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MULTIPLE-BANK LENDING WITH A PUBLIC SIGNAL

TESINA

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PRESENTA

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Abstract

Examinamos las interacciones entre múltiples jerarquías de bancos, oficiales de préstamos y prestatarios cuando existe una señal exogena informativa para el principal. La posibilidad de colusión entre el prestatario y los oficiales de crédito a cargo del seguimiento da forma a los incentivos para los oficiales de crédito. Cuando la probabilidad con la que aparezca la señal es baja, las amenazas de colusión inducen a un control excesivo en un equilibrio libre de colusión, mientras que para una alta probabilidad, el monitoreo se encuentra en su nivel de no delegación, un resultado similar a la integración vertical. Bajo los préstamos de múltiples bancos, los contratos de delegación pueden resolver el problema del parasitismo en el monitoreo y conducir a un monitoreo más intenso en relación con los préstamos de un solo banco. Esto se debe a que las amenazas colusorias hacen que los esfuerzos de monitoreo sean complementos estratégicos debido al efecto de "bloqueo de rentas". Además, mostramos que un banco puede decidir no emplear un monitor y aprovecharse de la información recopilada por el oficial de crédito del otro banco, lo que a su vez proporciona una nueva justificación para los préstamos sindicados basados en amenazas de colusión.

Palabras clave: *Multiple-bank lending*; *Vertical collusion*; *Counter-cyclical monitoring*; *Public signal*
Clasificación JEL:

Contents

List of Figures

Chapter 1

Introduction

Whenever a principal delegates enforcement authority, opportunities for corruption arise.[1] Sanitation inspectors, auditors, production foremen, and financial regulators all have discretion to 'sell out'. In developing countries especially, corruption severely impedes collection of taxes, enforcement of regulations, and management of public-sector enterprises.[2] Using a simple model of delegated monitoring, we show that the loan officer payment entails a relationship between the (exogenous) probability at which the principal knows the true income. In our model, a bank engages a loan officer to monitor the income from some firm. The bank can control the loan officer's monitoring effort. However, the bank cannot prevent the firm from bribing the loan officer. The bank can motivate the loan officer by paying her share of the income that the loan officer reports.

We investigate how the possibility of collusion and the existence of the signal affect incentive contracts between loan officers and ask whether delegated monitoring leads to more intense monitoring than direct bank monitoring without delegation. Both lending modes are critically affected by the possibility of collusion, as well as the public signal. We first limit our attention to non-collusion contracts, i.e.contracts designed so that the loan officers have no incentive to collude with the borrower, in other words, optimal contracts adhere to the non-collusion constraint of

[1]See Rose-Ackerman (1978)

[2]See Myrdal (1968) and Alatas (1968)

very simple form—the incentive pay for each loan officer must exceed his share of collusion.The incentive pay has two functions in this situation. The increase in incentive compensation not only relaxes the participation constraints of each loan officer, thereby allowing banks to enforce higher levels of monitoring, but also reduces the attractiveness of collusion. We show that the monitoring effort only depends on the (expected) amount repaid by the borrower, divided by a constant.

We first show that, under both lending structures, when the probability that the bank can know the true income is low, collusion is high, and the no-collusion constraint binds, implying that the incentive problem is severe. To discourage collusion, a high repayment rate is required from the loan officer. As a result, there is more monitoring of borrowers relative to the non-delegation solution, in which the banks could monitor the borrower directly. When the bank knows the true income with high probability, the collusion incentive problem becomes insignificant, since the no-collusion constraint is slack. In this case, the bank delegates less monitoring to the subsidiary.

Our main result is that two-bank lending yields less monitoring and weaker incentives than single-bank lending when the probability that the bank can know the true income is high. When the probability is low, this result is reversed—two-bank lending induces higher monitoring efforts, as well as stronger incentives. First consider the case when the probability is low. This case illustrates how monitoring efforts can become strategic complements to one another. As oversight by a loan officer increases, the other bank's loan officer's participation restriction is relaxed. However, the affected bank cannot earn the additional rent by lowering the performance fee, as there is a low probability that the constraint of no collusion exists on any loan officer ties, and consequently a reduction in the performance fee would violate the constraint. We term this the rent-jamming effect of multiple-bank lending. The only way to increase the loan officer's monitoring effort is to relax the participation constraint. This strategic complementarity intensifies as the probability declines, so that when the probability is low, the rent-jamming effect predominates over the free-riding effect. Therefore, compared to lending between a single bank, lending between two banks results in an over-provision of monitoring efforts. Next, take into account the scenario in which the chance is large and neither loan officer is bound by the no-collusion criterion. Since loan officers' reports are public information, each bank is allowed to employ the monitoring services provided by the loan officer of the other bank. As a result, monitoring efforts become strategic substitutes, resulting in monitoring under-provision in the two-bank lending mode. Given that collusive considerations are irrelevant in this case, two-bank lending necessitates less monitoring effort than single-bank lending due to the negative externality resulting from the free-riding effect.

In Section 4.2, we then conduct two conceptual exercises to untangle the two aforementioned effects. First, we investigate a scenario in which the two banks merge, maximizing joint profits so that the free-riding channel is closed, but employing two loan officers so that the rent-jamming effect remains. As expected, the absence of free-riding means that both monitoring and incentives are higher in this instance, compared to the baseline two-bank lending structure in which banks act independently. Second, we explore a scenario in which the two loan officers collaborate rather than compete. The rent-jamming effect is absent in this instance, and not unexpectedly, both incentives and monitoring are lower than in the baseline two-bank lending system. We then examine a scenario in which banks can strategically decide not to implement the collusion-free contracts. There is an equilibrium in which one bank does not employ a loan officer and relies on information acquired by the other bank, while the other bank acts as a liaison between the other bank and the borrowing enterprise.

1.1 Related literature

This work is related to a number of others. Dam and Roy Chowdhury (2021) investigates the interactions of various bank hierarchies, loan officers, and borrowers. The probability of collaboration between the borrower and the monitoring loan officer (s) influences loan officer incentives. Collusion threats drive excessive tracking in a collusion-free equilibrium when "borrower quality is poor," whereas tracking is conducted at its non-delegation level when "borrower quality is high," a result comparable to vertical integration. In a similar manner, Carletti (2004) examines the influence of several bank loans on follow-up incentives. The key problem in Carletti is provisional moral hazard, with monitoring intended at preventing borrower wrongdoing, and it tends to explain a borrower's endogenous choice of various loan forms. The current work, however, varies from both of the preceding works in that the principle only knows the genuine income of the project with a high degree of certainty. Our findings contribute to the literature by demonstrating that multi-bank lending can drive higher monitoring even when project returns are linked, leaving little possibility for diversification.

A closely linked paper by Mookherjee and Png (1995) investigates the best remuneration policy for a corruptible inspector tasked with monitoring plant pollution. Their strategy emphasizes the trade-off between corruption, pollution, and enforcement effort. Bribery is found to be an unproductive technique of persuading inspectors to monitor; society should eradicate corruption; and fears of cooperation enhance incentives for over-monitoring. Burlando and Motta (2015) Consider a single principal-auditor-agent hierarchy with adverse selection. The possibility of collaboration between a productive agent and the auditor in charge of production monitoring can have an impact on a variety of organizational characteristics of the enterprise. There are no rents owing to collusion in equilibrium, and the efficient worker operates outside the firm. The conclusions of these two articles are consistent with our main finding that collusion threats lead to over-monitoring. The fundamental contribution we make to the collusion literature is that we expand the single-hierarchy concept to many competing hierarchies. There are two intriguing implications.First, when the principals (banks) may enter into collusion-free contracts, the inclusion of another competing hierarchy can assist reduce the problem of free-riding in monitoring that develops as a result of the principals' strategic engagement. However, there is a cost to this: numerous hierarchies increase the incentives for excessive surveillance. Second, the collusion-proof principle may fail under single and multiple hierarchies when principals (banks) are unable to adhere to collusion-free contracts.

Chapter 2

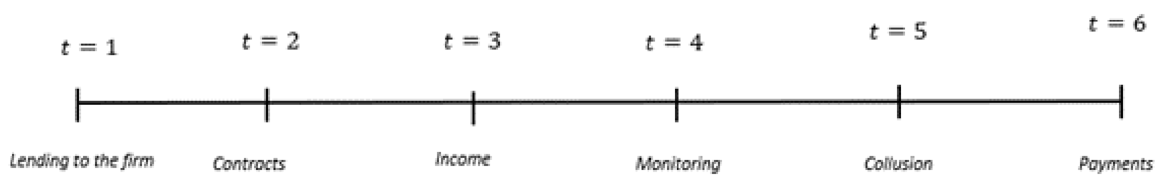
The model

We examine a three-tier hierarchy consisting of a firm of borrower, a bank and two loan officers or monitors. The firm owns a risky project which returns a profit θ. We assume that the bank lacks either the time or the knowledge required to supervise the bank and the borrower does not have any fund of her own, and hence, any investment must be externally funded. The agent is able to observe the realization of the profit θ, while the principals known only with probability λ the true income, so the agent has the opportunity to keep some of the profit instead of delivering all to the principal.

Let $m \in [0, 1]$ represent the loan officer's monitoring effort. We assume that the bank can verify the loan officer's monitoring effort, and hence monitoring levels or efforts can be agreed upon. The bank, however, cannot confirm the outcome of the monitoring process, i.e., whether it was successful or not. By'successful monitoring,' we imply that a loan officer has detected borrower disobedience and is able to take necessary actions to make her behave diligently, which occurs with probability m. The inability to observe monitoring results raises the risk of cooperation between the loan officer and the firm. When a loan officer colludes with the borrowing firm, he allows the borrower to evade in exchange for a bribe and declares to his boss that he has learned nothing about the firm's behavior.The cost of m for a loan officer is $C(m) = 1/2cm^2$, where c > 0.

A bank contingent contract (m, s) defines the needed monitoring effort $m \in [0, 1]$ as well as a share $s \in [0, 1]$ of $r\theta$ for the loan officer which is the (expected) amount repaid by the borrower. The sequence of events is as follows (figure 2.1). At $t = 1$, each bank lends 1 to the firm. At date 2, the bank hires a loan officer and offers a contract (m, s). At $t = 3$, income is realized, but only the agent is aware of it. The loan officers monitor at the level stated in the contract at $t = 4$. At $t = 5$, the firm and the loan officer determine whether to collaborate, which is only possible if the loan officer in question has been successful in monitoring. At $t = 6$, the firm pays the bribe to the loan officer and the bank (if she conspired with the loan officer).

Figure 2.1. The timing of events.



Source: Own elaboration.

Chapter 3

Optimal loan officer monitoring and incentives

3.1 Single-bank lending

We begin with the case when there is just one bank lending

1

to the borrowing enterprise.

3.1.1 Direct bank monitoring without delegation

As a starting point, we examined optimal monitoring assuming the bank had access to the same $C()$ monitoring technology and had decided to monitor the company directly. The following issue is solved via optimal monitoring effort:

$$max_{(m\in[0,1])}B\left(m\right)\equiv m\theta r+\left(1-m\right)r\hat{\theta}-\frac{1}{2}cm^{2}-1$$

Then, the optimal monitoring intensity is given by:

$$m^* = \frac{(\theta - \hat{\theta})r}{c}$$

We assume that the firm chooses $\hat{\theta}$ that maximizes her profit, which is given by:

$$F(\hat{\theta}) = \theta - mr\theta - (1 - m)\, r\hat{\theta}$$

Note that they are decreasing in $\hat{\theta}$, and so, will be maximized with $\hat{\theta} = 0$, then, the optimal monitoring intensity is:

$$m^* = \frac{\theta r}{c}$$

3.1.2 Delegated monitoring

Now consider the situation in which the bank lacks access to monitoring equipment and must delegate monitoring tasks to a loan officer. Let m and s denote the monitoring effort and repayment share, respectively. Collusion between the firm and the loan officer is only possible at date 5 if the loan officer is successful in detecting the true income. At this point, the loan officer can either report accurately or, in exchange for a bribe b, collude with the borrower and report to the bank that the actual income is $\hat{\theta}$. Let $F(\sigma)$ and $M(\sigma)$ be the firm's and monitor's payoffs, respectively, where $\sigma \in \{\hat{\theta}, \theta\}$, with $\hat{\theta}$ signifying collusion and θ representing no-collusion. The payoffs are:

$$F\left(\hat{\theta}\right) = \theta - \lambda r\theta - (1-\lambda)\,\hat{\theta}r - b, \qquad and \qquad M\left(\hat{\theta}\right) = sr\hat{\theta} + b - C(m)$$

$$F\left(\theta\right) = \theta - \theta r, \qquad and \qquad M\left(\theta\right) = sr\theta - C(m)$$

Thus, collusion is impossible if and only if

$$F\left(\theta\right) + M\left(\theta\right) \geq F\left(\hat{\theta}\right) + M\left(\hat{\theta}\right) \leftrightarrow s \geq 1-\lambda \tag{3.1}$$

The no-collusion restriction is straightforward: the loan officer's incentive pay, s, must exceed the likelihood that the bank does not know the actual income. Clearly, the optimal contract in a collusion-free equilibrium must satisfy the no-collusion criterion. At t = 2, the bank would provide a contract (m, s) that, in addition to satisfying the no-collusion criterion, must also satisfy the loan officer's participation constraint.

$$mrs\theta - \frac{1}{2}cm^2 \geq 0 \tag{3.2}$$

and (ii) the feasibility constraint

$$(m,\ s)\ \in\ [0,\ 1][0,1] \tag{3.3}$$

The bank thus solves the following maximization problem:

$$max_{m,s}B\,(m,\ s) \equiv\ m\theta r\,(1\ -\ s) -\ 1 \tag{3.4}$$

Proposition 1. *There are threshold values of the probability at which the bank can know the true income, λ^0, λ^{min} and $\bar{\lambda}$, with $0\ < \lambda^{min}\ <\ \lambda^0\ <\ \bar{\lambda}$, where λ^{min} is such that bank-lending is not feasible for any $\lambda < \lambda^{min}$.*

1) The optimal monitoring intensity is:

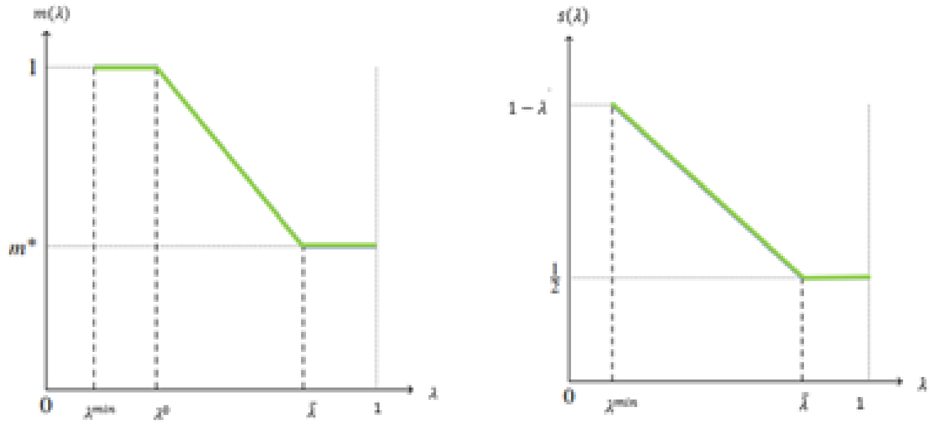
$$m = \begin{cases} 1 & \lambda\epsilon\left[\lambda^{min}, \lambda^0\right] \\ \frac{2r\theta(1-\lambda)}{c} & \lambda\epsilon\left(\lambda^0, \bar{\lambda}\right] \\ \frac{\theta r}{c} & \lambda\epsilon\left(\ \bar{\lambda},\ 1\right] \end{cases}$$

As a result, anytime the likelihood that the bank knows the actual income is low, i.e., $\lambda^{min}\ \leq\ \lambda \leq \bar{\lambda}$, the equilibrium result entails over-monitoring relative to the non-delegation level of monitoring, m^*. When the likelihood that the bank will discover the genuine income is high,i.e.,$\lambda >\ \bar{\lambda}$, the monitoring level is set to non-delegation.

2) The optimal share of repayment is given by:

$$s = \begin{cases} 1-\lambda & \lambda\epsilon\left[\lambda^{min}, \bar{\lambda}\right] \\ \frac{1}{2} & \lambda\epsilon\left(\bar{\lambda}, 1\right] \end{cases}$$

Figure 3.1. Equilibrium monitoring and share of the loan officer



(a) Equilibrium monitoring

(b) Equilibrium share

Equilibrium monitoring and share of the loan officer as functions of the probability at which the bank knows the true income. For $\lambda < \lambda^{min}$, bank-lending is not feasible. For $\lambda^{min} \leq \lambda < \bar{\lambda}$ the no-collusion constraint binds, and there is over-monitoring relative to the non-delegation level, m^*. For$\lambda > \bar{\lambda}$ the no-collusion constraint does not bind and monitoring is at the non-delegation level. Source: Own elaboration.

The results in Proposition 1 are depicted in Figure 3.1.2. Because the loan rate is fixed exogenously in an optimum contracting model, the only instrument the bank has to give incentives is the repayment part. Consider first the high λ values, which indicate a low possibility that the bank is unaware of the true income. As a result, the non-collusion prohibition is null and void. As a result, the bank can continue to cut expenses without altering incentives until all of the rent is extracted from the loan officer, indicating that the participation limitation is linked. In the absence of a collusion incentive problem, the monitoring level without delegation, m^*, can thus be implemented with a minimal incentive payout.

Consider the following scenario: the probability that the bank will be able to determine the actual income is low, and thus the probability that the bank will not be able to determine the actual income is high. The non-collusion requirement is binding in this circumstance. The only way to discourage cooperation is to increase the incentive payment in the form of s. By designating a greater m, the bank can continue to recover the full rent from the loan officer. As λ drops, both m and s grow, and the tracking effort is greater than without delegation, implying excessive tracking. When λ is reduced further, the monitoring effort is optimally set at its highest level, 1.

Welfare

Under single bank loans, we compare balance monitoring to the socially efficient level. In any monitoring effort m, the (anticipated) wellfare is defined as the sum of the borrower's expected utility and the bank-loan officer ratio's expected surplus, that is,

$$W(m) \equiv \theta - \lambda r\theta + m\lambda r\theta - \frac{1}{2}cm^2 - 1.$$

The socially optimal level of monitoring is the one that maximizes the above expression.

Proposition 2. *Under single-bank lending, the socially optimal level of monitoring is provided by:*

$$m^{**} = \frac{\lambda r\theta}{c}$$

Thus, under single-bank lending with delegation, the equilibrium requires over-monitoring in comparison to the socially efficient level, i.e., $m^{**} \leq$ m for all $\lambda \in [\lambda^{min}, 1]$.

3.2 Two-bank lending

When there are two banks in the market, the firm obtains

$$1$$

from each bank to invest, resulting in a total loan amount of

$$2$$

. The aggregate monitoring intensity is given by:

$$\pi\left(m_i,\ m_j\right) = m_i + m_j - m_i m_j \tag{3.5}$$

Given the monitoring efforts $m_i, m_j \in [0, 1]$.

3.2.1 Direct bank monitoring without delegation

We examine the situation in which each bank has direct access to the borrower. Bank i resolves the problem:

$$\max_{m_i\in[0,\ 1]} B_i\left(m\right) \equiv \pi\left(m_i,\ m_j\right)\theta r + \left(1 - \pi\left(m_i,\ m_j\right)\right)\hat{\theta} r - \frac{1}{2} c m_i^2 - 1 \tag{3.6}$$

The best reply functions are determined by the first order requirements of the maximization problems of banks i and j.

$$\left(1 - m_j\right)\theta r + m_j \hat{\theta} r - c m_i = 0 \tag{3.7}$$

$$\left(1 - m_i\right)\theta r + m_i \hat{\theta} r - c m_j = 0 \tag{3.8}$$

Proposition 3. *When two banks lend to the borrower and may directly monitor her, the best monitoring effort is provided by:*

$$m_2^* = \frac{\theta r}{c + \theta r}$$

3.2.2 Delegated monitoring

Following the monitoring success of the loan officer, there are two probable outcomes. Consider the instance when loan officer j did not successful. Let $F(\sigma)$ and $M(\sigma)$ be the firm's and monitor's payoffs, respectively, where $\sigma \in \hat{\theta}, \theta$, with $\hat{\theta}$ signifying collusion and θ representing no-collusion. The payoffs are

$$F\left(\hat{\theta}\right) = \theta - 2\lambda r\theta - 2\left(1-\lambda\right)\hat{\theta}r - b_i, \qquad and \qquad M\left(\hat{\theta}\right) = sr\hat{\theta} + b_i - C(m_i)$$

$$F\left(\theta\right) = \theta - 2\theta r, \qquad and \qquad M\left(\hat{\theta}\right) = sr\theta - C(m_i)$$

Thus, collusion is not feasible if and only if

$$F\left(\theta\right) + M\left(\theta\right) \geq F\left(\hat{\theta}\right) + M\left(\hat{\theta}\right) \leftrightarrow s \geq 2(1-\lambda) \tag{3.9}$$

Consider the situation in which loan officers i and j both successfully recognized borrower behavior. Let $\hat{\theta}$ denote collaboration between the borrower and the two lending officers, and θ denote no-collusion, i.e., at least one loan officer has opted not to collaborate. The payoffs are as follows:

$$F\left(\hat{\theta}\right) = \theta - 2\lambda r\theta - 2\left(1-\lambda\right)\hat{\theta}r - b_i - b_j, \quad M_i\left(\hat{\theta}\right) = s_i r\hat{\theta} + b_i - C(m_i),$$

$$M_j\left(\hat{\theta}\right) = s_j r\hat{\theta} + b_j - C(m_j)$$

$$F\left(\theta\right) = \theta - 2\theta r, \quad M_i\left(\theta\right) = s_i r\theta - C(m_i), \quad and \qquad M_j\left(\theta\right) = s_j r\theta - C(m_j)$$

Thus, collusion is not feasible if and only if

$$F\left(\theta\right) + M_i\left(\theta\right) + M_j\left(\theta\right) \geq F\left(\hat{\theta}\right) + M_i\left(\hat{\theta}\right) + M_j\left(\hat{\theta}\right) \leftrightarrow s_i + s_j \geq 2(1-\lambda) \tag{3.10}$$

At date t = 2, bank I gives its loan officer a contract (m_i, s_i). Aside from satisfying the no-collusion constraint, the contract must also satisfy the loan officer participation constraint.

$$\pi\left(m_i,\ m_j\right) rs\theta - \frac{1}{2} c m_i^2 \geq 0 \tag{3.11}$$

and (ii) the feasibility constraint

$$(m_i,\ s_i)\ \in\ [0,\ 1][0,1]. \tag{3.12}$$

The bank solves the following maximization problem:

$$max_{m_i,s_i} B_i\,(m,\ s) \equiv\ \pi\left(m_i,\ m_j\right)\theta r\,(1\ - s_i) -\ 1 \tag{3.13}$$

Lemma 1. *The participation constraint of each loan officer binds in two-bank lending. Furthermore, (a) when the no-collusion constraints are relaxed, monitoring efforts are strategic substitutes, i.e., the best reply functions $m_i(m_j)$ and $m_j(m_i)$ are negatively sloped; and (b) when both the no-collusion constraints are relaxed, monitoring efforts are strategic complements, i.e., the best reply functions $m_i(m_j)$ and $m_j(m_i)$.*

At the optimum, each loan officer's participation constraint binds. When neither of the two no-collusion requirements binds, the agency problem has no effect on the banks' monitoring level selection in comparison to non-delegation levels of monitoring. The optimal response functions in this scenario are provided by (3.7) and (3.8).

Assume that both no-collusion constraints are satisfied. We can substitute the binding participation conditions for *si* into (3.9) to obtain the best replies $m_i\left(m_j\right)$ and $m_j\ (m_i)$:

$$cm_i^2\ =\ 4\,(1-\lambda)\,\pi\,(mi,\ mj\ )\,r\theta \tag{3.14}$$

$$cm_j^2\ =\ 4\,(1-\lambda)\,\pi\,(mi,\ mj\ )\,r\theta \tag{3.15}$$

The best response functions shown above are sloped upward. An intriguing relationship between the two binding participation limits results in the strategic complementarity of monitoring efforts.

Proposition 4. *There are probability thresholds at which the bank can determine the actual income, λ_2^0, and $\bar{\lambda}_2$, with $0\ <\ \lambda_2^0 <\ \bar{\lambda}_2$, such that*

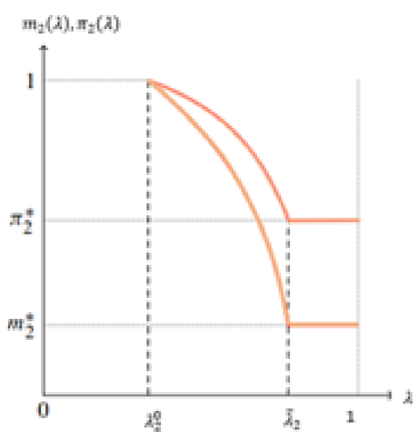
1) The symmetric equilibrium monitoring effort is given by:

$$m_2(\lambda) = \begin{cases} \frac{8((1-\lambda)r\theta)}{c+4(1-\lambda)r\theta} \;\; for\ \lambda \in \left(\lambda_2^0,\ \bar{\lambda_2}\right], \\ \frac{r\theta}{c+r\theta} \;\; for\ \lambda \in \left(\bar{\lambda_2},\ 1\right], \end{cases}$$

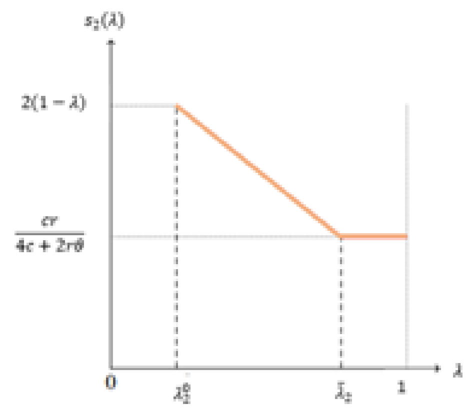
2) The optimal share of repayment for the loan officers, on the other hand, is given by:

$$s_2(\lambda) = \begin{cases} 2(1-\lambda) \;\; for\ \lambda \in \left(\lambda_2^0,\ \bar{\lambda_2}\right] \\ \frac{cr}{4c+2r\theta} \;\; for\ \lambda \in \left(\bar{\lambda_2},\ 1\right], \end{cases}$$

Figure 3.2. The equilibrium monitoring effort, aggregate monitoring intensity and share of the loan officers



(a) Equilibrium monitoring



(b) Equilibrium share

The equilibrium monitoring effort, aggregate monitoring intensity and share of the loan officers as functions of the probability at which the bank knows the true income. For $\lambda \le \bar{\lambda_2}$, the no-collusion constraints bind, and there is over-monitoring relative to the non-delegation level. Source: Own elaboration.

Proposition 4 is depicted in Figure 3.2. The equilibrium and variables connected to two banks' loans are expressed by letters with subscripts, for example, m_2 -denotes each loan officer's symmetric equilibrium monitoring effort in two-bank lending. In addition, in the credit structure k, λ_k^0 signifies the probability threshold such that $mk1$ for $lambda > lambdak0$, and $\bar{\lambda_k}$ denotes the probability threshold such that the non-collusion constraints bind if $\lambda > \bar{\lambda_k}$. There is a positive externality between banks when no collusion regulations are in place. Because both s_i and s_j are set to zero with the (3.9) bound, any strategic interaction between lenders must come through modifications to m_i and m_j. This externality is more severe for lower λ values: if λ is very tiny (very high collusion participation), shares are very high due to the binding constraints of no collusion. As a result, the temptation to grow m_i is also high because m_j can be significantly increased.

The equilibrium relationship between monitoring and borrower quality outlined in Propositions 1 and 4 is comparable because they share a same intuition. A low value of λ correlates to a substantial share of cooperation in both loan structures, worsening the problem of collusion incentives. Furthermore, in both circumstances, the repayment component is the sole tool available to banks to address collusion issues because they cannot alter the magnitude of the collusion stake, $1-\lambda$, because the loan rate is determined exogenously. As a result, we find a positive relationship between equilibrium participation and collusion involvement.

Welfare

The (expected) social welfare, which is the total of the expected company utility and the aggregate expected surplus of the two bank loan officer pairs at any symmetric monitoring effort, $m_i = m_j = m$, is provided by:

$$W_2(m) \equiv \theta - 2\lambda r\theta + 2\pi(mi,\ mj)\lambda r\theta - cm^2 - 2.$$

The amount of monitoring that optimizes the above expression is the one that is socially optimum.

Proposition 5. *Under two-bank lending, the socially optimal level of monitoring is provided by:*

$$m_2^{**}(\lambda) = \frac{2\lambda r\theta}{2\lambda\theta r + c}$$

Furthermore, there is a unique probability threshold $\theta^{**} \in \left(\lambda_2^0,\ \bar{\lambda}_2\right)$ such that the equilibrium under two-bank lending entails over-monitoring compared to the socially efficient level, i.e. $m_2^{**}(\lambda) \leq m_2(\lambda)$ if and only if $\lambda \leq \theta^{**}$

In contrast to the single-bank lending structure, the equilibrium under two-bank lending may indicate under-monitoring relative to the socially optimal level if the likelihood that the banks know the actual income is, i.e., $\lambda > \theta^{**}$. This occurs because $m_2(\lambda)$ is too low (equivalent to the non-delegation level) due to inefficiency caused by strategic interaction between the two banks, despite the fact that the collusion incentive problem has no bite for high values of λ. However, there is still over-monitoring relative to the socially ideal level for $\lambda \leq \theta^{**}$.

Chapter 4

A comparison of the lending structures of one and two banks

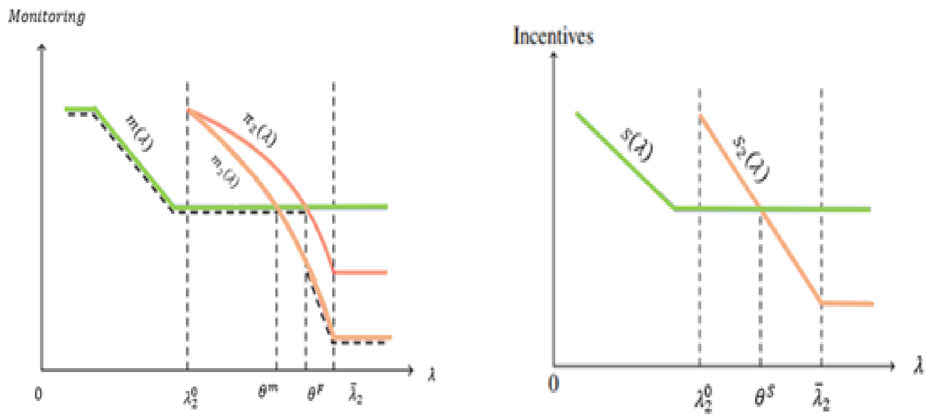
4.1 The free-riding and rent-jamming effects of two-bank lending

We now proceed to the thesis fundamental question: a comparison of the equilibrium monitoring as well as the incentives provided to loan officers under single- and two-bank lending models. Proposition Two banks lending implies more collusive threats, i.e., each loan officer's no-collusion constraint binds over a bigger range of the probability at which the bank knows the true income (i.e., $\bar{\lambda}_2 > \bar{\lambda}$). As a result, there is inefficient over-monitoring throughout a broader range of the chance that the bank knows the genuine income λ. Furthermore, for a given loan rate r, there are distinct probability threshold values, $\theta^m, \theta^s \in (\lambda_2^0, \bar{\lambda}_2)$ such that:

1) Equilibrium monitoring effort is greater in two-bank lending than in single-bank lending, i.e., $m_2(\lambda) \geq m(\lambda)$ if and only if $\lambda \leq \theta^m$;

2) Under two-bank lending, the loan officers' equilibrium incentives are stronger, i.e., $s_2(\lambda) \geq s(\lambda)$ if and only if $\lambda \leq \theta^s$.

Figure 4.1. The equilibrium monitoring and incentives under single- and two-bank lending structures.



(a) Equilibrium monitoring (b) Equilibrium share

The equilibrium monitoring and incentives under the single- and two-bank lending structures. Under two-bank lending, each bank elicits higher monitoring effort and provides stronger incentives if and only if firm quality is low. Source: Own elaboration.

The results in Proposition 4.1 is depicted in Figure 4.1. Proposition 6 demonstrates that when the likelihood that the bank is aware of the actual income is substantial, two-bank lending results in less monitoring effort. Furthermore, under two-bank lending, banks have less incentives to loan officers. When the likelihood that the bank is aware of the actual income is minimal, lending from two banks implies more intense supervision and stronger incentives for loan officers. The two compensating channels are responsible for these outcomes. The first is the free-riding impact, which results in strategic substitutability of monitoring efforts; the second is the rent-jamming effect, which results in strategic complementarity. Clearly, the two impacts are polar opposites, making the consequences of lending from two banks on monitoring effort and loan officer incentives uncertain. Which of these two effects takes precedence is determined on the probability with which the bank knows the genuine income λ.

When the likelihood that the bank is aware of the actual income is large, there is no viable bribe that would make the collaboration beneficial, and hence the rent-jamming effect is irrelevant. Only the free-riding effect is at work, which results in less monitoring effort under two bank loans. When the likelihood that the bank is aware of the actual revenue is low, no collusion limitations are imposed. As previously stated, this leads to excessive supervision in both single-bank and two-bank lending. However, when two banks lend to each other, a further effect occurs, namely the rent-jamming effect, which magnifies the effect on m_i caused by a bigger m_j.As a result, for low levels of λ, the monitoring effort for two-bank loans outnumbers that of single-bank loans. As a consequence, the reimbursement share should be increased in order to discourage cooperation. Also, because lower λ shifts the optimum response functions defined by (3.14) and (3.15) outward, strategic complementarity is stronger for low λ values, necessitating even more balance monitoring work.

4.2 Unraveling the two compensatory effects

We demonstrated that switching from a loan from one bank to one from two banks had confusing implications for monitoring and loan officer incentives. We reasoned that this ambiguity results from the interaction of two compensating channels, namely the freeriding and rent-jamming effects of two banks' loans. In order to separate the two effects, we will do a completely conceptual exercise in what follows. We specifically close one channel at a time and investigate how the closing of a specific channel impacts monitoring and incentives under lending by two banks.

4.2.1 Strategic versus merged banks: the free-riding effect

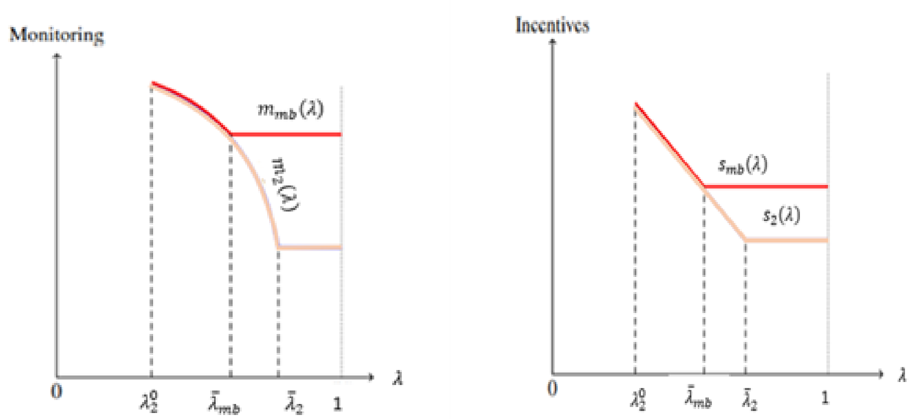
We begin by contrasting the baseline two-bank lending system examined in Section 3.2 with the one in which the free-riding channel is eliminated. To that purpose, we consider a situation in which the two banks merge, with the merged bank maximizing shared profits while continuing to employ two independent loan officers. The coordination of surveillance by the banks assures that there is no free-riding. The rent-jamming effect, however, remains because the merged entity employs two independent loan officers. To guarantee that loan amount has no confounding effect, we assume that the merged bank continues to lend 2 to the firm. Formally, the combined bank solves the maximization problem described below:

$$\max_{\{(m_i,s_i)\in F_i,(m_j\ ,s_j\ )\in F_j\}} \quad B_i\left(m_i,\ m_j,\ s_i\right) + B_j\ \left(m_i,\ m_j,\ s_j\ \right) = \ \pi\left(m_i,\ m_j\ \right)\theta r\left(2 - s_i - s_j\right) - 2$$

The combined entity is subject to the same participation and no-collusion rules as outlined in Section 3.2. The optimal solution to the maximizing problem described above is compared to the one described in Proposition 4. The following proposition investigates the role of the free-riding effect in selecting the appropriate monitoring and incentives.

Proposition 6. *When the two banks function as a unified organization (to avoid free-riding), monitoring effort is raised, and loan officer incentives are higher, rather than when they optimize their own earnings independently (when free-riding is present).*

Figure 4.2. The equilibrium monitoring efforts and shares.



(a) Equilibrium monitoring (b) Equilibrium share

The equilibrium monitoring efforts and shares under strategic and merged banks. Subscript 'mb' denotes the variables under merged banks. Source: Own elaboration.

The results in Proposition 6 is depicted in Figure 4.2.Intuitively, whether the banks function as a merged company or not, they are subject to the same no-collusion restrictions. When the no-collusion criteria are enforced, the optimal contracts for strategic and merging banks coincide. Whereas if the no-collusion limitations are relaxed, combined banks can give stronger incentives to their loan officers because the free-riding effect is missing, resulting in increased monitoring, i.e., the equilibrium monitoring effort function goes up from $m_2(\lambda)$ to $m_{mb}(\lambda)$.

4.2.2 Competing versus cooperating loan officers: the rent-jamming effect

Following that, we examine the role of the rent-jamming effect by contrasting the baseline framework in Section 3.2 with one in which the rent-jamming effect is missing. To be more specific, we consider a scenario in which the loan officers cooperate in the sense that if at least one of them is successful in monitoring, they communicate this knowledge among themselves. Furthermore, if they decide to conspire with the corporation, they will collect the bribe jointly. Assume at least one of the loan officers is successful, and the loan officers all conspire with the borrower. In this situation, the no-collusion restriction is given by:

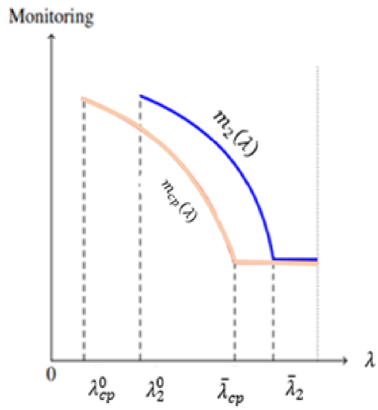
$$s_i + s_j \geq 2(1 - \lambda)$$

Bank i would thus select (m_i, s_i) to maximize the same objective function as in the case of two-bank lending, (3.13), subject to the same participation and feasibility requirements, (3.11) and (3.12), respectively, as well as the (joint) no-collusion constraint, (3.10). When we compare the best contract in this case to the one given in Proposition 4, we can see how the rent-jamming effect affects the optimal monitoring and loan officer incentives.

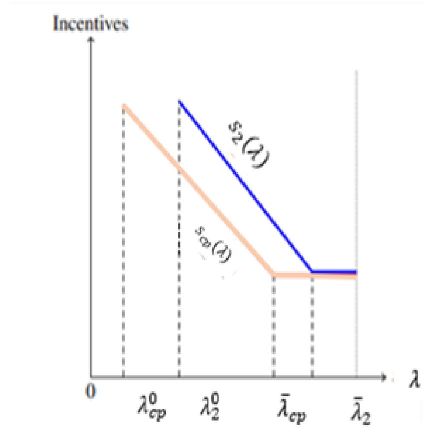
Proposition 7. *When loan officers compete for bribes rather than acting cooperatively, the equilibrium monitoring effort is larger and loan officer incentives are stronger.*

The results in Proposition 7 is depicted in Figure 4.3. Intuitively, lesser shares are required to dissuade collusion when loan officers cooperate rather than compete for bribes. When the monitors compete, the minimal share required to dissuade collusion in each bank-loan officer relationship is provided by $2(1 - \lambda)$. When they collaborate, however, (3.10) shows that the least aggregate collusion-deterring share $s_i + s_j$ is $2(1 - \lambda)$. As a result of the equilibrium monitoring effort function shifting down from $m_2(\lambda)$ to $m_{cp}(\lambda)$, the rent-jamming effect disappears and the inefficiency due to incentives for over-monitoring decreases. As a result, the required incentives are lower, and the optimal share decreases from $s_2(\lambda)$ to $s_{cp}(\lambda)$.

Figure 4.3. The equilibrium monitoring effort and share.



(a) Equilibrium monitoring



(b) Equilibrium share

The equilibrium monitoring effort and share under competing and cooperating loan officers. Subscript 'cp' denotes the variables under cooperating loan officers. Source: Own elaboration.

4.3 The loan structure used by the firm

We will now examine the borrower's decision to choose between loans from one or two banks. Remember that one of the contrasts between the two financial agreements is that, if the project is successful, the corporation obtains double the cash flow but also pays twice the sum. It would be beneficial to control for effects that occur only from the difference in loan size when comparing borrowers' preferences between the two financing modalities, so that we can isolate the impacts of incentives. To that purpose, we significantly tweak the single bank lending mode by assuming that the organization has two identical single bank loan connections.

In this scenario, each loan officer is responsible for only one project, and there are no monitoring spillovers, which means that if loan officer I is successful in monitoring the project's bank finances, monitor j does not profit from his success. This funding structure is referred to as independent funding (a scheme denoted by S). Clearly, the equilibrium monitoring effort under separate financing, i.e., $m_S(\lambda)$ is the same as with single-bank lending, $m(\lambda)$. The expected payoff of the firm under single-bank lending is $F(\lambda) = \theta rm(\lambda)(\lambda - 1) + \theta(1 - \lambda r)$. Therefore, borrower payoff under separate financing is $F_S(\lambda) = 2F(\lambda) .We compare F_S(\lambda)$ with the expected payoff of the firm under two-bank lending which is $F_2(\lambda) = 2[2\theta r\pi_2(\lambda)(1 - \lambda) + \theta(1 - 2\lambda r)]$. The difference in the payoffs between the two modes is given by:

$$F_S(\lambda) - F_2(\lambda) = 2\theta[r(m(\lambda) - 2\pi_2(\lambda))(\lambda - 1) + \lambda r]$$

Which is positive if and only if $2\pi_2(\lambda) \geq m(\lambda)$. It is worth noting that, assuming the firm is sensible, the estimated amount to be repaid, $2\theta r$, is the same under both financing modalities. As a result, when the likelihood that the bank is aware of the genuine income is low, the borrowing firm favors the financing arrangement that results in lower collective monitoring intensity.

Proposition 8. *When the likelihood that the bank knows the genuine income is low, i.e., $\lambda < \lambda_2^0$, only separate financing is conceivable, whereas for high values of probability, both financing arrangements—namely, separate financing and two-bank lending—are feasible.*

1) *If either $c > 0$ and $\theta r \leq \frac{1}{2}\left(\sqrt{5c} - c\right)$, then there is a unique $\theta_F \in \left(\lambda_2^0, 1\right)$ such that $F_S(\lambda) \leq F_2(\lambda)$ if and only if $\lambda \geq \theta^F$;*

2) *Otherwise, $F_S(\lambda) > F_2(\lambda)$ for all $\lambda \in \left[\lambda_2^0, 1\right]$.*

3) *In both of the preceding situations, bank monitoring, taking the borrowing firm's choice of lending structures into consideration, is non-increasing in the probability λ.*

To grasp the preceding proposition, imagine a low probability that the bank knows the genuine income, i.e., low values of λ. Because $\pi_2(\lambda) \geq m_2(\lambda)$ and $m_2(\lambda) > m(\lambda)$ due to the rent-jamming effect, two-bank lending necessitates more aggregate monitoring. As a result, when the chance is minimal, the corporation favours independent financing over aggregate follow-up. The free-riding effect, on the other hand, prevails at high λ levels. However, even if the [degree of non-delegation of] individual monitoring effort is lower with two-bank loans (that is, $m_2^* < m^*$), aggregate monitoring is not necessarily lower than with separate (equivalently single-bank) funding. To grasp this, consider the extent of the free-riding problem as $m^* - m_2^*$. As parasitism is severe, the level of aggregate monitoring without delegation under two-bank loans, π_2^* is clearly lower (higher) than with separate funding, m^* (slight). Parts (a) and (b) of the preceding proposition arise from the fact that the breadth of the parasitism issue,$m^* - m_2^*$, decreases by c and increases by θr.

For low probability values, that is, $\lambda \leq \theta^F$, the company chooses separate funding, and therefore bank monitoring matches $m(\lambda)$ for all $\lambda \leq \theta^F$. In contrast, the firm decides to borrow from two banks for $\lambda > \theta^F$, and so bank control is given by $m_2(\lambda)$ for all $\lambda > \theta^F$. As a result, bank monitoring that takes the borrower's preference into account does not improve the probability. If portion (b) of the previous proposition is correct, the corporation chooses separate funding for every λ, and so the monitoring effort is $m(\lambda)$, which is also not increased by λ .

Chapter 5

The collusion-proofness principle

Tirole (1986) establishes the collusion-proofness principle, which states that limiting attention to collusion-free contracts results in no loss of generality. We abstracted from the issue of whether or not the collusion-proofness principle holds in the baseline model. 18 However, for the sake of completeness, we will now address this matter.

5.1 The collusion-proofness principle under single-bank lending

Proposition 9. *There is a unique probability threshold $\lambda > \lambda^0$ such that there is a collusion equilibrium for any $\lambda > \lambda^0$. Furthermore, for each $\lambda \leq \lambda^0$, the bank provides a free collusion contract. The bank establishes a positive level of monitoring in the collusion equilibrium, which is given by:*

$$m \leq \frac{2\,(1-\lambda)^2\,\beta r\theta}{c}$$

In the no collusion equilibrium, however, the bank sets the amount of monitoring to its maximum, i.e. $m = 1$.

If the signal's informativeness is high, it is not in the best interests of the principal to commit to collusion-free contracts because the projected profits from discouraging collusion are limited.

5.2 The principle of collusion-proofness in two-bank lending

We will see that the collusion-proofness principle can fail in this case. Because monitoring technology is a public utility, one bank may find it advantageous to take benefit of the information gathered by the other and so save on the cost of giving incentives by not hiring a monitor. We demonstrate that if the signal's informativeness is strong enough, it is best for both banks to offer collusion-free contracts to their loan officers. However, if λ is tiny, then while one bank implements the collusion-free contract, the other bank does not; instead, it benefits from the monitoring performed by its rival bank.

1) If both banks implement the collusion-free contract in such a way that neither loan officer colludes, the equilibrium strategy profile is (NC, NC);

2) If one bank does not implement the collusion-free contract while the other does, the equilibrium strategy profile is (C, NC);

3) If neither of them implements the collusion-free contract., the equilibrium strategy profile is (C, C)

Without sacrificing generality, we assume that in an equilibrium (C, NC), bank i does not execute the collusion-free contract, but bank j does. It is worth noting that for large values of λ, that is, $\lambda > \bar{\lambda}_2$, neither (3.9) nor (3.10) binds, and so the banks are unconcerned about the incentive difficulties that may arise from collusion possibilities. As a result, (NC, NC) is an equilibrium for every $\lambda > \bar{\lambda}_2$. The equilibrium (C, NC), (C, C) can only hold for $\lambda \leq \bar{\lambda}_2$, thus we focus on the probability $\lambda \leq \bar{\lambda}_2$ to determine whether banks have incentives not to execute collusion-free contracts. We move through a number of lemmata.

Lemma 2. *There is a unique threshold of probability $\theta^d < \bar{\lambda}_2$, such that for any $\lambda \geq \theta^d$ there is an (NC, NC) equilibrium.*

Lemma 3. *There is a unique threshold of probability $\hat{\theta}$, with $\theta^d < \hat{\theta} \leq \bar{\lambda}_2$ such that for any $\lambda \geq \hat{\theta}$ there is an (C, NC) equilibrium.*

Lemma 4. *There is a unique threshold of probability θ^c, with $\theta^c < \theta^d < \hat{\theta} \leq \bar{\lambda}_2$ such that for any $\lambda \geq \theta^c$ there is an (C, C) equilibrium.*

It is important to note that the equilibrium (NC, NC) corresponds to the equilibrium stated in Section 3.2, which is the sole one for any $\theta^d < \bar{\lambda}_2$. In other words, the collusion-proof principle applies to all $\theta^d < \bar{\lambda}_2$ values. For intermediate values of the signal's informativeness, there exist multiple equilibria—one of type (NC, NC), another of type (C, NC), and one of type (C, C), and so the collusion-proofness principle holds only weakly over this range of probability. For low λ, it is best for bank I not to discourage collusion.

In an equilibrium (C, NC), when bank I has no purpose of discouraging collusion, it intuitively sets $s_i = 0$. Furthermore, because loan officer I colludes, neither bank benefits from whatever monitoring this loan officer may do, therefore we get $\pi(m_i, m_j) = m_j$. As a result, this condition is comparable to the case in which bank I does not employ any loan officers, i.e. $m_i = 0$, saving the cost of giving incentives and taking use of the loan officer j's monitoring effort. When the informativeness of the signal is strong, the cost of providing incentives to dissuade collusion is cheap since larger values of λ suggest a lesser incentive for vertical collusion.

Proposition 10. *Single bank lending implies larger range of the probability in which the collusion-proofness principle.*

Proposition 11 show that under multiple bank lending, the collusion-proofness principle holds in a smaller range on probability. These results are driven by the free-riding effect and the presence of the external probability.

Chapter 6

Conclusion

We have considered the problem of a principal attempting to obtain income from a privately informed agent and a loan officer. A contribution of our analysis is to note that if the principal is able to know the true state of the world it can affect financial contracts. The degree to which this affects the contract depends on its value. For instance, if the principal cannot know the true state of the world, then they will offer a contact with the highest monitoring effort. As the probability increases, then the monitoring effort decreases. This is because if the principal knows that he has a high probability of knowing (even without monitoring) the true state of the world, then the higher this probability, the less monitoring by the loan officer he will need. Note that for higher probability values, the monitoring required of the loan officer coincides with that which the principal performs when he monitors.

Our results suggest that there is also a relationship with the share offered to the loan officer and the probability at which the banks know the true income. Intuitively, when the principal has a high probability of knowing the true income, then he is not going to care if the loan officer and the firm collude, because he is still going to know the income. So, the higher this probability, the lower the share will be, until it reaches a limit value, which is the minimum share accepted by the loan officer for implementing the same monitoring effort as when the principal monitors. Moreover, in both settings, the monitoring level is higher than the socially efficient level.

On the other hand, we know that in instances where borrower misconduct can only be verified by costly monitoring by lenders, multiple-bank lending is often considered as adverse to efficiency in the sense that it might lead to a free-riding problem in monitoring (e.g. Khalil and Parigi (2007)), hence lowering the monitoring effort of each lender. We discovered another source of inefficiency if monitoring operations must be delegated and there is a possibility of vertical collaboration between a loan officer and the borrower, resulting in the rent-jamming effect. The rent-jamming effect assures that if the probability is low, then the incentives supplied to monitors are larger in order to dissuade collusion, resulting in a higher level of monitoring. Our research also has some intriguing implications. For example, when the chance is large, borrowers are financed through standard multiple-bank lending. Second, they borrow from lending syndicates when the probability is minimal.

Appendix A

Appendix

A.1 Proof Proposition 1

Consider the (3.4) maximization issue. First, we argue that neither $m = 0$ nor $s = 1$ is an optimal choice. When $m = 0$ or $s = 1$, $B(m, s) = 1 < 0$, and hence the bank is better off not lending. Furthermore, $s = 0$ is not ideal since it violates the loan officer's participation condition at any $m > 0$. As a result, the only important feasibility constraint left is $m \leq 1$. The Lagrangian is supplied by:

$$\mathcal{L} = mr\theta\,(1 - s) - 1 + \mu_p \left(mrs\theta - \frac{1}{2}cm^2\right) + \mu_N\,(s - 1 + \lambda) + \mu_F\,(1 - m)$$

where μ_P , μ_N and μ_F are the associated Lagrange multipliers. The Karush-Kuhn-Tucker conditions are

$$\frac{\partial L}{\partial m} = \theta r\,(1 - s) + \mu_t p\,(rs\theta - cm) - \mu_F \tag{A.1}$$

$$\frac{\partial L}{\partial s} = -m\theta r + \mu_p mr\theta + \mu_N \tag{A.2}$$

$$\mu_p \left(mrs\theta - \frac{1}{2}cm^2\right) = 0 \tag{A.3}$$

$$\mu_N\,(s-1+\lambda)=0$$

$$\mu_F\,(1-m)=0$$

$$\left(mrs\theta-\frac{1}{2}cm^2\right)\geq 0$$

$$(s-1+\lambda)\geq 0$$

$$(1-m)\geq 0$$

$$\mu_p\geq 0$$

$$\mu_N\geq 0$$

$$\mu_F\geq 0$$

First, consider the case when $m<1$ and hence $\mu_F=0$. The participation requirement must be binding in this scenario. If, on the other hand, it does not bind, then $\mu_P=0$, and so (A.1) implies $s=1$ and $B(m,\ s)=-1<0$. As a result, the bank is better off not lending. There are two sub-cases given that the participation constraint binds at the optimum. Assume that the no-collusion constraint holds, i.e., $s=1-\lambda$. We obtain by substituting the value of s into the binding participation constraint:

$$m=\frac{2r\theta\,(1-\lambda)}{c}$$

Because (3.3) is slack, i.e., $m<1$, we have that $\lambda>1-\frac{c}{2r\theta}\equiv\lambda^0$. Substituting m, s and $\mu_F=0$ into (A.1) and (A.2), we obtain

$$\mu_P=\frac{\lambda}{1-\lambda}\quad and\quad \mu_N=\frac{(2-4\lambda)\,(r\theta)^2}{c}.$$

Now, $\mu_N\geq 0$ implies $\lambda\leq\frac{1}{2}\equiv\bar{\lambda}$

Consider the sub-case where the no-collusion criterion is weak, i.e., $\mu_N=0$. Thus, substituting

$\mu_N = \mu_F = 0$ into (A.1) and (A.2), we obtain

$$\theta r\,(1 - s) + \mu_P\,(\theta r s - cm) = 0, \tag{A.4}$$

$$-\theta r m + \mu_P\, r m \theta = 0. \tag{A.5}$$

It follows from (A.5) that $\mu_P = 1$. By substituting $\mu_P = 1$ into (A.4), we get $m = \theta r / c$. We get $s = 1/2$ from the binding participation restriction. We have $s > 1 - \lambda \Longleftrightarrow \lambda > \frac{1}{2}$ because the no-collusion constraint is lax.

Consider the scenario where $\mu_F > 0$, implying that $m = 1$. The no-collusion condition must bind in this scenario. Assume not, i.e., $\mu_N = 0$. By substituting $m = 1$ and $\mu_N = 0$ into (A.2), we get $\mu_P = 1$. Substituting $\mu_P = 1$ into (A.1) yields $\theta r - c = \mu_F > 0$, which contradicts our assumption that

$$\theta r \leq c$$

. As a result, the no-collusion constraint holds, and $s = \lambda - 1$. With $m = 1$ and $s = 1 - \lambda$, we need $\theta r \lambda - 1 \geq 0 \Longleftrightarrow \lambda \geq \frac{1}{\theta r} \equiv \lambda^{min}$ for each bank to break even. The participation constraint, on the other hand, simplifies to $-\lambda r\theta + r\theta - \frac{c}{2} \geq 0$, which is identical to $\lambda \leq 1 - \frac{c}{2r\theta} \equiv \lambda^0$. Finally, we show that the bank makes a non-negative expected profit in the collusion-free equilibrium. The bank's net profit is:

$$B = \begin{cases} \theta r \lambda - 1 & \lambda^{min} \leq \lambda \leq \lambda^0 \\ \frac{2(\theta r)^2(1-\lambda)\lambda}{c} - 1 & \lambda^0 < \lambda \leq \bar{\lambda} \\ \frac{(\theta r)^2}{2c} - 1 & \lambda > \bar{\lambda} \end{cases}$$

A.2 Proof Proposition 2

It is important to note that m^{**} is a strictly increasing function of λ that is maximized at $\lambda = 1$, i.e., $m^{**}\,(1) = \frac{\theta r}{c} = \min m(\lambda)$.

As a result, the equilibrium under the single-bank lending mode involves over-monitoring in comparison to the socially optimum level of monitoring.

A.3 Proof Proposition 3

From

$$\left(1 - m_j\right)\theta r + m_j\hat{\theta}r - cm_i = 0$$
$$\left(1 - m_i\right)\theta r + m_i\hat{\theta}r - cm_j = 0$$

We have that

$$\left(m_i\right)\theta r - m_i\hat{\theta}r + cm_j = \left(m_j\right)\theta r - m_j\hat{\theta}r + cm_i$$

Which gives us a symmetric solution, i.e, $m_j = m_i$ Using one of the first order conditions, and substituting $m_j = m_i$, we have

$$\left(1 - m_i\right)\theta r + m_i\hat{\theta}r - cm_i = 0$$

Then,

$$m_i^* = \frac{\theta r}{c + \theta r - \hat{\theta}r}$$

A.4 Proof Lemma 1

Consider the Bank i maximization issue; the only significant feasibility constraints are $m_i \leq 1$ and $m_j \leq 1$. As a result, the Lagrangean for bank i is given by:

$$\mathcal{L}_i = \pi\left(m_i,\ m_j\right) r\theta\left(1 - s_i\right) - 1 + \mu_p^i\left(\pi\left(m_i,\ m_j\right) r s_i\theta - \frac{1}{2}cm_i^2\right) + \mu_N^i\left(s_i - 1 + \lambda\right) + \mu_F^i(1 - m_i)$$

where μ_P , μ_N and μ_F are the associated Lagrange multipliers. The Karush-Kuhn-Tucker conditions are

$$\frac{\partial L}{\partial m_i} = (1 - m_j)\theta r\,(1 - s) + \mu_p^i\,(r s_i \theta - c m_i) - \mu_F^i \tag{A.6}$$

$$\frac{\partial L}{\partial s_i} = \pi\left(m_i,\ m_j\right)(\mu_p^i - 1) - \mu_N^i \tag{A.7}$$

$$\mu_p^i\left(\pi\left(m_i,\ m_j\right) r s_i \theta - \frac{1}{2} c m_i^2\right) = 0 \tag{A.8}$$

$$\mu_N^i\,(s_i - 1 + \lambda) = 0$$

$$\mu_F^i\,(1 - m_i) = 0$$

$$\pi\left(m_i,\ m_j\right) r s_i \theta - \frac{1}{2} c m_i^2 \geq 0\,(s_i - 1 + \lambda) \geq 0$$

$$(1 - m_i) \geq 0$$

$$\mu_p^i \geq 0\,, \quad \mu_N^i \geq 0\,, \mu_F^i \geq 0 \tag{A.9}$$

Bank j has similar optimality conditions. At the optimum we must have $m_i < 1$, $m_j < 1$. Suppose $m_j = 1$, (A.6) reduces to

$$-\mu_p^i c m_i = \mu_F^i$$

Given that $m_i > 0$, the above equation indicates that μ_p^i and μ_F^i have opposite signs, which contradicts the non-negativity conditions in (A.9) As a result, $m_j < 1$, $\mu_F^j = 0, m_i < 1\ and\ \mu_F^i = 0$.

Following that, we demonstrate that both participation constraints must bind at the optimum. Assume that at least one of them, say (3.11), is slack, and therefore $\mu_p^i = 0$. Given that $\mu_F^i = 0$, (A.6) reduces to

$$\left(1 - m_j\right)\theta r\,(1 - s_i) = 0$$

Given that $m_j < 1, \ s_i = 1 and B_i < 0$. Finally, the restrictions on participation bind. The loan officer i bound participation constraint produces

$$r s_i \theta = \frac{c m_i^2}{2\,\pi\left(m_i,\ m_j\right)} \tag{A.10}$$

By substituting s_i into the objective function and imposing the no collusion requirement,

$$max_{m_i}\ \pi\left(m_i,\ m_j\right) t\theta r - \frac{1}{2} c m_i^2 - \ 1\ s.t \frac{c m_i^2}{2\,\pi\left(m_i,\ m_j\right)} \geq 2(1-\lambda)$$

When the loan officer's no collusion constraint applies at the optimum, the first order conditions of the maximization problems of banks I and j produce the best reply functions, that solve $m_i\left(m_j\right)$ and $m_j(m_i)$

$$\theta r\left(1 - m_j\right) - c m_i = 0 \tag{A.11}$$

$$\theta r\left(1 - m_i\right) - c m_j = 0 \tag{A.12}$$

It is important to note that $m_i'\ \left(m_j\right) = m_j'\ (m_i) = -\frac{\theta r}{c} < 0$, and so m_i and m_j are strategic replacements. Finally, we show that when both no-collusion constraints are satisfied, m_i and m_j are strategic complements for $m_i, m_j \in [0, 1]$. In this situation, the optimal response functions $m_i(m_j)$ and $m_j(m_i)$ answer the two equations below:

$$c m_i^2 \ = \ 4\,(1-\lambda)\,\pi\,(mi,\ mj\ )\,r\theta \tag{A.13}$$

$$c m_j^2 \ = \ 4\,(1-\lambda)\,\pi\,(mi,\ mj\ )\,r\theta(27) \tag{A.14}$$

Because the behavior of $m_i(m_j)$ is symmetric, analyzing its behavior suffices to verify the assumption. To begin, (3.14) might be written as

$$\frac{m_i^2}{m_i + m_j - m_i m_j} = \frac{4\,(1-\lambda)\,r\theta}{c}$$

The answer on the left side of the equation is less than one. In order to be in equilibrium, we must have $c \geq 4(1-\lambda) r\theta$. When we solve for m_i from (3.14), we get

$$m_i\left(m_j\right) = \frac{-\frac{4(1-\lambda)r\theta}{c}m_j + \frac{4(1-\lambda)r\theta}{c} \pm \sqrt{\left(\frac{4(1-\lambda)r\theta}{c}m_j - \frac{4(1-\lambda)r\theta}{c}\right)^2 + 4\frac{4(1-\lambda)r\theta}{c}}}{2}$$

Differentiating the above expression we obtain

$$m_i\prime\left(m_j\right) = \frac{-\frac{4(1-\lambda)r\theta}{c} + \frac{1}{2}\left(\left(\frac{4(1-\lambda)r\theta}{c}m_j - \frac{4(1-\lambda)r\theta}{c}\right)^2 + 4\frac{4(1-\lambda)r\theta}{c}\right)^{-\frac{1}{2}} 2\left(\frac{4(1-\lambda)r\theta}{c}m_j - \frac{4(1-\lambda)r\theta}{c}\right)\frac{4(1-\lambda)r\theta}{c}}{2}$$

The above expression is positive if $c \geq 16(1-\lambda) r\theta$.

A.5 Proof Proposition 4

We have already demonstrated that both participation constraints are binding. We have two possibilities: (a) both no-collusion restrictions bind, and (b) neither binds. Consider the case where the no-collusion requirements are enforced. The optimal m_i and m_j are solutions to the (3.14) and (3.15) systems, which have two symmetric solutions.

$$(0,0) \quad and \quad \left(\frac{8\left((1-\lambda) r\theta\right)}{c+4(1-\lambda) r\theta}, \quad \frac{8\left((1-\lambda) r\theta\right)}{c+4(1-\lambda) r\theta}\right)$$

Because each bank's expected profit equals -1 when $m_i = m_j = 0$, this method is not ideal. The alternative symmetric solution thus provides the optimal monitoring efforts m_i and m_j. Using (A.10), we can calculate the optimal share, which is provided by:

$$s_i = 2(1-\lambda)$$

The feasibility constraints must be slack and we require

$$m_2 = \frac{8\left(\left(1-\lambda\right) r\theta\right)}{c+4\left(1-\lambda\right) r\theta} < 1 \leftrightarrow \lambda > \frac{c}{4r\theta}+1 \equiv \lambda_2^{\circ}$$

Consider the instance where the no-collusion requirements do not apply. Because both $m_i(m_j)$ and $m_j(m_i)$ defined by (A.11) and (A.12) are linear and downward-sloping, the system of equations has a unique solution that is also symmetric. This is provided by

$$m_i = \frac{r\theta}{c+r\theta}$$

And the optimal share is

$$s_i = \frac{cr}{4c+2r\theta}$$

The non-binding no-collusion constraints imply

$$\frac{cr}{4c+2r\theta} > 2\left(1-\ \lambda\right)\lambda > \frac{8c-4r\theta-cr}{8c+4r\theta} \equiv \bar{\lambda}_2$$

A.6 Proof Proposition 4.1

We first show that $\bar{\lambda}_2 > \bar{\lambda}$ which is equivalent to $\frac{8c+4r\theta-cr}{8c+4r\theta} > \frac{1}{2}$. The last inequality always holds because $\frac{1}{2} > \frac{cr}{8c+4r\theta}$, then $\frac{4}{r}+\frac{2\theta}{c} > 1$. It is also necessary to show that $\bar{\lambda} < \lambda_2^0$, which holds because $\frac{1}{2} > \frac{c}{4r\theta}$, then $\frac{2r\theta}{c} > 1$.

To show part (a), note that because $\bar{\lambda} < \lambda_2^0$ we have $m_1\left(\lambda_2^0\right) = \frac{\theta r}{c}$. Thus,$m_2\left(\lambda_2^0\right) = 1 \geq \frac{\theta r}{c} = m_1\left(\lambda_2^0\right)$. On the other hand, $m_2\left(\bar{\lambda}_2\right) = \frac{2c\theta r^2}{2c^2+cr\theta+c\theta r^2} < \frac{\theta r}{c} = m_1\left(\bar{\lambda}_2\right)$. Because $m_2\left(\lambda\right)$ is strictly decreasing on $\left[\lambda_2^0, \bar{\lambda}_2\right]$, there is a unique $\theta^m \in (\lambda_2^0,\ \bar{\lambda}_2)$ such that $m_2\left(\lambda\right) > m\left(\lambda\right)$ if and only if $\lambda < \theta^m$. The proof of part (b) is similar because $s_2\left(\lambda_2^0\right) = \frac{c}{2r\theta} > \frac{1}{2} = s\left(\lambda_2^0\right)$ and $s_2\left(\bar{\lambda}_2\right) = \frac{cr}{4c+2r\theta} < \frac{1}{2} = s\left(\bar{\lambda}_2\right)$ and $s_2\left(\lambda\right)$ is a strictly decreasing function.

A.7 Proof Proposition 6

The merged bank maximizes shared earnings while offering loan officers i and j individualized contracts $(m_i\ ,\ s_i)$ and $(m_j\ ,\ s_j)$, respectively. As a result, we can determine the best contract for each loan officer individually. The best contract $(m_i\ , s_i)$ between loan officer I and the merged entity solves the following problems:

$$\max_{\{m_i\ ,s_i\}} \pi(m_i\ ,\ m_j)pr(2 - s_i\ - s_j) - 2,$$

subject to (3.8), (3.11), (3.12). Subscript 'mb' denotes the threshold levels of firm quality and the equilibrium variables. When both no-collusion conditions bind in a symmetric equilibrium, as in Proposition 4, the optimal contracts overlap with those under two bank lending. As a result, we have $\lambda^0_{mb} = \lambda^0_2$, $m_{mb}(\lambda) = m_2(\lambda)$ and $s_{mb}(\lambda) = s_2(\lambda)$. This is due to the fact that the rent-jamming effect is equally strong under both loan structures.

When none of the no-collusion criteria bind, the equilibrium contracts of merged banks differ from those of two-bank lending (strategic banks). The reason is straightforward. When the no-collusion restrictions are lax, we can ignore both the no-collusion and feasibility constraints and write using the binding participation constraints in both loan modes.

$$\pi\left(m_i\ , m_j\right)\theta\ rs_i = \frac{1}{2}\ cm_i^2,\ \ and\ \ \pi\left(m_i\ ,\ m_j\right)\theta\ rs_j = \frac{1}{2}cm_j^2$$

When banks choose the contracts independently, and the preceding expressions are substituted into the objective functions, the payoffs of banks i and j are reduced to:

$$B_i\left(m_i\ ,\ m_j\right) \equiv \pi\left(m_i\ ,\ m_j\right)\theta\ r\ - \frac{1}{2}\ cm_i^2 - 1,\ \ and\ \ B_j\left(m_i\ ,\ m_j\right) \equiv \pi\left(m_i\ ,\ m_j\right)\theta\ r\ - \frac{1}{2}\ cm_j^2 - 1$$

On the other side, the combined entity's goal function [under binding participation constraints] becomes

$$B\left(m_i,\ m_j\right) \equiv 2\pi\left(m_i\ ,\ m_j\right)\theta\, r\ -\frac{1}{2}\,cm_i^2 - \frac{1}{2}\,cm_j^2 - 2$$

It is important to note that, in the case of strategic banks, each bank seeks to maximize the net surplus of the bank-monitor relationship, defined as the bank's expected revenue minus the sum of monitoring costs and the opportunity cost of capital. In contrast, merging banks optimize joint projected income less aggregate monitoring and opportunity costs. Clearly, the aggregate surplus is bigger in merged banks due to the lack of the free-riding problem, and thus monitoring efforts, shares, and aggregate monitoring intensity are higher than in strategic banks. Thus, in the absence of a collusion incentive problem, we have merged banks.

$$m_{mb}\left(\lambda\right) = \frac{2\theta r}{c+2\theta r},\ \ \pi_{mb}(\lambda) = 1 - \left(\frac{c}{2\theta r + c}\right)^2\ \ and\ \ s_{mb}\left(\lambda\right) = \frac{2c}{8\left(\theta r\right)^2 + 12\theta rc + 6c^2}$$

Each of the preceding statements is strictly greater than that of two-bank lending. It is also true that $\bar{\lambda}_{mb} < \bar{\lambda}_2$, i.e., the incentives for over-monitoring, are reduced in merged banks.

A.8 Proof Proposition 7

When banks choose contracts independently but loan officers cooperate, bank i selects $(m_i\ ,\ s_i)$ to solve

$$max_{\{m_i\ ,s_i\}}\ \pi(m_i\ ,\ m_j)\theta\, r(1 - s_i) - 1,$$

subject to (3.10), (3.11), (3.12). We look at a symmetric equilibrium, where $m_i = m_j$ and $s_i = s_j$. When the no-collusion criterion (10) is relaxed, the equilibrium contracts correspond to those resulting from two-bank lending. When (3.10) is bound, we get $s_i = s_j = 1 - \lambda$. It derives from the legally enforceable participation requirements that

$m_i = m_j = m_{cp}(\lambda) = \frac{4r\theta(1-\lambda)}{c+2r\theta(1-\lambda)}$. We must have $m_{cp}(\lambda) < 1$ which is equivalent to $\lambda > 1-\frac{c}{2r\theta} \equiv \lambda^0_{cp} = \lambda^0 < \lambda^0_2$. The threshold value of borrower quality $\bar{\lambda_{cp}}$ solves $\frac{cr}{4c+2r\theta} = 1-\lambda$, whereas $\bar{\lambda}_2$ solves $\frac{cr}{4c+2r\theta} = 2(1-\lambda)$. Thus, $\bar{\lambda_{cp}} < \bar{\lambda}_2$, i.e., when compared to two-bank lending with competing monitors, cooperative loan officers alleviate the collusion incentive problem. As a result, cooperative loan officers improve their efficiency. It is simple to demonstrate that $m_{cp}(\lambda) < m_2(\lambda)$ and $\pi_{cp}(\lambda) < \pi(\lambda)$ given that $c > 0$. Clearly, $s_{cp}(\lambda) < s_2(\lambda)$.

A.9 Proof Proposition 8

The firm's expected utility under separate financing is given by $F_S(\lambda) = 2F(\lambda) = 2[\theta\, rm\,(\lambda)\,(\lambda-1)+\theta(1-\lambda\, r)]$, whereas that under two-bank lending is given by $F_2(\lambda) = 2[2\theta\, r\pi_2\,(\lambda)\,(1-\lambda)+\theta(1-2\lambda\, r)]$, where $\pi_2(\lambda)$ is the aggregate monitoring intensity under two-bank lending, which is given by:

$$\pi_2(\lambda) = \begin{cases} \pi^0_2 = \frac{16c(1-\lambda)r\theta}{(c+4(1-\lambda)r\theta)^2} & \lambda^0_2 < \lambda \leq \bar{\lambda}_j \\ \pi^*_2 = \frac{2r\theta}{c+r\theta} + \left(\frac{r\theta}{c+r\theta}\right)^2 & \bar{\lambda}_j < \lambda \leq 1 \end{cases}$$

Note first that two-bank lending is feasible only if $\lambda > \lambda^0_2$ which is equivalent to $m_2(\lambda) < 1$. Because $F_S\,(\lambda) - F_2\,(\lambda) = 2\theta\,[r\,(m\,(\lambda) - 2\pi_2\,(\lambda))\,(\lambda-1) + \lambda r]$ and $\lambda - 1 \leq 0$, the firm prefers separate financing if and only if $2\pi_2(\lambda) \geq m(\lambda)$. Recall also that $\bar{\lambda} < \lambda^0_2$, and hence, $m(\lambda) = m^*$ for all $\lambda \in [\lambda^0_2, 1]$, where m^* is the non-delegation level of monitoring under single-bank lending. Because $\pi_2\left(\lambda^0_2\right) = 1 > \frac{\theta r}{c} = m^* = m(\lambda^0_2)$ and $\pi_2(\lambda)$ is strictly decreasing on $[\lambda^0_2, 1]$, we must compare $m(\bar{\lambda}_2) = m^*$ with $\pi_2(\bar{\lambda}) = \pi^*_2$. When $c > 0$ and $\theta\, r \geq \frac{1}{2}(\sqrt{5}c - c)$, we have $m^* > \pi^*_2$ which guarantees the existence and uniqueness of $\theta^F \in (\lambda^0_2, 1) such$ that $\pi_2(\lambda) \geq m(\lambda)$ if and only if $\lambda \leq \theta^F$. Therefore, $F_S(\lambda) \geq F_2(\lambda)$ if and only if $\lambda \leq \theta^F$. On the other hand, if $c > 0$ and $\theta\, r \leq \frac{1}{2}(\sqrt{5}c - c)$, then $m^* < \pi^*_2$, and hence, $\pi_2(\lambda) > m(\lambda)$, i.e., $F_S(\lambda) \geq F_2(\lambda)$ for all $\lambda \in \left(\lambda^0_2\right., 1]$ ..

A.10 Proof Proposition 9

For a given distribution $(\beta, 1\beta)$ of bargaining power between the loan officer and the firm, the Nash bargaining solution for the optimal bribe is given by:

$$max\theta \ \left[(\mathbf{1}-\lambda)\, r\left(\theta-\hat{\theta}\right)-b\right]^{\mathbf{1}-\beta}\left[b-sr\left(\theta-\hat{\theta}\right)\right]^{\beta}$$

The first order condition is represented by

$$(1-\beta)\left[(\mathbf{1}-\lambda)\, r\left(\theta-\hat{\theta}\right)-b\right]^{-\beta}(\mathbf{1}-\lambda)\, rb^{\beta}=0b=max\left\{0,\ [\beta(1-\lambda)+(1-\beta)\, s]\, r\left(\theta-\hat{\theta}\right)\right\}$$

Thus, the loan officer's participation constraint is given by:

$$m\lambda sr\theta+(1-\lambda)\, mb-\frac{1}{2}cm^{2}\geq 0$$

Then,

$$m\leq\frac{2\,(1-\lambda)^{2}\,\beta r\theta}{c}(A)$$

Given that the bank does not implement the collusion-free contract, s_i should be set to 0. As a result, the bank resolves

$$\max B_C = m\lambda\theta r-1\ \ st\ A$$

On the other hand, by implementing the collusion-free contract, the bank obtains

$$B_{NC}=\begin{cases}\theta r\lambda-1 & \lambda^{min}\leq\lambda\leq\lambda^{0}\\ \frac{2(\theta r)^{2}(1-\lambda)\lambda}{c}-1 & \lambda^{0}<\lambda\leq\bar{\lambda}\\ \frac{(\theta r)^{2}}{2c}-1 & \lambda>\bar{\lambda}\end{cases}$$

Thus, the bank does not deviate from the collusion free contract if and only if $B_{NC} \geq B_C$ Note that for $\lambda^{min} \leq \lambda \leq \lambda^0$, the bank is indifferent between the two contracts. However, for $\lambda > \lambda^0$, the bank chooses the collusion contract, because $B_C \geq B_{NC}$. Note that for $\lambda^0 < \lambda \leq \bar{\lambda}$, we have $\frac{2(\theta r)^2(1-\lambda)\lambda}{c} - 1 \leq \lambda\theta r - 1$ if and only if $\lambda > 1 - \frac{c}{2\theta r} \equiv \lambda^0$. In addition, for $\lambda > \bar{\lambda}$ $\frac{(\theta r)^2}{2c} - 1 \leq \lambda\theta r - 1$ if and only if $\lambda > \frac{\theta r}{2c}$, and $\lambda > \frac{1}{2}$.

A.11 Proof Lemma 2

Consider the scenario in which loan officer j is strategic, and hence bank j must enforce the no-collusion requirement. Consider a (NC, NC) equilibrium and consider whether bank I can profitably deviate by not executing the collusion-free contract, i.e., a contract that violates the no-collusion condition (3.9). Remember that the risk of collaboration arises if loan officer I is successful in monitoring while loan officer j is not. As a result, if the equilibrium involves loan officer I conspiring with the borrower, this occurs with probability $m_i\ (1 - m_j)$. For a given distribution $(\beta,\ 1 - \beta)$ of bargaining power between loan officer I and the firm, the Nash bargaining solution for the optimal bribe is given by:

$$b_i^*(\lambda) = max\,\{0, 2\beta\ \ (1 - \lambda)\, r\theta\}$$

Thus, the participation constraint of loan officer i is given by:

$$m_j\lambda\ s_i r\theta + (1 - \lambda)\, m_i\ \ \left(1 - m_j\right) b_i - \frac{1}{2} c m_j \geq 0$$

Given that bank i does not use the collusion-free contract, it would be best to set $s_i = m_i = 0$, which is comparable to not hiring a loan officer. As a result, bank I solves

$$max_{m_i\in[0,1]} m_j\ \theta r\ - 1$$

Remember that in the (NC, NC) equilibrium, both banks keep an eye on the level

$$m_2 \ (\lambda) = \frac{8 \ (1-\lambda) \, r\theta}{c + 4 \ (1-\lambda) \, r\theta}$$

For $\lambda \leq \ \bar{\lambda}_2$. As a result, the deviation payoff for bank I is calculated by replacing $mi = 0$ and $m_j = m_2$, which is given by:

$$\widetilde{B}_i \, (\lambda) = \frac{8 \, (\theta r)^2 \ (1-\lambda)}{c + 4\theta r \ (1-\lambda)} - 1$$

Remember that in the (NC, NC) equilibrium, the payoff of bank I is given by:

$$B_i \, (\lambda) \ \equiv \ B_2(\lambda) = \frac{16c \ (1-\lambda) \, r\theta}{(c + 4\theta r \ (1-\lambda))^2} \ r\theta \, (2\lambda - 1) - 1.$$

Consequently, bank i does not deviate from (NC, NC) if and only if

$$B_i \, (\lambda) \ \geq \ \widetilde{B}_i \, (\lambda) \iff \lambda \ \geq \frac{3c + 4r\theta}{4 \ (c + r\theta)} \ \equiv \ \theta^d$$

To recapitulate, the equilibrium outcomes in Proposition 4 continue to constitute an equilibrium for every $\lambda \ \geq \ \ \theta^d$. In other words, the collusion-proofness principle holds for all $\lambda \ \geq \ \theta^d$ in the sense that there is one equilibrium in which enforcing the no-collusion restrictions results in no loss of generality.

A.12 Proof Lemma 3

Suppose first that loan officer j is not honest. From Lemma 1 it follows that there cannot be a type equilibrium (NC, NC) for any $\lambda \ \leq \ \ \theta^d$, and hence, (C, NC) is the only possible equilibrium for these values of λ. Because in a (C, NC) equilibrium, we have $s_i = m_i = 0$ and $\pi \left(m_i, m_j\right) = m_j$, bank j solves

$$max_{m_j,s_j\in[0,1]} m_j\theta r\left(1-s_j\right)-1,$$

subject to

$$m_j\theta\, r s_j-\frac{1}{2}cm_j^2\geq 0$$
$$s_j\geq 2\left(1-\lambda\right)$$

The optimal monitoring effort of loan officer j is given by:

$$m_j^c=\begin{cases} 1 & \lambda_j^{min}\leq\lambda\leq\lambda_2^0 \\ \frac{4(\theta r)^2(1-\lambda)}{c}-1 & \lambda_2^0<\lambda\leq\bar{\lambda}_j \\ \frac{\theta r}{c} & \lambda>\bar{\lambda}_j \end{cases}$$

Where $\lambda_j^{min}=\frac{1}{2\theta r}+\frac{1}{2}$, $\lambda_2^0=1-\frac{c}{4\theta r}$ and $\bar{\lambda}_j=\frac{3}{4}$ Bank i's expected payoff at $s_i=0$ is given by:

$$B_I^c=\begin{cases} \theta r-1 & \lambda_j^{min}\leq\lambda\leq\lambda_2^0 \\ \frac{4(\theta r)^2(1-\lambda)}{c}-1 & \lambda_2^0<\lambda\leq\bar{\lambda}_j \\ \frac{(\theta r)^2}{c} & \lambda>\bar{\lambda}_j \end{cases}$$

To prove that such an equilibrium exists, we must show that, given mjc, bank I has no incentive to stray from a collusion-free contract. We begin by calculating bank i's payout from such a deviation when it satisfies the maximization issue (3.13) while keeping in mind that $m_j(m_j^c)$. When the loan officer's no-collusion constraint binds, the bank I would choose $\widetilde{m_i\left(\lambda\right)}\equiv m_i\left(m_j^C\left(\lambda\right)\right)$, where $m_i(m_j)$ is given by

$$cm_i^2=4\ \left(1-\lambda\right)\pi\ \left(m_i,m_j\right)r\theta$$

On the other hand, if loan officer i's no-collusion requirement does not bind, bank i would prefer $m_i\bar{}(\lambda) \equiv m_i\left(m_j^C(\lambda)\right)$, where $m_i(m_j)$ is given by

$$(1 - m_j)\,\theta\, r - c m_i = 0$$

It is important to note that $\widetilde{m_i(\lambda)}$ is strictly decreasing in λ since $m_j^C(\lambda)$ is decreasing in λ, and $m'_i(m_j) > 0$ (i.e., m_i and m_j are strategic complements) when (3.14) returns the best answer. In contrast, $\bar{m}_i(\lambda)$ is not decreasing in λ since $m_j^C(\lambda)$ is decreasing in λ, and $m'_i(m_j) < 0$ (i.e., m_i and m_j are strategic replacements) when the optimal response of bank I is provided by (3.6). The deviation strategies $\widetilde{m_i(\lambda)}$ and $\bar{m}_i(\lambda)$ only cross once at $\lambda = \bar{\lambda}_i$, which is provided by:

$$\bar{\lambda}_i = \frac{\theta r}{4}\left(3 + \frac{c^2}{2 - 2c\theta r + \theta^2 r^2}\right)$$

It is easy to show that $\bar{\lambda}_2 < \bar{\lambda}_i$. As a result, the monitoring level established by bank i in the preceding deviation approach is given by $m_i^{dev}(\lambda) \equiv max\left\{\bar{m}_i(\lambda),\ \widetilde{m_i(\lambda)} = \widetilde{m_i(\lambda)}\right\}$. Also, because the no-collusion constraint of loan officer i binds at this deviation strategy, we have $s_i(\lambda) = 2(1 - \lambda)$ We next turn to compare bank i's expected profit in the (C, NC) equilibrium, $B_i^C(\lambda)$ with $B_i^{dev}(\lambda)$, its payoff from the deviation strategy $m_i^{dev}(\lambda)$, which is given by:

$$B_i^{dev}(\lambda) = \pi(\widetilde{m_i(\lambda)},\ m_j^C(\lambda))\,(\theta\, r(2\lambda - 1) - 1.$$

Note that $B_i^{dev}(\bar{\lambda}_j) < B_i^C(\bar{\lambda}_j)$ because

$$sign\ \left\{B_i^C(\bar{\lambda}_j) - B_i^{dev}(\bar{\lambda}_j)\right\} = sign\ \left\{c^2 + 2c\theta r - \theta^2 r^2 - (c - \theta r)\sqrt{5c^2 - 2c\theta r + \theta^2 r^2}\right\},$$

which is strictly positive. Thus, the fact that $B_i^{dev}(\lambda)$ is strictly increasing on $[\bar{\lambda}_j, \bar{\lambda}_2]$ guarantees the existence of a unique $\hat{\theta} \in (\bar{\lambda}_j, \bar{\lambda}_2]$. If we have, $B_i^{dev}(\bar{\lambda}_2) > B_i^C(\bar{\lambda}_2)$, then there is a unique $\hat{\theta} \in (\bar{\lambda}_j, \bar{\lambda}_2)$. such that $B_i^{dev}(\hat{\theta}) = B_i^C(\hat{\theta})$.Thus, bank i does not deviate to a collusion-free contract if and only if $\lambda \leq \hat{\theta}$. If, on the other hand, we have $B_i^{dev}(\bar{\lambda}_2) \leq B_i^C(\bar{\lambda}_2))$, then bank i cannot profitably deviate to a collusion-free contract for any $\lambda \leq \bar{\lambda}_2$. In this case, set $\hat{\theta} = \bar{\lambda}_2$. So, we have a unique $\hat{\theta} \in (\bar{\lambda}_j, \bar{\lambda}_2]$ so that (C, NC) is an equilibrium for all $\lambda \in [\lambda_j^{min}, \hat{\theta}]$.

A.13 Proof Lemma 4

Given that banks do not implement the collusion-free contract, they would optimally set $s_i = s_j = 0$. Thus, each bank solves

$$\max B_C = m\lambda\theta\, r - 1$$

Subject to the participation constraint of loan officer i, ie:

$$m_j \lambda s_i r\theta + (1-\lambda)\ m_i \left(1 - m_j\right)\ b_i - \frac{1}{2}\, c m_j^2 \geq 0$$

On the other hand, by implementing the collusion-free contract, the bank obtains

$$B_{NC} = \begin{cases} \frac{16c\theta r(1-\lambda)}{[c+4r\theta(1-\lambda)]^2} r\theta\,(2\lambda - 1) - 1 & {\lambda_2}^0 < \lambda \leq \bar{\lambda}_2 \\ \frac{2r+(\theta r)^2}{(c+r\theta)^2}\left(\frac{4c+2\theta r - cr}{4c+2\theta r}\right) - 1 & \lambda > \bar{\lambda}_2 \end{cases}$$

Thus, the bank does not deviate from the collusion free contract if and only if $B_{NC} \geq B_C$ Note that for $\lambda \in \left({\lambda_2}^0, \bar{\lambda}_2\right]$, the bank offers a collusion free contract. However, for $\lambda \geq \frac{8c^2 r\theta - 2c^2 r^2\theta - 2r\theta + cr^3\theta^2}{4c^3 + 10c^2 r\theta + 8c^2\theta^2 c + 2r^3\theta^3} = \theta^c$, the bank chooses the collusion contract, because $B_C \geq B_{NC}$

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