benevolent lender willing to maximize aggregate surplus offers a pooling contract with zero co-signature. Mixed results of group lending programs in developing countries may be the consequence of the fact that they are not based on the economics of co-signature, rather they are implemented by benevolent institutions (development banks, donors,…) to rescue people from poverty.

3. GROUP LENDING CONTRACTS IN A COMPETITIVE BANK SECTOR

In this section, we characterize a separating equilibrium that arises from the implementation of group lending programs by competitive banks (Section 3.1); then we state the conditions under which such an equilibrium exists (Section 3.2).

3.1. Separating contract

Now, consider an economic environment identical to the one described in Section 2 except for the fact that the bank sector is perfectly competitive. In other words, assume that there is free entry in the bank sector.

This implies that each competitive bank has to choose $\left\{R_b, R_g, q_b, q_g\right\}$ to maximize the following objective function:

$$\lambda\left[2p_b^2 R_b + 2p_b\left(1 - p_b\right)\left(R_b + q_b\right) - 2r\right] +$$
$$+\left(1 - \lambda\right)\left[2p_g^2 R_g + 2p_g \times\right.$$
$$\left.\times\left(1 - p_g\right)\left(R_g + q_g\right) - 2r\right],$$

such that:

$$p_b^2 U(\Pi - R_b) + p_b(1-p_b) \times \times U(\Pi - R_b - q_b) \geq \bar{u}, \quad (8)$$

$$p_b^2 U(\Pi - R_b) + p_b(1-p_b) U(\Pi - R_b - q_b) \geq \geq p_b^2 U(\Pi - R_g) + p_b(1-p_b) U(\Pi - R_g - q_g), \quad (9)$$

$$p_g^2 U(\Pi - R_g) + p_g(1-p_g) U(\Pi - R_g - q_g) \geq \geq p_g^2 U(\Pi - R_b) + p_g(1-p_g) U(\Pi - R_b - q_b), \quad (10)$$

and:

$$R_b \geq 0, R_g \geq 0, q_b \geq 0, q_g \geq 0,$$

where R_b and R_g are the gross interest rates for bad and good firms. Constraints (8) is the participation constraint for bad firms[11] and constraints (9) and (10) are the incentive compatibility constraints.

Given the Lagrangian multiplier $\gamma \geq 0, \varphi \geq 0, \theta \geq 0$, it is possible to derive the first order conditions and the complementary slackness conditions[12]. By making use of all conditions, it is possible to characterize the separating equilibrium through a set of lemmas.

The first order conditions and the complementary slackness conditions coincide with those derived in the case of a monopolistic lender.

However, given free entry, two zero profit conditions have to be added in order to properly describe the equilibrium on a competitive credit market[13]. So, the following equalities must hold:

$$R_b = \frac{-p_b q_b + p_b^2 q_b + r}{p_b}, \quad (11)$$

and

$$R_g = \frac{-p_g q_g + p_g^2 q_g + r}{p_g}. \quad (12)$$

Lemmas 2, 3, and 4 apply to this case, too. So, competitive banks will set:

$$p_g^2 U(\Pi - R_g) + p_g(1-p_g) U(\Pi - R_g - q_g) = = p_g^2 U(\Pi - R_b) + p_g(1-p_g) U(\Pi - R_b - q_b).$$

Moreover, either constraint (8) or (9) (or both) are binding and $q_b = 0$. In other words, good firms must be indifferent between revealing their type truthfully (i.e., accepting contract $\{R_g, q_g\}$) and cheating (i.e., accepting contract $\{R_b, q_b\}$); also, in any equilibrium, whether pooling or separating, firms with bad projects never cosign each other's loans.

Lemma 10. In any contract $q_g > 0$.

Proof: Since

$$p_g^2 U(\Pi - R_g) + p_g(1-p_g) U(\Pi - R_g - q_g) = = p_g^2 U(\Pi - R_b) + p_g(1-p_g) U(\Pi - R_b - q_b).$$

From zero profit conditions (11) and (12), it follows that:

$$p_g^2 U\left(\Pi - \frac{r}{p_g} - p_g q_g + q_g\right) + + p_g(1-p_g) U\left(\Pi - \frac{r}{p_g} - p_g q_g\right) = = p_g^2 U\left(\Pi - \frac{r}{p_b} - p_b q_b + q_b\right) + + p_g(1-p_g) U\left(\Pi - \frac{r}{p_b} - p_b q_b\right).$$

Given that $p_g > p_b$ by assumption, it can never be the case that:

$$q_g = q_b = 0.$$

So, since $q_b = 0$ from Lemma 4, then $q_g > 0$.

11 The participation constraint for good firms can be ignored. The proof is the same as in Lemma 1.

12 All conditions are reported in the Appendix.

13 From a technical standpoint, the zero profit conditions imply no cross subsidization. Banks make zero profits on each type of a firm/borrower.

Lemma 10 states that good firms co-sign a fraction $q_g > 0$ of their loans. This implies that in a perfectly competitive credit market the optimal contract is a separating contract, where good firms co-sign and bad firms do not. This does not mean that this separating outcome is an equilibrium. As it was already said, the conditions under which a separating equilibrium exists will be stated in the next subsection (3.2).

Lemma 11. $\varphi = 0$. Hence, $\gamma > 0$.

Proof: Consider (S5) and suppose $\varphi > 0$.

Then, it must be the case that:

$$p_b^2 U(\Pi - R_b) + p_b(1-p_b)U(\Pi - R_b - q_b) = \\ = p_b^2 U(\Pi - R_g) + p_b(1-p_b)U(\Pi - R_g - q_g).$$

Now, since $\theta > 0$ by Lemma 2 and $q_b = 0$ by Lemma 4, it follows that:

$$p_b U(\Pi - R_g) + (1-p_b)U(\Pi - R_g - q_g) = \\ = p_g U(\Pi - R_g) + (1-p_g)U(\Pi - R_g - q_g).$$

This is a contradiction by Lemma 10.

Hence, $\gamma > 0$ by Lemma 3.

Lemma 11 states that bad firms get no more than their reservation utility. Given the preceding Lemmas, it is possible to characterize the separating contract. In particular, from the zero profit conditions it is possible to derive the interest rates that banks are charging to good firms and bad firms. In particular, bad firms do not co-sign and pay a higher interest rate; good firms co-sign a fraction q_g of each other's loans and pay a lower interest rate.

The equilibrium level of co-signature, q_g, makes good firms indifferent between their contract and the one offered to bad firms. Finally, competition among banks determines the cost of capital. Lemma 12 summarizes these results.

Lemma 12. In any separating contract $R_b = r/p_b > (r/p_g) + p_g q_g - q_g = R_g$, where q_g is such that:

$$p_g^2 U\left(\Pi - \frac{r}{p_g} - p_g q_g + q_g\right) + p_g(1-p_g)\times \\ \times U\left(\Pi - \frac{r}{p_g} - p_g q_g\right) = p_g^2 U\left(\Pi - \frac{r}{p_b}\right) + \\ + p_g(1-p_g)U\left(\Pi - \frac{r}{p_b}\right).$$

Moreover, r is such that $p_b U\left(\Pi - \frac{r}{p_b}\right) = \overline{u}$.

Proof: It follows from all previous Lemmas.

Hence, if there is free entry, the equilibrium, if it exists, is a separating equilibrium in which good firms co-sign and bad firms do not. It is worth noticing that the great difference between the competitive case and the benevolent lender case is in the lack of cross subsidization.

So, the interpretation of this result is the following: firms in group lending programs may exhibit higher repayment rates than other firms when they are better ex-ante, that is when group lending contracts are able to screen good firms from bad ones. We proved that this is the case when markets are competitive, that is when free entry prevents subsidization across types.

3.2. Existence of separating equilibrium

The separating contract described in Section 3.1 is not an equilibrium if a profitable deviation breaks it.

Now, define $\overline{R_g}$ as the interest rate that satisfies the following equality:

$$p_g^2 U\left(\Pi - \frac{r}{p_g} - p_g q_g + q_g\right) + p_g(1-p_g)\times \\ \times U\left(\Pi - \frac{r}{p_g} - p_g q_g\right) = p_g U\left(\Pi - \overline{R_g}\right),$$

where q_g is the level of co-signature defined by Lemma 12. This equality implies that a contract $\left\{\overline{R_g}, q_g = 0\right\}$ guarantees to good firms the same level of utility that they get in the separating contract defined by Lemma 12.

Hence, for the separating equilibrium to exist, it must be the case that:

$$\overline{R_g} < \frac{r}{\lambda\left(p_g - p_b\right) + p_g}.$$

In other words, $\overline{R_g}$ must be smaller than the zero profit pooling interest rate. If it is not the case, then there exists a profitable deviation. For example, an entrant bank could offer a pooling contract without co-signature and charge an interest rate between $\overline{R_g}$ and $r/(\lambda\left(p_g - p_b\right) + p_g)$. So, the entrant bank could attract all firms[14] and earn a profit greater than zero[15].

From the previous equality it is easy to see that:

$$\frac{r}{p_g} + p_g q_g - q_g < \overline{R_g} < \frac{r}{\lambda\left(p_g - p_b\right) + p_g}.$$

So, a necessary condition for a separating equilibrium to exist is that:

$$\frac{r}{p_g} + p_g q_g - q_g < \frac{r}{\lambda\left(p_g - p_b\right) + p_g}.$$

This condition implies that:

$$\lambda > \frac{p_g q_g - p_g^2 q_g}{\left(p_b - p_g\right)\left(\frac{r}{p_g} + p_g q_g - q_g\right)} < 0,$$

which is always true.

Obviously, a sufficient condition for a separating equilibrium to exist is:

$$\frac{r}{p_g} + p_g q_g < \frac{r}{\lambda\left(p_g - p_b\right) + p_g}.$$

This condition implies that:

$$\lambda > \frac{p_g q_g - p_g^2 q_g}{\left(p_b - p_g\right)\left(\frac{r}{p_g} + p_g q_g\right)}.$$

If the fraction of bad firms is not large enough, there might be a profitable deviation that breaks the separating equilibrium. Co-signature is too expensive for good firms if bad firms are too few.

However, if the separating equilibrium exists, then it is also a constrained Pareto optimal outcome. In this case, good firms are better off and bad firms are worse off with respect to the case in which co-signature is not allowed.

CONCLUSION

The main result of this paper is that partial joint liability, co-signature, is a screening device only if the bank sector is perfectly competitive. In other words, if there is free entry in the credit market, equilibrium, if it exists, is a separating equilibrium in which good firms co-sign and bad firms do not.

Three different economic environments were compared in the paper.

The first comparison is between a competitive credit market and a monopolistic one. This comparison is to suggest that group lending contracts may become more effective if credit markets evolve toward liberalization and competition.

The second, and most relevant, comparison is between a competitive credit market and a credit market run by a benevolent lender. Co-signature helps lenders to screen firms only if the credit market is competitive. Hence, mixed results of group lending programs in developing countries may be seen as a consequence of this result.

14 It will obviously attract all bad firms. It will also attract good firms because the interest rate they are charged is lower than the interest rate that makes them indifferent between a contract with cosignature and one without.

15 Profit is greater than zero because the interest rate is greater than $r/(\lambda\left(p_g - p_b\right) + p_g)$, that is the zero profit pooling interest rate.

In other words, if the market is run by a benevolent lender, co-signature is proven not to be able to screen good firms from bad ones. This implies that both types of firms may enter group lending programs, yielding mixed outcomes in terms of performance and repayment rates.

As a final remark, few words about enforcement of joint liability in case of default deserve to be said, in particular since our focus is on SME. The discussion about enforcement is beyond the scope of the paper. However, it is a relevant topic: examples of group lending programs dedicated to individuals confirm that together with co-signature other actions should be undertaken by lenders in order to make enforcement easier: oblige borrowers to deposit on checking accounts managed by lenders, oblige weekly reports of cash-flow dynamics, and so on. Probably, if co-signature has to be implemented as a screening device, similar actions should be designed for SME.

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APPENDIX

First order conditions for a monopolistic bank:

$$\lambda 2 p_b - (\gamma + \varphi)\left[p_b^2 U'(\Pi - R_b) + p_b (1 - p_b) U'(\Pi - R_b - q_b) \right] + \\ + \theta \left[p_g^2 U'(\Pi - R_b) + p_g (1 - p_g) U'(\Pi - R_b - q_b) \right] = 0 \qquad \text{(A1)}$$

$$(1 - \lambda) 2 p_g + \varphi \left[p_b^2 U'(\Pi - R_g) + p_b (1 - p_b) U'(\Pi - R_g - q_g) \right] - \\ - \theta \left[p_g^2 U'(\Pi - R_g) + p_g (1 - p_g) U'(\Pi - R_g - q_g) \right] = 0 \qquad \text{(A2)}$$

$$\lambda \left[2 p_b (1 - p_b) \right] - (\gamma + \varphi)\left[p_b (1 - p_b) U'(\Pi - R_b - q_b) \right] + \\ + \theta \left[p_g (1 - p_g) U'(\Pi - R_b - q_b) \right] \le 0 \qquad \text{(A3a)}$$

$$\lambda \left[2 p_b (1 - p_b) \right] - (\gamma + \varphi)\left[p_b (1 - p_b) U'(\Pi - R_b - q_b) \right] + \\ + \theta \left[p_g (1 - p_g) U'(\Pi - R_b - q_b) \right] = 0 \qquad \text{if } q_b > 0 \qquad \text{(A3b)}$$

$$(1 - \lambda)\left[2 p_g (1 - p_g) \right] + \varphi \left[p_b (1 - p_b) U'(\Pi - R_g - q_g) \right] - \\ - \theta \left[p_g (1 - p_g) U'(\Pi - R_g - q_g) \right] \le 0 \qquad \text{(A4a)}$$

$$(1 - \lambda)\left[2 p_g (1 - p_g) \right] + \varphi \left[p_b (1 - p_b) U'(\Pi - R_g - q_g) \right] - \\ - \theta \left[p_g (1 - p_g) U'(\Pi - R_g - q_g) \right] = 0 \qquad \text{if } q_g > 0 \qquad \text{(A4b)}$$

Complementary slackness conditions for a monopolistic bank:

$$\gamma \left[p_b^2 U(\Pi - R_b) + p_b (1 - p_b) U(\Pi - R_b - q_b) - \bar{u} \right] = 0 \qquad \text{(S1)}$$

$$\varphi \begin{bmatrix} p_b^2 U(\Pi - R_b) + p_b (1 - p_b) U(\Pi - R_b - q_b) - \\ - p_b^2 U(\Pi - R_g) - p_b (1 - p_b) U(\Pi - R_g - q_g) \end{bmatrix} = 0 \qquad \text{(S2)}$$

$$\theta \begin{bmatrix} p_g^2 U(\Pi - R_g) + p_g (1 - p_g) U(\Pi - R_g - q_g) - \\ - p_g^2 U(\Pi - R_b) - p_g (1 - p_g) U(\Pi - R_b - q_b) \end{bmatrix} = 0 \qquad \text{(S3)}$$

First order conditions for a benevolent lender:

$$-\left[p_b^2 U'(\Pi - R_b) + p_b (1 - p_b) U'(\Pi - R_b - q_b) \right] + \gamma \left[2 p_b^2 + 2 p_b (1 - p_b) \right] = 0 \qquad \text{(A5)}$$

$$-\left[p_g^2 U'(\Pi - R_g) + p_g (1 - p_g) U'(\Pi - R_g - q_g) \right] + \gamma \left[2 p_g^2 + 2 p_g (1 - p_g) \right] = 0 \qquad \text{(A6)}$$

$$- p_b (1 - p_b) U'(\Pi - R_b - q_b) + \gamma 2 p_b (1 - p_b) \le 0 \qquad \text{(A7a)}$$

$$-p_b\left(1-p_b\right)U'\left(\Pi-R_b-q_b\right)+\gamma 2p_b\left(1-p_b\right)=0 \quad \text{if } q_b>0 \tag{A7b}$$

$$-p_g\left(1-p_g\right)U'\left(\Pi-R_g-q_g\right)+\gamma 2p_g\left(1-p_g\right)\le 0 \tag{A8a}$$

$$-p_g\left(1-p_g\right)U'\left(\Pi-R_g-q_g\right)+\gamma 2p_g\left(1-p_g\right)=0 \quad \text{if } q_g>0 \tag{A8b}$$

First order conditions for a competitive bank:

$$\begin{aligned}&\lambda 2p_b-\left(\gamma+\varphi\right)\left[p_b^2U'\left(\Pi-R_b\right)+p_b\left(1-p_b\right)U'\left(\Pi-R_b-q_b\right)\right]+\\&+\theta\left[p_g^2U'\left(\Pi-R_b\right)+p_g\left(1-p_g\right)U'\left(\Pi-R_b-q_b\right)\right]=0\end{aligned} \tag{A9}$$

$$\begin{aligned}&\left(1-\lambda\right)2p_g+\varphi\left[p_b^2U'\left(\Pi-R_g\right)+p_b\left(1-p_b\right)U'\left(\Pi-R_g-q_g\right)\right]-\\&-\theta\left[p_g^2U'\left(\Pi-R_g\right)+p_g\left(1-p_g\right)U'\left(\Pi-R_g-q_g\right)\right]=0\end{aligned} \tag{A10}$$

$$\begin{aligned}&\lambda\left[2p_b\left(1-p_b\right)\right]-\left(\gamma+\varphi\right)\left[p_b\left(1-p_b\right)U'\left(\Pi-R_b-q_b\right)\right]+\\&+\theta\left[p_g\left(1-p_g\right)U'\left(\Pi-R_b-q_b\right)\right]\le 0\end{aligned} \tag{A11}$$

$$\begin{aligned}&\lambda\left[2p_b\left(1-p_b\right)\right]-\left(\gamma+\varphi\right)\left[p_b\left(1-p_b\right)U'\left(\Pi-R_b-q_b\right)\right]+\\&+\theta\left[p_g\left(1-p_g\right)U'\left(\Pi-R_b-q_b\right)\right]=0\end{aligned} \quad \text{if } q_b>0 \tag{A11b}$$

$$\begin{aligned}&\left(1-\lambda\right)\left[2p_g\left(1-p_g\right)\right]+\varphi\left[p_b\left(1-p_b\right)U'\left(\Pi-R_g-q_g\right)\right]-\\&-\theta\left[p_g\left(1-p_g\right)U'\left(\Pi-R_g-q_g\right)\right]\le 0\end{aligned} \tag{A12a}$$

$$\begin{aligned}&\left(1-\lambda\right)\left[2p_g\left(1-p_g\right)\right]+\varphi\left[p_b\left(1-p_b\right)U'\left(\Pi-R_g-q_g\right)\right]-\\&-\theta\left[p_g\left(1-p_g\right)U'\left(\Pi-R_g-q_g\right)\right]=0\end{aligned} \quad \text{if } q_g>0 \tag{A12b}$$

Complementary slackness conditions for a competitive bank:

$$\gamma\left[p_b^2U\left(\Pi-R_b\right)+p_b\left(1-p_b\right)U\left(\Pi-R_b-q_b\right)-\bar{u}\right]=0 \tag{S4}$$

$$\varphi\begin{bmatrix}p_b^2U\left(\Pi-R_b\right)+p_b\left(1-p_b\right)U\left(\Pi-R_b-q_b\right)-\\-p_b^2U\left(\Pi-R_g\right)-p_b\left(1-p_b\right)U\left(\Pi-R_g-q_g\right)\end{bmatrix}=0 \tag{S5}$$

$$\theta\begin{bmatrix}p_g^2U\left(\Pi-R_g\right)+p_g\left(1-p_g\right)U\left(\Pi-R_g-q_g\right)-\\-p_g^2U\left(\Pi-R_b\right)-p_g\left(1-p_g\right)U\left(\Pi-R_b-q_b\right)\end{bmatrix}=0 \tag{S6}$$