Moral Hazard, Collusion and Group Lending

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Abstract

While group lending has attracted a lot of attention, the impact of collusion on the performance of group lending contracts has remained unclear, particularly in moral hazard environments. This paper uses a simple model, with risk-neutral agents and limited liability, to clarify this issue and distinguish entrepreneurs' information sharing from collusion. Lending efficiency is enhanced when entrepreneurs mutually observe their efforts but reduced when they can collude: lenders thus do not benefit from collusion; rather, information-sharing among the entrepreneurs improves lending *even if the entrepreneurs collude* – but lenders can do even better and actually achieve the first best if the entrepreneurs observe each other's efforts and do not collude.

When entrepreneurs observe each other's efforts and collude perfectly simple group lending contracts, based only on realized outputs, are optimal and outperform individual contracts. More sophisticated contracts which use revelation mechanisms to elicit effort levels are thus not useful. This result remains true when agents have only noisy signals of each other's efforts; however, the effectiveness of group lending contracts increases with the informativeness of the signals. Finally, group lending contracts can help provide monitoring incentives when monitoring the other entrepreneur's effort entails a cost, but become ineffective when the cost of monitoring is too high, so that the bank must resort to individual contracts.

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1 Introduction

The development of group lending through the Grameen Bank and similar institutions has attracted the interest of all those who believe that lending to the poor is a useful step to exit the vicious circle of underdevelopment. The empirical evaluation of the success of these new ways of lending to entrepreneurs who have no collateral is still subject to debate (see Khandker, Khalily and Kham (1995), Morduch (1997), Pitt and Khandker (1996)).

Theorists have proposed various explanations for the new opportunities provided by group lending.[3] They can help solve adverse selection problems,[4] monitor repayments to avoid strategic default,[5] or solve moral hazard problems.[6]

Various difficulties encountered by group lending have been pointed out in the literature. These mechanisms often impose various costs such as attending weekly group meetings (Morduch (1997)), may increase default probabilities for the entire group when some members run into difficulties (Besley and Coate (1995)), may induce excessively prudent behavior (Banerjee, Besley and Guinnane (1992)), may be less flexible than individual lending in growing businesses (Madajewicz (1996), Woolcock (1996)).

The impact of collusion on the performance of group lending, however, remains unclear. When adverse selection is the issue, N'Guessan and Laffont (2000) and Laffont (2003) show that group lending is often an efficient way to deal with collusion threats and even that group lending is really justified by such collusion threats. In the moral hazard literature, the dominant theme is instead that, when agents collude, mutual observation of each other's efforts improves welfare (Stiglitz (1990), Varian (1990), Itoh (1993)).[7]

This paper reconsiders the issue of collusion in moral hazard models with several (actually two) agents (entrepreneurs). Section 2 presents the basic model, with risk-neutral entrepreneurs that have limited liability, and studies the performance of individual contracts. Section 3 uses this model to review in a simple way the main results of the literature of group lending with moral hazard. We first note that group lending contracts are not effective when entrepreneurs do not observe each other's effort levels. And when entrepreneurs do observe each other's effort, "simple" group lending contracts (i.e., without

[3] See Ghatak and Guinnane (1999) for a survey.

[4] See Ghatak (1997), Armendariz de Aghion and Gollier (1998), Laffont and N'Guessan (2000), Laffont (1999).

[5] See Besley and Coate (1995), Besley and Jain (1994), Armendariz de Aghion (1999), Rai and Sjöström (2000).

[6] Stiglitz (1990), Varian (1990), Itoh (1991), (1993), Conning (1997).

[7] This literature appears as a special case of a more general literature on moral hazard within a principal-agents framework where agents observe each other's efforts (Itoh (1993), Holmström and Milgrom (1990) and Baliga and Sjöström (1998)).

any communication or revelation mechanisms) are dominated by revelation mechanisms, which achieve the first-best, when entrepreneurs do not collude. However, when instead entrepreneurs collude perfectly, a simple group lending contract is optimal. Section 4 shows that the fact that communication and revelation mechanisms are not useful when agents collude is quite robust: this result remains valid when collusion takes the form of side-contracting with an informed or uninformed third party, when entrepreneurs do not perfectly oberve each other's efforts, and when monitoring the other entrepreneur is moderately costly. Section 5 concludes.

2 Individual contracts

An entrepreneur wishes to carry out a project that costs 1 and generates an output $z > 0$ in case of success and 0 otherwise. The probability of success depends on whether the entrepreneur provides effort: providing effort generates a private cost c for the entrepreneur but increases the probability of success from $\underline{p} > 0$ to $\bar{p} > \underline{p}$.

The entrepreneur has no wealth; he must borrow to invest and can only repay his loan if he succeeds. Denoting by x the entrepreneur's share of output, his expected utility is[8]

$$\begin{array}{rl} \bar{p}x - c & \text{if he exerts effort} \\ \underline{p}x & \text{if he exerts no effort.} \end{array}$$

Funds are supplied by a profit-maximizing monopolistic bank which has a cost of funds r. For simplicity we assume that investment is socially valuable only if the entrepreneur exerts effort:

$$\bar{p}z - c > r > \underline{p}z. \tag{2.1}$$

It follows that the bank seeks to induce effort (or does not lend); it must therefore solve:

$$\begin{array}{lll} \max\limits_{x \geq 0} & \bar{p}\,(z - x) - r & \\ & \bar{p}x - c \geq \underline{p}x, & (IC) \\ & \bar{p}x - c \geq 0. & (PC) \end{array}$$

The incentive constraint (IC) asserts that the entrepreneur prefers to exert effort rather than not, while the participation constraint (PC) asserts that the entrepreneur's expected utility is higher than his outside opportunity utility level, normalized to 0.

Since the entrepreneur has no wealth ($x \geq 0$), the entrepreneur can only be rewarded and not be punished; the incentive constraint (IC) is therefore more stringent than the

[8] The lender could make an additional transfer to the entrepreneur when the project fails, but this would reduce the entrepreneur's incentives and is never optimal; for the sake of presentation, and without loss of generality, we will ignore this possibility.

participation constraint and is obviously binding:

$$x = x^* \equiv \frac{c}{\bar{p} - \underline{p}}. \tag{2.2}$$

To induce effort the bank must therefore give up an expected rent

$$R^* = \frac{\bar{p}c}{\bar{p} - \underline{p}} - c = \frac{\underline{p}c}{\bar{p} - \underline{p}}. \tag{2.3}$$

It follows that the bank grants a loan less often than socially desirable: granting a loan requires the value of the investment $\bar{p}z$ to be strictly larger than the social cost $c + r$, in order to cover the rent R^* that must be left to the entrepreneur for incentive reasons. Thus, whenever $R^* > \bar{p}z - (c + r)\,(> 0)$, socially valuable projects do not get financed.[9] Decreasing the minimal rent to be left to the entrepreneurs would thus make efficient lending more likely. We now explore how group lending can indeed decrease this minimal rent and therefore improve the efficiency of lending.

3 Group lending

We now suppose that two entrepreneurs can each carry a project with the same characteristics as above; we show in this context that group contracting can improve the efficiency of lending.

3.1 Private information

Suppose first that the entrepreneurs do not observe each other's efforts. Consider then a group lending contract (x_i, y_i) which specifies for entrepreneur i a payment x_i if his partner j succeeds, and a payment y_i if instead his partner fails.

To induce a Nash equilibrium where each entrepreneur exerts effort, the contract must satisfy the incentive constraint:

$$\bar{p}X_i - c \geq \underline{p}X_i. \tag{3.4}$$

where $X_i \equiv [\bar{p}x_i + (1 - \bar{p})\, y_i]$ denotes the expected payment to entrepreneur i in case of success. Since this incentive constraint has the same form as (IC), the expected payment (and thus the expected rent left to each entrepreneur) must be as large as with individual contracts. Therefore, *group lending does not perform better than individual loan contracts when entrepreneurs do not observe each other's efforts.*[10]

[9] This would be the case even if the banking sector were perfectly competitive: because of incentive problems, the "pledgeable income" $\bar{p}z - R^*$ does not allow lenders in that case to recoup the investment cost $c + r$.

[10] This result parallels theorem 1 in Itoh (1993) and Varian (1990).

3.2 Shared information

So, group lending can be effective only if it relies on more information among entrepreneurs. Let us therefore consider the other polar case, where the two entrepreneurs observe perfectly each other's effort levels. This additional information does not, in itself, affect the Nash behavior of the entrepreneurs – in the absence of communication with the bank, the above individual contracts would remain optimal. However, the bank may now try to obtain this shared information through revelation mechanisms. We first stress that these mechanisms would be indeed quite effective *in the absence of collusion* among entrepreneurs, but note that collusion limits their effectiveness.

Proposition 1 *When entrepreneurs observe each other's effort levels and behave non-cooperatively, the bank can achieve the complete information optimum.*

Proof. Consider the following mechanism, inspired from Nash subgame perfect implementation (Moore and Repullo (1988), Ma (1988)), to be played after the efforts have been undertaken, but before output is realized:

- Entrepreneur 2 is asked to reveal whether entrepreneur 1 provided effort
  - If entrepreneur 2 reports that entrepreneur 1 exerted effort, entrepreneur 1 gets c and entrepreneur 1 gets 0;
  - If entrepreneur 2 claims 1 did not exert effort, entrepreneur 1 gets 0 while entrepreneur 2 receives b, but must pay a penalty a if entrepreneur 1 succeeds.
- A similar revelation game is then played for entrepreneur 2's effort.

Choosing a and b such that $\underline{p}a < b < \bar{p}a$,[11] entrepreneur 2 truthfully reports entrepreneur 1's effort. Anticipating this, entrepreneur 1 is willing to exert effort. The same applies to entrepreneur 2's effort. ■

Thus, in the absence of collusion, a revelation mechanism allows the bank to achieve the first-best, without any group lending feature. As we show below, it is only the threat of collusion that makes group lending relevant.[12]

[11] Imposing a penalty may conflict with wealth constraints. However, both a and b can be chosen arbitrarily small. Furthermore, these penalties are expected ones, so that there is no conflict with ex post limited liability constraints: a can be implemented as a small penalty imposed on entrepreneur 2 when he succeeds.

[12] See Laffont (2003) for the same insight in adverse selection environments with correlated types.

3.3 Shared information and collusion

The revelation mechanisms used to extract the entrepreneurs' information are however generally not robust to collusion. Suppose for example that the entrepreneurs can perfectly collude and maximize the total sum of their utilities (we show in the next section that they can easily achieve this if they can side-contract with an even uninformed third party).

Note first that the contract used in the proof of Proposition 1 is obviously no longer operative when entrepreneurs can costlessly collude in this way, since they would then agree not to provide effort and claim that they did. Now, suppose that the bank offers contracts that eventually lead both entrepreneurs to exert effort, and denote by x the resulting expected payment (per entrepreneur) when both projects succeed, and by y the expected payment (per entrepreneur) when only one project succeeds. On average, each entrepreneur thus gets

$$\bar{u} \equiv \bar{p}^2 x + \bar{p}\left(1-\bar{p}\right) y - c.$$

One possible alternative for the entrepreneurs is to exert no effort and stick to the same messages as before. On average, each entrepreneur would thus get

$$\hat{u} \equiv \underline{p}^2 x + \underline{p}\left(1-\underline{p}\right) y.$$

For the entrepreneurs to exert effort, it must therefore be the case that $u^* \geq \hat{u}$. Maximizing the bank's expected profit (per entrepreneur)

$$\bar{p}^2\left(z-x\right) + \bar{p}\left(1-\bar{p}\right)\left(z-y\right) - r$$

subject to the necessary condition $u^* \geq \hat{u}$ and $x, y \geq 0$ would yield

$$x = x^{**} \equiv \frac{c}{\bar{p}^2 - \underline{p}^2}, \tag{3.5}$$

$$y = 0, \tag{3.6}$$

leaving each entrepreneur with a rent

$$R^{**} \equiv \bar{p}^2 \frac{c}{\bar{p}^2 - \underline{p}^2} - c = \frac{\underline{p}^2 c}{\bar{p}^2 - \underline{p}^2},$$

which is positive, although smaller than the rent $R^* = \frac{\underline{p}c}{\bar{p}-\underline{p}}$ needed to induce high levels of effort with individual loan contracts.[13]

It turns out that a simple group lending contract can precisely achieve this result. Specifically, consider the following contract:

[13]
$$\frac{\underline{p}^2 c}{\bar{p}^2 - \underline{p}^2} = \frac{\underline{p}}{\bar{p}+\underline{p}} \frac{\underline{p}c}{\bar{p}-\underline{p}} < \frac{\underline{p}c}{\bar{p}-\underline{p}}.$$

- each entrepreneur gets a payment x^{**} if both projects succeed and nothing otherwise, and
- no communication is required.

By construction, this contract satisfies the entrepreneurs' participation constraint and the entrepreneurs jointly prefer the situation where they both provide effort to the situation where none of them provides any effort. Last, if only one of them provides effort, on average each entrepreneur gets

$$\bar{p}\underline{p}x - \frac{c}{2},$$

which is less attractive than what they get by both providing effort.[14] Hence, it is in the entrepreneurs' joint interest to accept the contract and provide effort. We thus have:

Proposition 2 *When entrepreneurs observe each other's effort levels and can perfectly collude, a simple group lending contract (in which the entrepreneurs receive a payment only when both projects succeed, and there is no communication) is optimal.*

This proposition parallels theorem 5 in Itoh (1993). Note also that collusion does not affect the entrepreneurs' behavior when the bank only offers individual contracts.[15] Therefore, the proposition implies that simple group lending contracts improve on individual loan contracts:

Corollary 3 *When entrepreneurs observe each other's effort levels and can perfectly collude, group lending is more profitable for the bank and more efficient than individual lending.*

The better performance of group lending contracts comes from the fact that rewarding the entrepreneur's success with "shares" in the other entrepreneur's project generates additional incentives to exert effort when the two entrepreneurs coordinate their decisions.[16] When $R^* < \bar{p}z - (c + r)$, group lending allows the bank to reduce the rent left to the

[14] Indeed,

$$\bar{p}\underline{p}x^{**} - \frac{c}{2} < \bar{p}^2 x^{**} - c \Leftrightarrow \frac{c}{2} < \bar{p}\left(\underline{p} - \bar{p}\right)x^{**} = \frac{\bar{p}c}{\bar{p} + \underline{p}},$$

which is trivially satisfied since $\bar{p} > \bar{p}$.

[15] This observation relies however on the risk-neutrality assumption. If entrepreneurs were risk-averse, even with individual loan contracts they would have an incentive to share risks through side-contracting, which in turn would affect their incentives to exert effort.

[16] This better performance of group lending contracts is reminiscent of the "diversification" benefits already emphasized by Diamond (1984) in an audit framework: in the moral hazard framework considered here, as in Diamond's context, it is indeed easier to finance an entrepreneur who has two independent projects, than two independent entrepreneurs with one project each.

entrepreneurs; if instead $R^{**} < \bar{p}z - (c + r) < R^*$, then group lending allows the bank to finance projects which could not be financed with individual loan contracts.[17]

4 Robustness

The result obtained so far is that, when the entrepreneurs observe each other's and collude perfectly (i.e., can behave as a single entity), the optimal contract is a simple group lending contract that does not require any revelation mechanism or communication between the bank and the entrepreneurs. In Section 4.1, we show that even if side-contracting by the entrepreneurs is limited by their wealth constraints, collusion can still be perfect if they can side-contract with a benevolent (even uniformed) third party.

In Section 4.2, we extend our result to the case where each entrepreneur observes only a noisy signal of the other entrepreneur's effort. Again, the optimal contract does not require any exchange of messages.[18]

In Section 4.3, we introduce costly monitoring of efforts and show that group lending contracts remain optimal if these costs are not too high; otherwise, mutual observation breaks down and individual contracts are the only option.

4.1 Modeling of collusion

We have assumed so far that the entrepreneurs could perfectly collude and maximize their joint surplus. Two difficulties may arise, however. First, limited liability imposes restrictions on side-transfers. Second, if they want to rely on a third party to enforce their side-contracts, they need to convey the information about their efforts to that third party. We now show that the entrepreneurs can indeed overcome these difficulties. By redistributing between them the payments they receive from the bank, the entrepreneurs can indeed share their joint surplus in any way they want; and through simple revelation mechanisms à la Ma or Moore, the entrepreneurs can report truthfully to a third party their mutual observation of efforts despite the constraints imposed by their limited wealth.

To explore the scope for collusion in more detail, we consider the following framework:

- first, the bank offers contracts; these contracts can stipulate (possibly sequential) reports on each other's effort levels, once efforts have been chosen and before outcomes

[17] As noted above, group lending would improve lending efficiency in that case even if the banking sector were competitive

[18] The Baliga-Sjöström (1998) model where only one agent observes the effort of the other is a special case with the slight difference that agents choose their effort levels sequentially. They show that the optimal contract never requires communication.

are realized – and the sharing rules can be made contingent on those reports.

- second, the entrepreneurs sign a side-contract with a third party; this contract can also stipulate reports on the efforts and provide for payments (transfers from one entrepreneur to the other, or to the third party), based on these reports as well as on the reports to the bank;[19]
- third, the entrepreneurs choose their levels of effort;
- fourth, entrepreneurs play the revelation game generated by the contract signed with the bank;
- fifth, the entrepreneurs play the revelation game generated by the side contract;
- finally, outcomes are realized and payments are made; payments stipulated by the contract with the bank have senior priority over those stipulated by the side-contract.

We have:

Proposition 4 *Side-contracting with an informed third party (who observes the effort levels) or with an uninformed third party allows the entrepeneurs to maximize their joint utility and to share it in any individually rational way.*

Proof. Fix the contracts offered by the bank and let

- $(\bar{u}_1, \bar{u}_2)$ denote the expected levels of utility that the entrepreneurs would get in the absence of a side-contract if they behave non-cooperatively in stages 3 and 4, and
- u^* denote the maximal sum of expected utilities that the entrepreneurs could get in the absence of a side-contract, by coordinating their strategies in stages 3 and 4.

We now show that, for any $(\hat{u}_1, \hat{u}_2)$ satisfying $\hat{u}_1 + \hat{u}_2 = u^*$ and $\hat{u}_i \geq \bar{u}_i$, $i = 1, 2$, there exists a side-contract that induces the entrepreneurs to behave (non-cooperatively) in stages 3 and 4 so as to get exactly the expected levels of utility $\hat{u}_1$ and $\hat{u}_2$. We focus on the case of an uninformed third party – side-contracts can only be even more effective when the third party, too, observes the entrepreneurs' efforts.

[19] We thus assume for simplicity that reports to the bank are public; we believe that the analysis could further be extended to the case where the two entrepreneurs, but not the third party, observe any message to the bank – the side-contract should then simply induce the entrepreneurs to report these messages as well to the third party.

By construction, $u^* \geq \bar{u}_1 + \bar{u}_2$ (the entrepreneurs can always mimic the non-cooperative equilibrium) and $\bar{u}_i \geq 0$ (having no wealth, each entrepreneur can secure at least 0 by not providing effort). Therefore, by first transferring all payments from the bank to the third party and then redistributing these payments between them, the entrepreneurs can indeed achieve any individually rational sharing of the "pie" u^*. Now, let (σ_1^*, σ_2^*) denote the (coordinated) strategies used in stages 3 and 4 (including the private effort decisions (e_1^*, e_2^*) and all public messages (m_1^*, m_2^*) effectively sent to the bank) that would generate u^* in the absence of a side contract, and (u_1^*, u_2^*) denote the corresponding expected levels of utility.

Consider the following side-contract. First, all payments go to the third party, who then distributes them as follows. If the messages sent to bank differ from (m_1^*, m_2^*), the entrepreneurs get nothing. In addition:

- Stage 1:
  - Entrepreneur 2 is asked to report entrepreneur 1's effort level to the third party;
  - If entrepreneur 2 reports that 1 provided the appropriate effort e_1^*, 2 gets nothing at that stage while 1 gets payments so as to obtain utility $\hat{u}_1$;
  - Otherwise, entrepreneur 1 gets nothing but while entrepreneur 2 receives an amount a but pays b if entrepreneur 1 succeeds, where the lottery (a, b) is chosen so that entrepreneur 2 prefers reporting the true effort level rather than facing the lottery.[20]
- Stage 2 is similarly designed to elicit entrepreneur 1's effort level.

This side-contract clearly induces the entrepreneurs to send the required messages (m_1^*, m_2^*) and ensures that each entrepreneur truthfully reports the other entrepreneur's effort; anticipating this, each entrepreneur i chooses the appropriate effort e_i^*.

The only problem might be to implement the payments a and b when needed, because of the entrepreneurs' wealth constraints. However, both a and b can be chosen arbitrarily small and they only need to be made in expected terms. Hence, whenever there are gains from collusion (i.e., $u^* \geq \bar{u}_1 + \bar{u}_2$) and those gains are shared (even very asymmetrically), both entrepreneurs should be in position to pay an arbitrarily small penalty (since then $\hat{u}_i > \bar{u}_i \geq 0$). ■

[20] If for example entrepreneur 1 is supposed to exert effort, than a and b should be chosen so that $\bar{p}b > a > \underline{p}b$. Then, if 1 indeed exerts effort, 2 prefers to report the truth (and get 0) rather than lying and facing the lottery (which would give him $a - \bar{p}b < 0$); and if instead 2 does not exert effort, 2 prefers again reporting the truth (and get $a - \underline{p}b > 0$) rather than pretending 1 exerted effort. Inverting the sign of the payments (or reverting the roles of the fixed payment a and the contingent payment b) would again induce truthtelling when entrepreneur 1 is supposed not to exert effort.

4.2 Noisy observation of effort levels

We have shown so far that there is no scope for revelation mechanisms when entrepreneurs observe perfectly each other's efforts but collude. We show in this section that this insight generalizes to situations where entrepreneurs imperfectly observe the other's effort. While this imperfect observation reduces the efficiency of incentive mechanisms, it is still the case that the optimal mechanism does not need to require the entrepreneurs to report any information they may have about realized efforts.

To fix ideas, suppose that entrepreneur j does not observe entrepreneur i's effort level itself, but only a signal σ_i, which can take two values, $\bar{\sigma}$ or $\underline{\sigma}$. The signal is informative in the sense that a higher effort increases from $\underline{\zeta}$ to $\overline{\zeta}$ the probability of receiving a "high" signal $\bar{\sigma}$.

No collusion. Suppose first that the entrepreneurs cannot collude. In the absence of any collusion, it is straightforward to elicit any entrepreneur's information about the other's effort: on the one hand, the received signal is payoff irrelevant for the entrepreneur, who is thus willing to report it as long as it does not impact his own remuneration; and on the other hand, if the signal were publicly available the optimal contract would not make one entrepreneur's payment contingent on the signal relative to the other entrepreneur's effort. Hence, the contract that would be optimal if the signals were public is readily implementable when these signals are privately observed by the entrepreneurs.

Without loss of generality, we can furthermore restrict attention to contracts where each entrepreneur gets a positive share of his output, x, if and only the project is successful *and* the other entrepreneur reports a high signal:

Proposition 5 *The optimal contract consists in asking each entrepreneur to report his signal about the other's effort and to leave a positive share of output only if the reported signal is high.*

Proof. We first characterize the optimal contract assuming that signals are publicly available and then show that this contract can easily be implemented, as noted above. For notational purpose, let "1" refer to "success" or "high signal" and "0" to "failure" or "low signal." The most general contract specifies for each entrepreneur[21] a payment which can depend on the signal about his effort, on the entrepreneur's success and on the other entrepreneur's success. However, since the expected utility of an entrepreneur is independent of the other entrepreneur's effort, we can simply index the payments to the entrepreneurs, x_{ij}, on the signal about his effort ($i = 0$ or 1) and on his success ($j = 0$ or 1). To induce a

[21] While in principle contracts could be individualized, the analysis below shows that the optimal contract is symmetric (or "anonymous").

Nash equilibrium of high effort levels, the contract must satisfy the incentive constraint:

$$\overline{p}\left[\overline{\zeta}x_{11}+\left(1-\overline{\zeta}\right)x_{01}\right]+\left(1-\overline{p}\right)\left[\overline{\zeta}x_{10}+\left(1-\overline{\zeta}\right)x_{00}\right]-c \\ \geq \underline{p}\left[\underline{\zeta}x_{11}+\left(1-\underline{\zeta}\right)x_{01}\right]+\left(1-\underline{p}\right)\left[\underline{\zeta}x_{10}+\left(1-\underline{\zeta}\right)x_{00}\right],$$

or

$$\left(\overline{p}\overline{\zeta}-\underline{p\zeta}\right)x_{11}+\left[\overline{p}\left(1-\overline{\zeta}\right)-\underline{p}\left(1-\underline{\zeta}\right)\right]x_{01} \\ +\left[\left(1-\overline{p}\right)\overline{\zeta}-\left(1-\underline{p}\right)\underline{\zeta}\right]x_{10}+\left[\left(1-\overline{p}\right)\left(1-\overline{\zeta}\right)-\left(1-\underline{p}\right)\left(1-\underline{\zeta}\right)\right]x_{00}\geq c,$$

The last coefficient is negative, since project failure and low signal are both "indicative" of low effort. Hence, since the bank seeks to minimize the payments to the entrepreneurs, $x_{00}=0$. Next, consider a transfer from x_{10} to x_{11}. To maintain incentive compatibility, a reduction in x_{10} of ε must be compensated by an increase in x_{11} of

$$\frac{\left(1-\overline{p}\right)\overline{\zeta}-\left(1-\underline{p}\right)\underline{\zeta}}{\overline{p}\overline{\zeta}-\underline{p\zeta}}\varepsilon;$$

the impact on the expected payment to the entrepreneur is then

$$\overline{p}\overline{\zeta}\frac{\left(1-\overline{p}\right)\overline{\zeta}-\left(1-\underline{p}\right)\underline{\zeta}}{\overline{p}\overline{\zeta}-\underline{p\zeta}}\varepsilon-\left(1-\overline{p}\right)\overline{\zeta}\varepsilon=\left[\frac{1-\frac{1-\underline{p}}{1-\overline{p}}\frac{\underline{\zeta}}{\overline{\zeta}}}{1-\frac{\underline{p\zeta}}{\overline{p}\overline{\zeta}}}\right]\left(1-\overline{p}\right)\overline{\zeta}\varepsilon<0,$$

where the inequality stems from $\overline{p}>\underline{p}$.

So it is possible to decrease the rent of the entrepreneur while still maintaining incentive compatibility (and therefore participation). Then the bank gains by setting x_{10} to 0. And similarly for x_{01}. Hence it is optimal for the bank to leave a positive share of output to the entrepreneur only when his project is successful and the signal about his effort is high. ■

The optimal contract for the bank leaves a share x to the entrepreneur that is just sufficient to maintain the incentive to exert effort:

$$\left(\overline{p}\overline{\zeta}-\underline{p\zeta}\right)x_{11}\geq c,$$

or

$$x_{11}=\hat{x}=\frac{c}{\overline{p}\overline{\zeta}-\underline{p\zeta}}.$$

The entrepreneur's expected rent is given by

$$\hat{R}=\overline{p}\overline{\zeta}\frac{c}{\overline{p}\overline{\zeta}-\underline{p\zeta}}-c=\frac{\underline{p\zeta}c}{\overline{p}\overline{\zeta}-\underline{p\zeta}}=\frac{c}{\frac{\overline{p}\overline{\zeta}}{\underline{p\zeta}}-1};$$

this rent is positive but lower than in the absence of any signal, and it decreases as the signal becomes more informative (that is, as $\overline{\zeta}/\underline{\zeta}$ increases).

Collusion. If the entrepreneurs can collude, they will always coordinate the reports they send to the bank so as to maximize their joint utility – whatever the signal they receive about the other's effort, since the realized signal has not impact on their utilities.[22] Hence, the bank has no hope to receive any useful information about realized signals. Note that the argument applies as well to the case where both entrepreneurs observe the realized signals as to the case where signal σ_i is only observed by entrepreneur j.

Colluding on effort levels is now more difficult, however. In particular, if the entrepreneurs rely on a third party to enforce side-contracts, this third party must construct an incentive scheme that induces the entrepreneurs to choose their jointly best levels of effort; this, in turn, requires the entrepreneurs to communicate the signals they receive. We can show that this communication is easy to implement; as a result, the entrepreneurs can indeed coordinate their effort levels, provided however that each entrepreneur gets a minimal rent. To see this in more detail, consider the following framework:

- first, the bank offers contracts, which can rely on (possibly sequential) reports on realized signals, before outcomes are realized.
- second, the entrepreneurs sign a side-contract with a third party; this contract can also stipulate reports on signals and provide for payments (transfers from one entrepreneur to the other, or to the third party), based on these reports as well as on the reports to the bank;
- third, the entrepreneurs choose their levels of effort;
- fourth, each entrepreneur observes a signal about the other entrepreneur's efforts;[23]
- fifth, entrepreneurs play the revelation game generated by the contract signed with the bank;
- sixth, the entrepreneurs play the revelation game generated by the side contract;
- finally, outcomes are realized and payments are made; payments stipulated by the contract with the bank have senior priority over those stipulated by the side-contract.

We have:

[22] In particular the signals do not affect the entrepreneurs' *beliefs* about each other's efforts and therefore do not affect either their perceived probability of success.

[23] As already noted, whether each signal is observed by one or both entrepreneurs does not affect the analysis.

Proposition 6 *Side-contracting with an informed third party (who observes the signals about the effort levels) or with an uninformed third party allows the entrepeneurs to maximize their joint utility and to share it in any individually rational way that gives a rent at least equal to $\hat{R}$ to each entrepreneur who must exert effort.*

Proof. Fix the contracts offered by the bank to induce effort and let

- $(\bar{u}_1, \bar{u}_2)$ denote the expected levels of utility that the entrepreneurs would get in the absence of a side-contract if they behave non-cooperatively in stages 3 and 5, and
- u^* denote the maximal sum of expected utilities that the entrepreneurs could get by coordinating their strategies in stages 3 and 5 and, for each entrepreneur, let $\hat{R}_i = \hat{R}$ if the entrepreneur must exert effort to achieve u^* and $\hat{R}_i = 0$ otherwise.

We now show that, for any $(\hat{u}_1, \hat{u}_2)$ satisfying $\hat{u}_1 + \hat{u}_2 = u^*$ and $\hat{u}_i \geq \max\left\{\bar{u}_i, \hat{R}_i\right\}$, $i = 1, 2$, there exists a side-contract that induces the entrepreneurs to behave (non-cooperatively) in stages 3 and 4 so as to get exactly the expected levels of utility $\hat{u}_1$ and $\hat{u}_2$.

Denote by (e_1^*, e_2^*) the efforts and by (m_1^*, m_2^*) the messages required to achieve u^* and consider the following type of side contract. Any payment from the bank to any entrepreneur is transferred to the third party, who then redistributes them as follows;

- the third party keeps all payments for itself if the messages sent by the entrepreneurs do not coincide with (m_1^*, m_2^*), otherwise:
- if entrepreneur i is supposed not to exert effort, the third party simply gives entrepreneur i a fixed payment w_i
- otherwise, the third party asks entrepreneur j to report the signal he observed about entrepreneur i's effort and then makes to entrepreneur i a payment of the form $w_i + \hat{x}_{ij}$, where
  - w_i is constant, and
  - $\hat{x}_{ij}$ is either 0 (if entrepreneur i is supposed not to exert effort) or the payments of the optimal incentive scheme for public signals (that is, if entrepreneur i is supposed to exert effort, $x_{ij} = \hat{x}$ if the project is successful and the other entrepreneur reports a high signal to the third party, and $x_{ij} = 0$ otherwise);

According to this side contract, the enterpreneur's payoff is only based on the entrepreneur's own performance and on the signal reported to the third party by the other

entrepreneur. Each entrepreneur is thus willing to report thruthfully the signal he observes to the third party, and this contract then induces the entrepreneurs to choose the appropriate effort levels. Last, there indeed exists non-negative payments (w_1, w_2) implementing $(\hat{u}_1, \hat{u}_2)$ whenever $\hat{u}_i \geq \hat{R}_i$ and both entrepreneurs are willing to accept the side-contract whenever $\hat{u}_i \geq \min \bar{u}_i$. ■

Collusion is thus still possible in spite of the difficulties mentioned above, with one caveat:

- entrepreneurs can perfectly coordinate their reports to the bank;
- but inducing an entrepreneur to exert effort requires to leave this entrepreneur with a rent at least equal to the minimal rent needed with public signals $\left(\hat{R}\right)$

The first property implies that the bank has no hope to elicit any relevant information about the signals received: there is thus no scope for revelation mechanisms. The second property implies in turn that the bank cannot hope to reduce the entrepreneurs' rent below $\hat{R}$ (in other words, here again collusion can only hurt the bank). Note that, from Proposition 6, entrepreneurs can always coordinate on low effort levels if they wish so. Therefore, they cannot get a rent lower than R^{**} identified in Section 3.2. Building on these insights, we can show that the optimal contract is a simple group lending contract:

Proposition 7 *Whatever the informativeness of the signal, the optimal contract is a simple group lending contract without any communication or revelation mechanism. In addition:*

- *if the signal is sufficiently informative* $\left(\hat{R} < R^{**}\right)$*, then the group lending contract of Section 3.2 (perfect mutual observation) is optimal and induces effort with a rent* R^{**}
- *if the signal is not so informative* $\left(\hat{R} > R^{**}\right)$*, then a group lending contract where the entrepreneurs get* $\hat{X} = \frac{\overline{\zeta}}{\overline{p}} \frac{c}{\overline{p}\overline{\zeta} - \underline{p}\underline{\zeta}}$ *if and only if both projects succeed is optimal and induces effort with a rent* $\hat{R}$*.*

Proof. From Proposition 6, there is no scope for revelation mechanisms. Suppose now that a contract induces the entrepreneurs to coordinate on high effort levels. Since they could coordinate as well on low effort levels – and share any increase in joint utility in any way they want, it must be the case that their joint utility is higher with high efforts than with low efforts. From Section 3.2, this implies that the entrepreneurs cannot get a rent lower than R^{**} each. Proposition 6 further implies that the entrepreneurs will not

be able to coordinate on high effort levels if they get a rent lower than $\hat{R}$. Consider now the following group lending contract, where the entrepreneurs get $\max\left\{\hat{R}, R^{**}\right\}/\bar{p}^2$ when both projects succeed precisely. This contract

- gives the entrepreneur the minimal rent $\max\left\{\hat{R}, R^{**}\right\}$,
- allows them to coordinate on high effort levels if they wish so (since it provides a rent at least equal to $\hat{R}$),
- and is such that the entrepreneurs' joint utility is maximal when they both exert effort (since X is at least equal to $R^{**}/\bar{p}^2$).

This contract thus induces the entrepreneurs to coordinate on high effort levels and minimizes the rent; it is therefore optimal. ■

This proposition confirms the optimality of simple group lending contracts. First, the structure of payments, where an entrepreneur gets a positive payment X only when both projects succeed, enhances both the incentives to provide effort and the incentives to monitor each other. Second, the payment X must give a rent ($\bar{p}^2 X$) that is sufficient to encourage the entrepreneurs to coordinate on high effort levels ($\bar{p}^2 X \geq R^{**}$) and also sufficient to allow the third party to induce effort $\left(\bar{p}^2 X \geq \hat{R}\right)$. The rent $\hat{R}$ decreases as signals become more and more informative about the entrepreneurs' efforts. When signals are sufficiently informative $\left(\hat{R} < R^{**}\right)$, the bank can actually do as well as if the entrepreneurs perfectly observed each other's efforts; because of collusion between the entrepreneurs, the bank is in this case forced to leave a larger rent $\left(R^{**} \text{ instead of } \hat{R}\right)$. When signals are less informative, however, the bank can only decrease the entrepreneurs' rents down to the level it could achieve if signals were public. It achieves this result not through revelation mechanisms (the entrepreneurs would always cheat on reported signals), but instead, through group lending contracts that induce the entrepreneurs to collude and exert effort. While collusion among entrepreneurs does not harm the bank in that particular case, it still leads the bank to modify the way it induces the entrepreneurs to exert effort (through a group lending contract rather than a revelation mechanism).

4.3 Costly monitoring of effort levels

It follows from the above analysis that the bank benefits from the entrepreneurs' mutual observation of efforts. It may be however costly for the entrepreneurs to monitor each other. Still, the bank would have an incentive to encourage such mutual monitoring as long as it is not excessively costly. Suppose for example that each entrepreneur must incur a cost γ for monitoring the other's effort. If monitoring is contractible, the bank

will ask the entrepreneurs to monitor each other as long as the cost of monitoring is lower than the rent differential ($\gamma < R^* - R^{**}$). If instead monitoring is not contractible, group lending contracts can be used to give each entrepreneur an incentive to monitor what the other is doing – and to make sure that he will indeed exert effort. To see this in more detail, consider for example the following situation:

- first, the bank offers (group lending) contracts;
- second, the entrepreneurs can sign a side-contract stipulating effort levels and side transfers;
- third, the entrepreneurs decide whether to observe each other's effort; if they do, they incur a cost γ;
- fourth, the entrepreneurs, having observed all previous decisions, choose their effort levels; if they have incurred the observation cost γ, they observe each other's choices.

It is clear that the entrepreneurs will incur the observation cost γ only if they have entered into a side-contract. Therefore, if they do not sign any side-contract, they will behave exactly as if their efforts were strictly private information, and the best contract for the bank, among those that do not induce side-contracting, is the optimal individual loan contract described in Section 2, which leaves each entrepreneur a rent $\underline{p}c/\left(\bar{p}-\underline{p}\right)$. The following proposition shows that, when side-contracting and monitoring costs are not too large, the bank performs better by encouraging the entrepreneurs to coordinate their effort decisions – and the above group lending contract (adjusted for the contracting and monitoring costs) precisely does so:[24]

Proposition 8 *If side-contracting and monitoring costs satisfy:*

$$\frac{\gamma}{c} < \frac{\underline{p}}{\bar{p}}, \tag{4.7}$$

then the simple group lending contract $\left(\hat{x} = \frac{c+\gamma}{\bar{p}^2-\underline{p}^2}, y = 0\right)$ *is optimal and induces the entrepreneurs to side-contract on high efforts and monitor each other, while leaving them a lower rent than individual loan contracts.*

Proof. Consider a contract that induces the entrepreneurs to exert effort and to monitor each other. Note first that, without loss of generality, we can restrict attention

[24] The bank may also help them to enforce side contracts, since it gains from such side contracting when it offers group lending contracts. The next section shows however that the bank would perform even better if it could both induce the entrepreneurs to monitor each other (i.e., observe each other' efforts) and prevent collusion (it could then costlessly ensure that the entrepreneurs report these efforts).

to contracts such that an entrepreneur does not exert effort if he is not monitored by the other entrepreneur – otherwise, the entrepreneur should get a rent at least equal to R^*.

Let x denote entrepreneur i's payment if they both succeed, y the payment if the other entrepreneur j does not succeed. The entrepreneurs must prefer to exert effort and monitoring, that outcome to not monitoring (and thus not exerting effort):

$$\bar{p}^2\hat{x} + \bar{p}\left(1-\bar{p}\right)y - c - \gamma \geq \underline{p}^2\hat{x} + \underline{p}\left(1-\underline{p}\right)y. \tag{4.8}$$

Maximizing the expected profit of the bank under this constraint leads to $\left(\hat{x} = \frac{c+\gamma}{\bar{p}^2-\underline{p}^2}, y = 0\right)$. This contract gives each entrepreneur a rent $\frac{\bar{p}^2(c+\gamma)}{\bar{p}^2-\underline{p}^2}$ which, under (4.7), is lower than the minimal rent needed to induce effort with individual contracts (R^*) – which furthermore ensures that an entrepreneur does not provide effort if not monitored by the other. ■

Therefore, group lending contracts (adjusted so as to induce mutual monitoring) are still optimal as long as the cost of monitoring is not too large.

5 Conclusion

The analysis presented above shows that, contrary to previous claims, banks do not benefit from collusion when entrepreneurs can observe each other's efforts. A more appropriate claim is that information-sharing among the entrepreneurs helps banks *even if the entrepreneurs collude*. If the entrepreneurs could observe each other's efforts but not collude, banks would do even better and actually achieve the first best (complete information optimum). In other words, and from a bank's perspective, information-sharing is desirable even if it leads to collusion, but collusion *per se* is not desirable.

The above analysis also shows that simple group lending contracts, based only on realized outputs, achieve better results than individual contracts when entrepreneurs observe each other's efforts (but not otherwise); furthermore, the more sophisticated contracts that are needed to get closer to the first-best are not robust to collusion between entrepreneurs, whereas simple group lending contracts constitute optimal contracts when entrepreneurs can implement efficient side contracts.

This paper derives lessons that are similar to the ones obtained in adverse selection environments with correlated types (Laffont (2003)). In the absence of collusion, group lending contracts are not the best contracts that banks can design when entrepreneurs share information. More powerful contracts based on the ideas of yardstick competition can elicit this common information at a lower cost. However, these contracts are not robust to collusion while simple group lending contracts, based on partners' production levels, remain robust to collusion.

The situations of moral hazard and of adverse selection however differ in the impact of collusion. In adverse selection contexts, the motivation for group lending contracts comes from the fact that information about one entrepreneur's "type" may also bring relevant information about the other entrepreneur's type; as a result, one entrepreneur's output provides a useful signal about both entrepreneurs' types. The optimal (collusion-proof) contract can however be quite complex; in particular, it may be useful to rely not only on the signals provided by the entrepreneurs' production levels, but also on messages directly sent by the entrepreneurs – that is, the optimal contract may require some communication between the entrepreneurs and their banks. In contrast, in moral hazard environments where entrepreneurs have no private information ex ante, a bank can no longer gain from trying to have the efforts revealed.[25]

[25] In essence, because they observe each other's efforts, the entrepreneurs behave as a single entity: they can achieve perfect collusion by dealing with a third party, using appropriate revelation mechanisms if necessary, when the third party does not directly observe their efforts; the situation with side-contracting is thus formally identical to a situation where one entrepreneur would be in charge of both projects.

Note that in the case of a unique entrepreneur (with one or several projects), the bank could easily induce this entrepreneur to truthfully report his effort(s) *ex post* (e.g., by letting the entrepreneur choose between a safe return and a lottery, contingent on the outcome of the project). However, such revelation mechanisms cannot be used to reduce the rent that must be promised *ex ante* to induce the entrepreneur to exert effort.

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