

Monitoring and incentives under multiple-bank lending: The role of collusive threats[☆]

Kaniška Dam^{a,*}, Prabal Roy Chowdhury^b

^a *Centro de Investigación y Docencia Económicas, 3655 Carretera Mexico-Toluca, Lomas de Santa Fe, 01210 Mexico City, Mexico*

^b *Indian Statistical Institute, Delhi Center, 7 Sahid Jit Singh Sansanwal Marg, New Delhi, India*

Received 1 August 2020; final version received 15 July 2021; accepted 16 July 2021

Available online 4 August 2021

Abstract

We examine interactions between multiple bank-loan officer-borrower hierarchies. Possibility of collusion between the borrower and the loan officer(s) in charge of monitoring shapes incentives for the loan officers. When ‘borrower quality is low’, collusive threats induce over-monitoring in a collusion-free equilibrium, whereas for high borrower quality, monitoring is at its non-delegation level—an outcome akin to vertical integration. Under multiple-bank lending, delegation contracts may solve the free-riding problem in monitoring, and lead to more intense monitoring relative to single-bank lending. This is because collusive threats make monitoring efforts strategic complements because of a novel ‘rent-jamming’ effect—a hitherto unexplored effect of multiple-bank lending. We further show that a bank may decide not to employ a monitor and free-ride on the information gathered by the loan officer of the other bank, which in turn provides a new rationale for syndicated lending based on collusive threats. Moreover, consistent with recent empirical evidence, our analysis implies that bank monitoring behaves counter-cyclically.

© 2021 Elsevier Inc. All rights reserved.

JEL classification: D23; D86; G21; L13

[☆] We are grateful to Xavier Vives (the editor), an associate editor, two anonymous referees and Fahad Khalil for insightful suggestions. We also thank Karna Basu, Dilip Mookherjee, Christine Parlour, David Pérez-Castrillo, Ashok Rai, Uday Rajan, Sudipta Sarangi, Jaume Sempere, Rajdeep Sengupta, Kostas Serfes, Ricardo Serrano-Padial, Thierry Verdier and the participants at the Mexico City Economic Theory Conference, 29th Annual Conference on Contemporary Issues in Development Economics, 15th Annual Conference on Economic Growth and Development, and seminars at ISI Delhi, IIT Kanpur, Presidency University and ITAM Business School for helpful discussions.

* Corresponding author.

E-mail addresses: kaniska.dam@cide.edu (K. Dam), prabalc@isid.ac.in (P. Roy Chowdhury).

Keywords: Multiple-bank lending; Vertical collusion; Counter-cyclical monitoring; Syndicated lending

1. Introduction

In recent years, borrowing from multiple lenders, such as lending consortia and syndicates, has been pervasive. Ongena and Smith (2000) document that more than 85% of the firms across twenty European countries tend to maintain multiple lending relationships. Detragiache et al. (2000) and Farinha and Santos (2002) find similar results in relation to small business lending. However, in a scenario where a borrower requires intense monitoring and due diligence, lending relationships with multiple banks may lead to lower level of monitoring because of the free-riding problem and costly monitoring duplication (e.g. Sufi, 2007).

We seek to develop a framework for financial intermediation that can reconcile these apparently conflicting pieces of evidence. To this end, we analyze a one-period model with one borrowing firm and multiple lenders in which borrower moral hazard (i.e., misbehaving by the firm) can only be mitigated by costly monitoring. The novel feature of our model is that (unlike e.g. Winton, 1995) banks delegate monitoring activity to loan officers. Delegation in turn opens up the possibility of collusion between the borrower and corruptible loan officers.¹ We establish that the likelihood of such vertical collusion generates a hitherto unexplored effect in the event of borrowing from multiple lenders, what we term the *rent-jamming* effect. In contrast to the well known free-riding problem in monitoring, this effect tends to enhance bank monitoring, rather than decrease it, and as a consequence, monitoring under multiple-bank lending may exceed that under the single-bank lending mode.

We analyze a banking market where a firm borrows from two banks to invest in a project. Diligent behavior (high effort) by the borrowing firm generates a stochastic but verifiable cash-flow, whereas if the firm misbehaves (low effort), then the project yields only a non-verifiable private benefit. Non-monitored lending is not feasible because in this case the firm necessarily misbehaves, and the banks fail to break even. Banks must delegate the task of monitoring to loan officers. While the monitoring level is verifiable, and hence, contractible,² its outcome, i.e., whether monitoring has been successful in detecting borrower misbehavior is not verifiable. Therefore, delegation gives rise to a conflict of interest between each bank and its loan officer (collusion incentive problem), and the optimal contract thus involves each bank designing an incentive scheme for its loan officer which consists of a stipulated monitoring effort and a share of repayment. In case of two-bank lending the optimal contract between a bank and its loan officer depends on that of the other, i.e., contracts are interdependent. Using a parsimonious model involving competing bank-loan officer-borrower hierarchies, we answer the following relevant questions pertaining to the internal organization of a bank under multiple-bank lending:

¹ Goldmann (2010) documents many recent cases of loan officer frauds in the United States. In fact, it has been argued that most U.S. bank failures outside of severe depression can be attributed to causes that are redolent of collusion (Williams et al., 1991; Sinkey Jr., 1992; Scheepens, 1995).

² In many situations, a bank's internal rules specify tasks such as frequency of document submissions (e.g. Ono and Uesugi, 2009), the intervals of reviews of borrower quality and collateral (e.g. Cerqueiro et al., 2016), and the maximum number of times a given loan is invigilated during the life of the loan (e.g. Gustafson et al., 2021). Diverse empirical measures of monitoring thus suggest that in many contexts delegated bank monitoring is verifiable and measurable.

- (a) How does the possibility of vertical collusion shape incentive contracts for loan officers in a bank? Further, what are the welfare properties of two-bank lending?
- (b) Building on (a), does multiple-bank lending elicit more intense monitoring and induce banks to provide stronger incentives to their loan officers relative to single-bank lending?

Under both lending modes, contracts are critically affected by the presence of collusion possibilities. We first restrict attention to *collusion-free contracts*, i.e., contracts that are so designed that loan officers have no incentive to collude with the borrower. In other words, the optimal contracts adhere to a *no-collusion constraint* which takes a very simple form—the incentive pay of each loan officer must exceed his stake in collusion. The incentive pay plays a dual role here. An increase in incentive pay not only relaxes the participation constraint of each loan officer, thus allowing the bank to mandate higher levels of monitoring, it also makes collusion less attractive. We first show that, under both lending structures, when borrower quality is low or equivalently, the stake in collusion is high, the no-collusion constraint binds implying that the incentive problem is severe. Thus, a high share of repayment for the loan officer is required to deter collusion. As a result, there is over-monitoring relative to the non-delegation solution, i.e., the one where the banks could monitor the borrower directly. By contrast, for high borrower quality, the collusion incentive problem becomes insignificant as the no-collusion constraint is slack, and hence, the non-delegation level of monitoring is implemented.

Our main focus is to compare the equilibrium outcomes of the single- and two-bank lending modes. Our central result is that, relative to single-bank lending, two-bank lending yields lower monitoring efforts and weaker incentives when firm quality is high. By contrast, when firm quality is low, this result is reversed—two-bank lending induces higher monitoring efforts, as well as stronger incentives.

First consider the case when firm quality is high, so that the no-collusion constraint of neither loan officer binds. Because the reports by loan officers are public information, it allows each bank to free-ride on the monitoring done by the loan officer of the other bank. Consequently, monitoring efforts become strategic substitutes which leads to the under-provision of monitoring in the two-bank lending mode (similar to Carletti, 2004; Carletti et al., 2007; Khalil et al., 2007). Given that collusive considerations play no role in this case, two-bank lending induces lower monitoring effort relative to single-bank lending because of the negative externality arising from the free-riding effect.

Next, consider the case when borrower quality is low. Interestingly, in this case the monitoring efforts become strategic complements. With an increase in monitoring by any loan officer, the participation constraint of the other bank's loan officer gets relaxed. But the concerned bank cannot extract the additional rent by lowering incentive pay because, with firm quality being low the no-collusion constraint of each loan officer binds, and consequently, lowering incentive pay would violate the constraint. The only way to exploit the relaxation of the participation constraint is to increase the loan officer's monitoring effort. We term this the (*collusion-driven*) *rent-jamming* effect of multiple-bank lending (*rent-jamming* effect for brevity). An increase in the monitoring effort of any loan officer therefore induces an increase in the effort of the other. As firm quality decreases, this strategic complementarity becomes stronger (steeper best reply functions), so that when firm quality is low, the rent-jamming effect dominates the free-riding effect. As a result, two-bank lending leads to over-provision of monitoring efforts relative to single-bank lending.

In Section 5.2, we then perform two conceptual exercises in a bid to disentangle the two aforementioned effects. First, we consider a scenario where the two banks merge, maximizing

joint profits so that the free-riding channel is shut down, but employing two loan officers so that the rent-jamming effect is still present. As expected, the absence of free-riding ensures that both monitoring as well as incentives are higher in this case, relative to the baseline two-bank lending framework in which banks act independently. Second, we consider a scenario where the two loan officers coordinate their activities instead of competing with each other. In this case, the rent-jamming effect is absent, and not surprisingly, we find that both incentives and monitoring are lower relative to the baseline two-bank lending structure.

We next analyze two extensions of our model where vertical collusion may arise in equilibrium. The first extension in Section 6.1 considers a scenario where the borrowing firm owns two independent and identical projects, and has the option to bundle the two projects into a single corporation that is funded jointly by the two banks (as in Winton, 1999; Banal-Estañol et al., 2013). We find that there can be scenarios where it may not even be feasible for the banks to prevent collusion. In Section 6.2, the second extension analyzes a situation when under two-bank lending, the banks can strategically choose not to implement the collusion-free contracts. In particular, there is an equilibrium where one bank does not employ a loan officer and free-rides on the information gathered by the other bank, whereas the other bank serves as a liaison between the other bank and the borrowing firm (as in syndicated lending).

Finally, our model offers interesting testable implications regarding bank monitoring and multiple-bank lending. First, empirical evidence suggests that bank monitoring behaves counter-cyclically (e.g. Keys et al., 2010; Lisowsky et al., 2017; Asriyan et al., 2021). We demonstrate that bank monitoring is decreasing in firm quality, not just if one holds the lending structure fixed, but even when one allows the borrowing firm to endogenously choose the lending mode. Arguing, as we do, that firm quality is pro-cyclical, our framework thus provides a theory of counter-cyclicality of bank monitoring based on the threat of vertical collusion. Moreover, our results imply that two-bank lending makes the counter-cyclicality of monitoring more pronounced as, under two-bank lending, free-riding depresses monitoring during booms, while rent-jamming enhances monitoring in bad times relative to single-bank lending. Second, while multiple-bank lending has traditionally been organized as lending consortia, with the participating banks playing largely symmetric roles, lending syndicates, where the banks assume asymmetric roles, have become an important form of financing arrangement in corporate loan markets (e.g. Aoki, 1994; Sufi, 2007; Lin et al., 2012; Gustafson et al., 2021). When banks are not bound to offer the collusion-free contracts, for low values of firm quality, there is an equilibrium that involves monitoring by only one bank and no monitoring by the other, which is akin to syndicated lending. Whereas if firm quality is high, then we have an equilibrium where both banks implement the collusion-free contract, and supply identical amounts of monitoring, which is reminiscent of consortium lending. Thus, our framework generates a theory of syndicated lending based on firm quality and vertical collusion, and not on the asymmetry of bank characteristics such as ability to monitor.

2. Related literature and our contribution

Our paper is related and contributes to two strands of the literature: bank monitoring under multiple-bank lending and collusion in hierarchical organizations.

Multiple-bank lending and bank monitoring. The papers closest to ours are by Carletti et al. (2007), Carletti (2004) and Khalil et al. (2007). Carletti et al. (2007) analyze a model with multiple lenders. There are two-sided moral hazard problems in the effort exerted by the

borrowers as well as in the level of bank monitoring. Multiple-bank lending induces a trade-off between the benefits of greater diversification and costs arising from free-riding and monitoring duplication. Whenever the first effect is stronger, which happens for example if the monitoring costs are sufficiently large, and/or inside equity is small, multiple-bank lending induces over-provision of per-project monitoring compared with single-bank lending. Our paper adds to the literature by showing that multiple-bank lending can induce higher monitoring even when project returns are correlated, so that there is little scope for diversification. We argue that this happens when collusion between the borrower and loan officers is a serious concern, via the rent-jamming effect.

Both Carletti (2004) and Khalil et al. (2007) analyze the effect of multiple-bank lending on monitoring incentives. In Carletti (2004) the central issue is of *interim* moral hazard, with monitoring aimed at preventing borrower misbehavior, whereas in Khalil et al. (2007) the central problem is of costly state verification (ex-post moral hazard). Further, while Carletti (2004) intends to explain the endogenous choice of alternative lending modes by a borrower, Khalil et al. (2007) focus on whether, under multiple-bank lending, equilibrium contracts exhibit debt-like properties (as in Winton, 1995). Both these papers though make the same fundamental point that, in the presence of multiple investors, free-riding due to strategic interaction among banks leads to under-provision of monitoring.³ The present paper however differs from both the aforementioned works in that we explicitly take into account the agency problem emerging from collusive threats in bank-monitor-borrower hierarchies. This induces an interplay between the free-riding effect and collusion incentives for the loan officers. Interestingly, Khalil et al. (2007) also demonstrate that if principals coordinate on monitoring levels, but not on the transfers, then there may be over-monitoring relative to the case when the principals merge. By contrast, our results are driven by the possibility of vertical collusion. Thus, by adding loan officers and collusion possibility to bank-borrower relationships, our paper delivers a key relevant feature that is absent in the extant literature on the effect of multiple-bank lending on bank monitoring, which leads to novel implications.

The extant literature (see Vives, 2016, chapters 4 and 5, and the references therein) has unearthed diverse channels via which multiple-bank lending can have a positive effect on firm quality – other than its effect on bank monitoring – e.g. by limiting the ability of any single lender to holdup (Sharpe, 1990; von Thadden, 1992; Padilla and Pagano, 1997), by ameliorating the soft budget constraint problem (Dewatripont and Maskin, 1995), and by reducing strategic default by making debt renegotiation more difficult (Bolton and Scharfstein, 1996).

Collusion in organizations. The analysis of vertical collusion in principal-supervisor-agent hierarchies goes back to Tirole's (1986) seminal paper where a supervisor is defined as an imperfect technology that produces verifiable information about the productivity of the agent (adverse selection). He establishes a *collusion-proofness principle* which asserts that there is no loss of generality in restricting attention to collusion-free contracts. The principal can deter collusion by setting a high enough incentive pay for the supervisor, which must exceed the supervisor's stake in collusion. Our model has a similar structure where the incentive pay is the collusion-deterring instrument. It is worth mentioning that Scheepens (1997) applies Ti-

³ While Diamond (1984) makes a fundamental point that non-cooperative contracting can lead to over-monitoring, neither Diamond (1984), nor much of the literature following from it explicitly allows for strategic interactions among lenders, and the consequent contractual externalities. Of course, notable exceptions include Carletti (2004) and Khalil et al. (2007).

role's (1986) model to a bank-loan officer-borrower hierarchy under adverse selection [about the borrower], and shows that collusion [between the loan officer and the borrower] can be deterred only if the bank can commit to use a committee who scrutinizes the loan proposals.

A closely related paper is by Mookherjee and Png (1995), which studies the issue of how to compensate corruptible law enforcers in a single organizational hierarchy, showing that collusive threats exacerbate the incentives for over-monitoring. Burlando and Motta (2015) consider a single principal-auditor-agent hierarchy under adverse selection. Under the possibility of vertical collusion between the auditor and the agent, an efficient agent chooses to stay outside the firm without monitoring (an outsourcing contract), whereas an inefficient agent works within the firm and is monitored more intensely (an insourcing contract). The results in both these papers find resonance in our main results that collusive threats lead to over-monitoring, and that, irrespective of the lending structures, there is a negative association between monitoring intensity and borrower quality. Finally, Laffont and Martimort (1999) analyze whether separation of regulatory powers helps reduce regulatory capture. They consider a principal-regulator(s)-firm hierarchy (with adverse selection, rather than moral hazard), where the principal wants to gather two different pieces of private information regarding a regulated firm with each piece of information requiring a distinct monitoring technology. Separation of regulatory powers relaxes the no-collusion constraint(s) and reduces regulatory capture. This is in sharp contrast with our finding because, in our model, both monitors would gather the same piece of information even if they monitor the borrower separately. In fact, unlike Laffont and Martimort (1999), competition makes the no-collusion constraints more stringent which exacerbates the incentives for over-monitoring by strengthening the rent-jamming effect (see the analysis of Section 5.2.2).

Our principal contribution to the collusion literature is to extend the single-hierarchy framework (e.g. Tirole, 1986) to multiple competing hierarchies. There are two novel implications. First, when principals (banks) can commit to collusion-free contracts, the presence of another competing hierarchy can help mitigate the free-riding problem in monitoring that emerges because of the strategic interaction between the principals. However, this comes at a cost—multiple hierarchies exacerbate incentives for over-monitoring.

Second, when principals (banks) cannot commit to collusion-free contracts, the collusion-proofness principle may fail to hold under multiple hierarchies. A similar conclusion has been drawn in relation to single hierarchy when a principal can rely on an external signal that is informative about collusion (e.g. Kofman and Lawarrée, 1993; Strausz, 1997; Khalil and Lawarrée, 2006). These papers find that when collusion can be detected with a high exogenously given probability, it is not in the principal's interest to commit to collusion-free contracts as the expected gain of deterring collusion is small. In the present context, the collusion-proofness principle may fail to hold because of a different reason—one principal may find it optimal to free-ride on the information gathered by the other, and save on the cost of incentive provision by not hiring a monitor. Tressel and Verdier (2011) also analyze the failure of collusion-proofness principle under multiple-bank lending where banks, having advantage in monitoring borrowers, may collude with the latter. However, each bank lends to a single firm, and following the opening up of the economy, foreign capital that flows in via FDI exacerbates collusion incentive problem of banks by making domestic bank capital scarcer relative to uninformed capital, thereby increasing the relative cost of bank monitoring. As a result, a fraction of domestic banks collude with domestic firms.

3. The model

The economy, which spans five dates $t = 1, \dots, 5$, consists of three classes of risk neutral agents—a firm or borrower (she), two banks or lenders (it), and two loan officers or monitors (he). The firm owns a risky project: $I > 0$ dollars invested in the project yield a verifiable cash-flow yI (with $y > 1$) if it succeeds, and nothing if the project fails. The probability of success depends on borrower behavior. If she (or the manager overseeing the firm) behaves diligently (works), then the project succeeds with probability $p \in (0, 1)$. On the other hand, if the borrower misbehaves (shirks), the project fails (probability of success is zero), but it generates a non-verifiable private benefit $v > 0$ per dollar invested. These actions are not publicly verifiable, and hence, there is moral hazard at the firm level.⁴ We assume that the project is economically viable only when the firm is diligent, i.e., $py > 1 > v$. Let $z \equiv py - v$ represent ‘firm quality’, which can be low either due to the expected per unit cash-flow, py being low [even if the firm is diligent], or because the private moral hazard, v is high.

The borrower does not have any fund of her own, and hence, any investment must be externally funded. Each bank invests \$1 in loan at an exogenously given loan rate $r \geq 1$. Banks incur a per unit opportunity cost of capital equal to 1. We assume $v \geq p(y - r)$, i.e., $z \leq pr$, so that the firm has incentives to shirk by diverting funds to private uses. Given that borrower actions cannot be contracted upon, non-monitored lending is not feasible because the firm, if not monitored, will necessarily misbehave and the banks will not break even. Bank monitoring thus helps ameliorate borrower moral hazard. Formally, if the firm is monitored at an intensity $\pi \in [0, 1]$, then with probability π the borrower can be obliged to behave diligently (e.g. Holmström and Tirole, 1997; Repullo and Suárez, 2000). Monitoring in the present context is what Aoki (1994) terms ‘interim monitoring’, which is an instrument to mitigate borrower moral hazard, as opposed to ‘ex-ante monitoring’ or screening which is meant to improve upon adverse selection problems, or ‘ex-post monitoring’ that is used to verify the [hidden] financial states of the borrowing firm.⁵⁶

Banks however do not possess any monitoring technology, and hence, must delegate monitoring to loan officers.⁷ We assume that the delegation contract is exclusive, i.e., the banks hire a loan officer apiece, and each loan officer can work for only one bank.⁸ Let $m_i, m_j \in [0, 1]$ be the individual monitoring efforts exerted by loan officer i and j , respectively, which determine

⁴ Following Holmström and Tirole (1997), an equivalent interpretation is that the borrower can choose between two versions of the project—a “good project” that yields yI with probability $p_H = p > 0$ and no private benefits, and a “bad project” that yields yI with probability $p_L = 0$ and a strictly positive private benefit v .

⁵ An alternative interpretation is the following (see Boot and Thakor, 2000). The payoff structure of the project when the borrower shirks may be thought of as the one under *transaction lending*. By contrast, *relationship lending* (when the borrower is monitored at a strictly positive intensity π) enhances the probability of success relative to transaction lending, i.e., $\pi p > 0$ which reaches its full potential p when $\pi = 1$.

⁶ Empirical measures of monitoring such as intervals of collateral reviews (Cerqueiro et al., 2016), number of times of loan invigilation (Gustafson et al., 2021) also suggest that bank monitoring is often an activity that is performed in the interim stage of a lending relationship. However, all our results qualitatively remain the same in the context of costly state verification in which monitoring is of ex-post nature.

⁷ The assumption that banks do not own a monitoring technology holds for example if bank managers, who oversee many departments including a bank’s lending division, do not possess specialized skills (such as the knowledge of regulation, passing licensing tests, etc.) that the loan officers do.

⁸ A loan officer is typically an employee of a bank, and is not allowed to moonlight in other lending companies. Regulation in many U.S. states prohibits mortgage loan officers (MLOs) to work for more than one mortgage banker or broker (see, for example, Section 8 of the MLO licensing guidelines of the State of New York, available at https://www.dfs.ny.gov/apps_and_licensing/mortgage_companies/mlo_guide).

the aggregate monitoring intensity π . We assume that each bank can verify the monitoring effort exerted by its loan officer, and hence, monitoring levels or efforts can be contracted upon. However, the banks cannot verify the *outcome* of the monitoring process, i.e., whether it has been successful or not. By ‘successful monitoring’ we mean that a loan officer, say i , has been able to detect borrower misbehavior, and is in a position to take appropriate actions to make her behave diligently, which happens with probability m_i . Non-observability of monitoring outcome opens up the possibility of collusion between the concerned loan officer and the firm. When a loan officer colludes with the borrowing firm, he lets the borrower shirk (and enjoy the private benefit) in exchange for a bribe, and reports to his employer that he has not learnt anything about the actions of the firm. This is a typical incentive problem that stems from delegation contracts (between a bank and its loan officers).

The aggregate monitoring intensity, i.e., the probability that at least one loan officer has been successful is given by:

$$\pi(m_i, m_j) = 1 - (1 - m_i)(1 - m_j) = m_i + m_j(1 - m_i). \quad (1)$$

Of course, m_i (resp. m_j) contributes effectively to π only if loan officer i (resp. j) does not collude with the firm. Thus, the aggregate monitoring function $\pi(m_i, m_j)$ is well-defined only if neither loan officer colludes. From now on, we shall refer to m_i and m_j as ‘monitoring efforts’, and to $\pi(m_i, m_j)$ as ‘aggregate monitoring intensity’. The above function is increasing in monitoring effort because $\pi_i(m_i, m_j) = 1 - m_j \geq 0$.⁹ However, increased effort by one loan officer decreases the marginal benefit of monitoring by the other because $\pi_{ij}(m_i, m_j) = -1 < 0$, suggesting that free-riding may arise in equilibrium. For loan officer i , m_i comes at a cost of

$$C(m_i) = \frac{1}{2} c m_i^2,$$

where $c > 0$. We assume that

Assumption 1. $1 + \frac{c}{2} \leq pr \leq c$.

The upper bound on the expected loan rate guarantees that, in case the banks did possess the monitoring technology themselves, the optimal monitoring effort is less than 1 (see Proposition 1 later). Whereas the lower bound implies that the expected repaid amount must cover the cost of capital plus the maximum monitoring cost, $C(1)$. We normalize the outside option of the loan officers to 0.

A contingent contract (m_i, s_i) of bank i specifies the required monitoring effort $m_i \in [0, 1]$ as well as a share $s_i \in [0, 1]$ of py for loan officer i which is the (expected) amount repaid by the borrower. Although bank i can specify m_i in the contract offered to loan officer i , bank j cannot observe m_i . Therefore, contract offer by one bank cannot be conditioned on that of the other. However, monitoring is a public good, in that if one loan officer is successful in monitoring (and decides not to collude), then the borrower behaves diligently so that the other bank benefits as well. The possibility of collusion between the loan officer(s) and the borrower, and its effect on monitoring will be the central issue of our paper. One of the main focuses of our paper is to study the strategic effects of incentive contracts on bank monitoring under multiple-bank lending, and

⁹ If loan officer j , say, colludes if successful, whereas loan officer i does not, then the effective aggregate monitoring function becomes $\pi(m_i, m_j) = m_i$, and $\pi(m_i, m_j) = 0$ in case both collude.

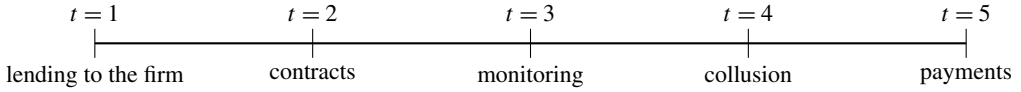


Fig. 1. The timing of events.

hence, we first analyze collusion-free contracts. In Section 6.2, we examine whether there is any loss of generality if we restrict attention only to collusion-free contracts.

The timing of events is as follows (Fig. 1). At $t = 1$, each bank lends \$1 to the firm. At date 2, the banks employ loan officers, with banks i and j offering contracts (m_i, s_i) and (m_j, s_j) to loan officers i and j , respectively. At $t = 3$, the loan officers monitor at the level specified in the contract. At $t = 4$, the firm and the loan officer(s) decide whether to collude, which of course is feasible only if the concerned loan officer has been successful in monitoring. We assume that the outcome of the monitoring effort is private information, i.e., one loan officer does not observe whether the other one has succeeded in detecting firm behavior. In case at least one loan officer is successful and decides not to collude, the borrower is diligent. Otherwise, the borrower misbehaves. There are the following three potential scenarios:

- 1) *Neither loan officer succeeds*: Collusion between the borrower and loan officer(s) does not take place, and the borrower shirks and consumes $2v$;
- 2) *Only one of the two loan officers succeeds*: This loan officer, say i , can either take actions in order to make the borrowing firm behave diligently or collude with the borrower. In case the borrower is diligent, she obtains $2p(y - r)$ and the concerned loan officer receives $pr s_i$. On the other hand, in case they collude, the borrower enjoys private benefit $2v$, and loan officer i receives bribe b_i ;
- 3) *Both loan officers succeed*: There are two possibilities—(a) either one or both loan officers behave honestly, and the firm behaves diligently, (b) or both loan officers collude with the borrower, let her enjoy private benefit $2v$, and they receive bribes b_i and b_j from her.

At date 5, the cash-flow from the project is realized and the agreed upon payments are made.

4. Optimal loan officer incentives and monitoring

4.1. Single-bank lending

We first consider the case when there is only one bank that lends \$1 to the borrowing firm.

4.1.1. Direct bank monitoring without delegation

As a benchmark, we first analyze optimal monitoring if the bank had access to the same monitoring technology $C(\cdot)$, and had chosen to directly monitor the firm. The optimal monitoring effort solves

$$\max_{m \in [0, 1]} B(m) \equiv mpr - \frac{1}{2} cm^2 - 1.$$

The solution to the above maximization problem (derived from its first-order condition) is characterized as follows:

Proposition 1. *When the single bank lends to the borrower and monitors her directly, the optimal monitoring intensity is given by:*

$$m^* = \frac{pr}{c}.$$

Clearly, $m^* \leq 1$ by Assumption 1. The optimal level of monitoring is independent of firm quality z . This is because in the absence of delegation, the bank does not face any incentive problem arising from collusion possibilities. As we shall later find, collusion incentives do however depend on firm quality. We refer to the optimal monitoring effort under direct bank monitoring, m^* as the *non-delegation level of monitoring*.

4.1.2. Delegated monitoring

We now turn to the case where the bank has no access to the monitoring technology, and must delegate monitoring duties to a loan officer. Let m and s denote respectively the monitoring effort and share of repayment. We solve this game backwards.

The bribery subgame: incentives to deter collusion. At date 4, collusion between the firm and the loan officer is feasible only if the loan officer is successful in detecting borrower behavior. At this stage, the loan officer can either choose to report truthfully, or he can collude with the borrower in exchange for a bribe b and report to the bank that he has not learnt anything. We follow much of the literature on collusion (e.g. Tirole, 1986) which abstracts from the minutiae of any particular bargaining protocol involved in the collusion process, and instead focuses on deriving a no-collusion constraint which ensure that collusion is not possible under any such protocol. To that end, we derive a condition that ensures that the aggregate surplus for the loan officer and the firm is low enough in case there is collusion, so that one cannot sustain a positive amount of bribe, whatever may be the bargaining protocol.

Let $F(\sigma)$ and $M(\sigma)$ respectively be the payoffs of the firm and the monitor where $\sigma \in \{0, 1\}$ with 0 representing *collusion* and 1 representing *no-collusion*. The payoffs are

$$F(0) = v - b, \quad \text{and} \quad M(0) = b - C(m);$$

$$F(1) = p(y - r), \quad \text{and} \quad M(1) = prs - C(m).$$

Thus, collusion is not feasible if and only if

$$F(1) + M(1) \geq F(0) + M(0) \iff prs \geq pr - z. \quad (2)$$

The *no-collusion constraint* (2) takes a simple form—the incentive pay of the loan officer, prs must exceed his stake in collusion, $v - p(y - r) = pr - z$. Clearly, in a collusion-free equilibrium, the optimal contract must satisfy the no-collusion constraint, which we would refer to as the *collusion-free contract*.

Optimal loan officer incentives and monitoring. At $t = 2$, the bank would offer a contract (m, s) which, apart from satisfying (2), must also satisfy (i) the *participation constraint* of the loan officer

$$mprs - \frac{1}{2}cm^2 \geq 0, \quad (3)$$

and (ii) the *feasibility constraint*

$$(m, s) \in [0, 1] \times [0, 1]. \quad (4)$$

Note that the monitor's contract (m, s) is subject to *limited liability* as well, in that he obtains a payment only if the project yields a verifiable cash-flow. We denote by \mathcal{F} the set of *feasible contracts*, i.e., the set of contracts that satisfies (2), (3) and (4). The bank thus solves the following maximization problem:

$$\max_{(m, s) \in \mathcal{F}} B(m, s) \equiv mpr(1 - s) - 1. \quad (5)$$

The optimal monitoring intensity and share of repayment for the loan officer are characterized as follows.

Proposition 2. *There are threshold values of firm quality, z^{\min} , z^0 and \bar{z} , with $0 < z^{\min} < z^0 < \bar{z} < pr$, where z^{\min} is such that bank-lending is not feasible for any $z < z^{\min}$.*

(a) *The optimal monitoring intensity is given by:*

$$m(z) = \begin{cases} 1 & \text{for } z \in [z^{\min}, z^0], \\ \frac{2(pr-z)}{c} & \text{for } z \in (z^0, \bar{z}], \\ \frac{pr}{c} & \text{for } z \in (\bar{z}, pr]. \end{cases}$$

Thus, whenever firm quality is low, i.e., $z^{\min} \leq z \leq \bar{z}$, the equilibrium outcome involves over-monitoring relative to the non-delegation level of monitoring, m^ . On the other hand, the monitoring level is at the non-delegation level whenever firm quality is high, i.e., $z > \bar{z}$.*

(b) *The optimal share of repayment for the loan officer is given by:*

$$s(z) = \begin{cases} 1 - \frac{z}{pr} & \text{for } z \in [z^{\min}, \bar{z}], \\ \frac{1}{2} & \text{for } z \in (\bar{z}, pr]. \end{cases}$$

(c) *Moreover, in equilibrium the bank earns non-negative profits.*

The results in Proposition 2 are depicted in Fig. 2. In an optimal contracting model under limited liability such as ours, the typical trade-off the bank faces is between incentive provision (setting a high share of repayment in order to deter collusion) and rent extraction from the loan officer (setting a low share as long as the contract is individually rational). Thus, (2) and (3) together play a crucial role in determining the optimal contract. Note that, because the loan rate is exogenously fixed, the only instrument the bank has in order to provide incentives is the share of repayment. Consider first high values of z which means low stake in collusion, $pr - z$. As a result, the no-collusion constraint does not bind. The bank can thus keep on lowering s without affecting incentives until the entire rent of the loan officer has been extracted, i.e., the participation constraint binds. Therefore, in the absence of collusion incentive problem, the non-delegation level of monitoring, m^* can be implemented via a low incentive pay.

Next, consider the situation when borrower quality is low, and hence, the stake in collusion is high. In this case, the no-collusion constraint binds. The only way to deter collusion is to raise the incentive pay through s . The bank can continue extracting the entire rent of the loan officer by specifying a larger m (as the binding participation constraint implies a positive association between m and s). Both m and s increases as z decreases, and the monitoring effort is higher than that under no delegation implying over-monitoring. When z is lowered further, due to very high stake in collusion, the agency problem is so severe that the loan officer must be given

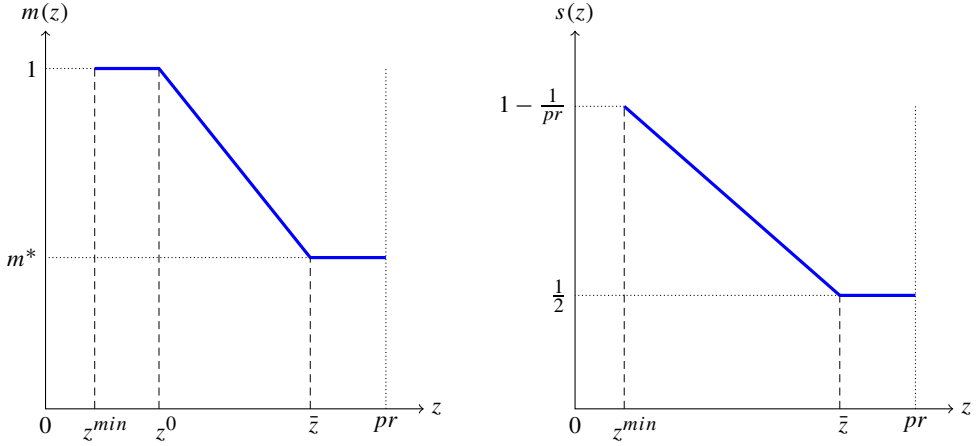


Fig. 2. Equilibrium monitoring and share of the loan officer as functions of firm quality. For $z < z^{min}$, bank-lending is not feasible. For $z^{min} \leq z \leq \bar{z}$, the no-collusion constraint binds, and there is over-monitoring relative to the non-delegation level, m^* . For $z > \bar{z}$, the no-collusion constraint does not bind and monitoring is at the non-delegation level.

incentives in the form of additional rent, i.e., (3) does not bind anymore (the loan officer earns *efficiency wage*), and the monitoring effort is optimally set at its highest possible level, 1.

Welfare. We compare the equilibrium monitoring with the socially efficient level under single-bank lending. At any monitoring effort m , (expected) welfare is defined as the sum of the expected borrower utility and the expected surplus of the bank-loan officer relationship, i.e.,

$$W(m) \equiv mpy + (1 - m)v - \frac{1}{2}cm^2 - 1.$$

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

Proposition 3. *The socially optimal level of monitoring under single-bank lending is given by:*

$$m^{**}(z) = \frac{z}{c}.$$

*Thus the equilibrium under single-bank lending with delegation involves over-monitoring relative to the socially efficient level, i.e., $m^{**}(z) \leq m(z)$ for all $z \in [z^{min}, pr]$.*

The proof of the above proposition is trivial as $m^{**}(z)$ is a strictly increasing function of z which is maximized at $z = pr$, i.e., $m^{**}(pr) = pr/c = \min m(z)$. Therefore, the equilibrium under the single-bank lending mode entails over-monitoring relative to the socially efficient level of monitoring.

4.2. Two-bank lending

When there are two banks in the market, the firm receives \$1 to invest from each bank, and hence, the aggregate loan amount is \$2. Given the monitoring efforts $m_i, m_j \in [0, 1]$, the aggregate monitoring intensity is given by (1). We continue assuming that the loan rate is exogenously given, and is the same under both lending structures, which is equal to r .

4.2.1. Direct bank monitoring without delegation

As in the previous subsection, we first analyze the situation where each bank can monitor the borrower directly. Bank i solves

$$\max_{m_i \in [0, 1]} B_i(m_i, m_j) \equiv \pi(m_i, m_j)pr - \frac{1}{2}cm_i^2 - 1.$$

The first-order conditions of the maximization problems of banks i and j yield the following best reply functions:

$$cm_i = pr(1 - m_j), \quad (6)$$

$$cm_j = pr(1 - m_i). \quad (7)$$

These best reply functions have a unique and symmetric solution m_2^* .

Proposition 4. *When two banks lend to the borrower, and they can monitor her directly, the optimal monitoring effort is given by:*

$$m_2^* = \frac{pr}{c + pr},$$

and the aggregate monitoring intensity is $\pi_2^* = \pi(m_2^*, m_2^*) = 1 - (1 - m_2^*)^2 > m_2^*$.

As in Proposition 1, the monitoring effort, and thus the aggregate monitoring intensity, are independent of the level of borrower quality because there is no collusion under no delegation.

4.2.2. Delegated monitoring

The bribery subgame. We analyze the collusion possibility between the firm and loan officer i . Recall that for loan officer i to be able to collude with the firm he must have succeeded in detecting borrower misbehavior. There are two possible cases following the monitoring success of loan officer i . First, consider the case when loan officer j has not succeeded. Let $F(\sigma_i)$ and $M_i(\sigma_i)$ respectively be the payoffs of the firm and monitor i where $\sigma_i \in \{0, 1\}$ with 0 representing *collusion* and 1 representing *no-collusion*. The payoffs are

$$\begin{aligned} F(0) &= 2v - b_i, \quad \text{and} \quad M_i(0) = b_i - C(m_i); \\ F(1) &= 2p(y - r), \quad \text{and} \quad M_i(1) = prs_i - C(m). \end{aligned}$$

Thus, collusion is not feasible if and only if

$$F(1) + M_i(1) \geq F(0) + M_i(0) \iff prs_i \geq 2(pr - z). \quad (8)$$

Similarly, the no-collusion constraint for loan officer j (when he succeeds in monitoring, but loan officer i does not) is given by:

$$prs_j \geq 2(pr - z). \quad (9)$$

We then consider the second scenario where loan officers i and j have both successfully detected borrower behavior. In this case, the no-collusion constraint the banks must take into account is different from (8) and (9). Let 0 represent collusion among the borrower and two loan officers, and 1 represent no-collusion, i.e., at least one loan officer has decided not to collude

with the borrower. In case one loan officer decides not to collude, there is no shirking on behalf of the borrower and the loan is paid in full. The payoffs in this case are

$$F(0) = 2v - (b_i + b_j), \quad M_i(0) = b_i - C(m_i) \quad \text{and} \quad M_j(0) = b_j - C(m_j);$$

$$F(1) = 2p(y - r), \quad M_i(1) = prs_i - C(m_i) \quad \text{and} \quad M_j(1) = prs_j - C(m_j).$$

Thus, collusion is not feasible if and only if

$$F(1) + M_i(1) + M_j(1) \geq F(0) + M_i(0) + M_j(0) \iff pr(s_i + s_j) \geq 2(pr - z). \quad (10)$$

The no-collusion constraint (10) asserts that the aggregate incentive pay of the two loan officers must exceed their combined stake in collusion under two-bank lending, $2(pr - z)$. We impose only (8) and (9) in order to ensure no-collusion because they together imply (10).

Optimal loan officer incentives and monitoring. At date $t = 2$, bank i offers a contract (m_i, s_i) to its loan officer. Apart from satisfying the no-collusion constraint, the contract must satisfy the *participation constraint* of loan officer i

$$\pi(m_i, m_j) prs_i - \frac{1}{2} cm_i^2 \geq 0, \quad (11)$$

and the *feasibility constraint*

$$(m_i, s_i) \in [0, 1] \times [0, 1]. \quad (12)$$

We denote by \mathcal{F}_i the set of *feasible contracts* of bank i , i.e., the set of contracts that satisfies (8), (11) and (12). We define \mathcal{F}_j of bank j in analogous manner. It is worth noting that the feasible set of bank i , \mathcal{F}_i depends on the contract offered by bank j and vice versa, although the contract offer by one bank is not contingent on that of the other. In other words, contracts for the loan officers are interdependent. Bank i solves the following maximization problem:

$$\max_{(m_i, s_i) \in \mathcal{F}_i} B_i(m_i, m_j, s_i) \equiv \pi(m_i, m_j) pr(1 - s_i) - 1. \quad (13)$$

We can define the optimization problem of bank j in a similar fashion.

We analyze an equilibrium in which the two no-collusion constraints either bind simultaneously or both are slack. Let $m_i(m_j)$ and $m_j(m_i)$ denote the best reply functions of banks i and j , respectively. Lemma 1 derives properties of the best reply functions which will be critical for the subsequent analyses.

Lemma 1. *Under two-bank lending, the participation constraint of each loan officer binds. Moreover,*

- (a) *when the no-collusion constraints are slack, monitoring efforts are strategic substitutes, i.e., the best reply functions $m_i(m_j)$ and $m_j(m_i)$ are negatively sloped;*
- (b) *When both the no-collusion constraints bind, monitoring efforts are strategic complements, i.e., the best reply functions $m_i(m_j)$ and $m_j(m_i)$ are positively sloped.*

Unlike the single-bank lending mode, under two-bank lending, the participation constraint of each loan officer binds at the optimum. When neither of the two no-collusion constraints binds, the agency problem does not affect the banks' choice of monitoring levels relative to the non-delegation levels of monitoring. In this case, the best reply functions are given by (6) and (7).

Thus, the fact that $\pi_{ij}(m_i, m_j) < 0$ leads to the *free-riding* effect of two-bank lending, and hence, monitoring efforts are strategic substitutes.¹⁰

Next, suppose that both the no-collusion constraints bind. We can use the binding participation constraints to substitute for s_i (resp. s_j) into (8) (resp. (9)) to obtain the best replies $m_i(m_j)$ and $m_j(m_i)$:

$$cm_i^2 = 4(pr - z)\pi(m_i, m_j), \quad (14)$$

$$cm_j^2 = 4(pr - z)\pi(m_i, m_j). \quad (15)$$

The above best reply functions are upward-sloping. The strategic complementarity of monitoring efforts emerges from an interesting interaction between the two binding participation constraints. Intuitively, the trade-off each bank faces is either to provide incentives to deter collusion or to extract rent from its loan officer. Consider the optimal contract for loan officer i . With an increase in m_j , the participation constraint of loan officer i gets relaxed because $\pi_j(m_i, m_j) > 0$. However, in order to extract this additional rent, bank i cannot lower the loan officer's share because s_i is fixed by the binding no-collusion constraint. Therefore, the only option bank i is left with is to increase m_i in order to restore the binding participation constraint. Moreover, given that bank i is constrained by (8), it has already been operating at a sub-optimal level of m_i . Thus, an increase in m_j in this case increases the bank's profits. Note that the strategic complementarity of the equilibrium monitoring efforts follows fundamentally from a bank's inability to extract rent by lowering the share of repayment (because of the binding non-collusion constraint). We therefore call this the (*collusion-driven*) *rent-jamming* effect, or simply the *rent-jamming* effect for brevity.

The optimal monitoring and share of repayment for each loan officer are characterized in Proposition 5 below. As in the case of single-bank lending, collusive threats exacerbate incentives for over-monitoring under two-bank lending as well, and hence, banks are required to offer stronger incentives to deter collusion.

Proposition 5. *There are threshold values of firm quality, z_2^0 and \bar{z}_2 with $0 < z_2^0 < \bar{z}_2 < pr$ such that*

(a) *The symmetric equilibrium monitoring effort is given by:*

$$m_2(z) = \begin{cases} \frac{8(pr-z)}{c+4(pr-z)} & \text{for } z \in (z_2^0, \bar{z}_2], \\ \frac{pr}{c+pr} & \text{for } z \in (\bar{z}_2, pr]. \end{cases}$$

The aggregate monitoring intensity is $\pi_2(z) = 1 - (1 - m_2(z))^2$. Thus, whenever borrower quality is low, i.e., $z \leq \bar{z}_2$, the outcome involves over-monitoring relative to the non-delegation level of monitoring, i.e., m_2^ . Whereas for all $z > \bar{z}_2$, so that firm quality is high, the monitoring efforts are at the non-delegation level.*

¹⁰ In the absence of the incentive problems with respect to collusion, wasteful duplication of monitoring effort implied by the technology $\pi(m_i, m_j) = m_i + m_j - m_i m_j$ results in the strategic substitutability of monitoring efforts m_i and m_j . If we have assumed instead that $\pi(m_i, m_j) = m_i + m_j + \delta m_i m_j$ with $\delta > 0$, i.e., there is no wasteful monitoring duplication, then monitoring efforts would have been strategic complements because the marginal benefit of monitoring by one loan officer is increasing in that by the other.

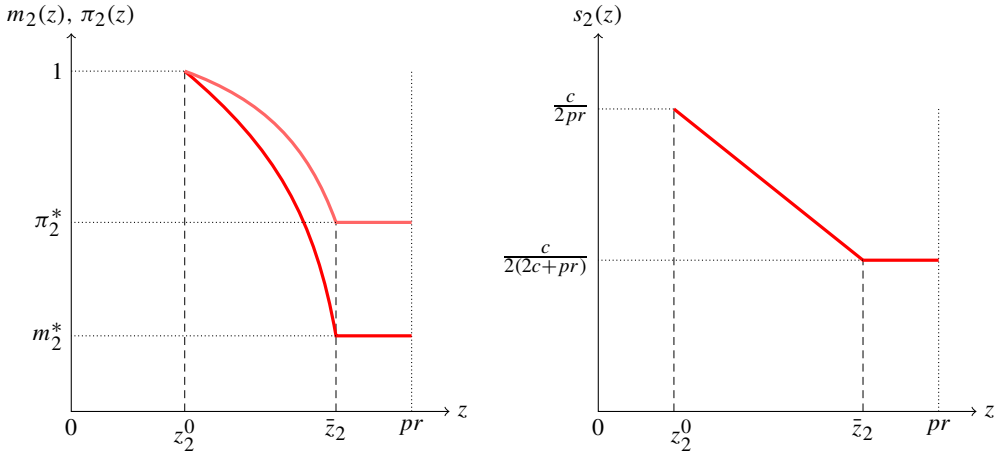


Fig. 3. The equilibrium monitoring effort, aggregate monitoring intensity and share of the loan officers as functions of firm quality. For $z \leq \bar{z}_2$, the no-collusion constraints bind, and there is over-monitoring relative to the non-delegation level.

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

$$s_2(z) = \begin{cases} 2 \left(1 - \frac{z}{pr}\right) & \text{for } z \in (z_2^0, \bar{z}_2], \\ \frac{c}{2(2c+pr)} & \text{for } z \in (\bar{z}_2, pr]. \end{cases}$$

(c) Moreover, in equilibrium each bank earns non-negative profits.

Proposition 5 is depicted in Fig. 3. In the subsequent sections, we shall analyze diverse financing arrangements that are variants of the two-bank lending mode. The equilibrium and related variables under two-bank lending are represented by letters with subscripts, e.g. $m_2(\cdot)$ denotes the symmetric equilibrium monitoring effort of each loan officer under two-bank lending. Moreover, in lending structure k , z_k^0 denotes the threshold of firm quality such that $m_k < 1$ for $z > z_k^0$, and \bar{z}_k denotes the threshold of firm quality such that the no-collusion constraints bind if $z > \bar{z}_k$.

When the no-collusion constraints bind, there is a positive externality between the banks. With (8) and (9) binding, both s_i and s_j are fixed at the minimum, so that any strategic interaction between the lenders must come about through changes in m_i and m_j . This externality is more severe for lower z : if z is very small (very high stake in collusion), the shares are very high due to the binding no-collusion constraints. Therefore, the incentive to increase m_i is also high because m_j can be increased significantly.¹¹

The equilibrium association between monitoring and borrower quality described in Propositions 2 and 5 are similar because they share a common intuition. Under both lending structures,

¹¹ Consider $m_i(m_j)$ defined by (14). For a given \bar{m}_j , differentiating (14) we obtain

$$\frac{dm_i}{dz} = - \frac{2\pi(m_i, \bar{m}_j)}{cm_i - 2(pr - z)(1 - \bar{m}_j)}.$$

Because for any $\bar{m}_j \in [0, 1]$ the denominator of the above expression is strictly positive, we have $dm_i/dz < 0$ implying that, for a given \bar{m}_j , m_i increases as z decreases, i.e. the best reply function $m_i(m_j)$ shifts outward for any $m_j \in [0, 1]$ as borrower quality lowers. In other words, the strategic complementarity becomes stronger as borrower quality worsens.

a low value of z is equivalent to having a high stake in collusion, which exacerbates the collusion incentive problem. Moreover, in both cases the share of repayment is the only instrument at banks' disposal to address collusion concerns because they are not able to reduce the size of the stake in collusion, $pr - z$ given that the loan rate is exogenously given. Therefore, we obtain a positive association between the equilibrium share and the stake in collusion. Similar intuition is present in earlier works on vertical collusion (e.g. Tirole, 1986). Notably, although the monitoring effort is contractible, it is not an instrument to provide incentives, rather the banks control this variable in order to extract rent from the loan officers.

It is also worth noting that we restrict attention to $z > z_2^0$ because in any symmetric equilibrium, we must have $m_2(z) < 1$ (which is equivalent to $z > z_2^0$). If either of the two banks, say bank j chooses $m_j = 1$, then the aggregate monitoring intensity is given by $\pi(m_i, 1) = 1$ for any $m_i \geq 0$. Thus, bank i has no incentive to induce any monitoring at all, let alone $m_i = 1$.

Welfare. At any symmetric monitoring effort, $m_i = m_j = m$, the (expected) social welfare, which is the sum of the expected firm utility and the aggregate expected surplus of the two bank-loan officer pairs, is given by:

$$W_2(m) \equiv 2[\pi(m, m)py + (1 - \pi(m, m))v] - cm^2 - 2.$$

The following proposition compares the symmetric equilibrium monitoring with the socially efficient level under two-bank lending.

Proposition 6. *The socially optimal level of monitoring under two-bank lending is given by:*

$$m_2^{**}(z) = \frac{2z}{c + 2z}.$$

Moreover, there is a unique threshold of firm quality $\theta^{**} \in (z_2^0, \bar{z}_2)$ such that the equilibrium under two-bank lending involves over-monitoring relative to the socially efficient level, i.e. $m_2^{**}(z) \leq m_2(z)$ if and only if $z \leq \theta^{**}$.

Unlike the single-bank lending structure, the equilibrium under two-bank lending may imply under-monitoring relative to the socially optimal level if firm quality is high, i.e., $z > \theta^{**}$.¹² This happens since $m_2(z)$ is too low (equal to the non-delegation level) because of the inefficiency arising due to strategic interaction between the two banks even though the collusion incentive problem does not have any bite for high values of z . However, for $z \leq \theta^{**}$ there is still over-monitoring relative to the socially optimal level. In Section 5.2, we further elaborate on the issue of strategic interaction between the banks.

5. Comparison of the single- and two-bank lending structures

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

We now turn to the central question of this paper—a comparison of the equilibrium monitoring as well as the incentives offered to the loan officer(s) under the single- and two-bank lending structures.

¹² Note that the efficient levels of monitoring under the two lending structures are in general different, i.e., $m_2^{**}(z) \neq m_2^*(z)$ because the welfare levels are different.

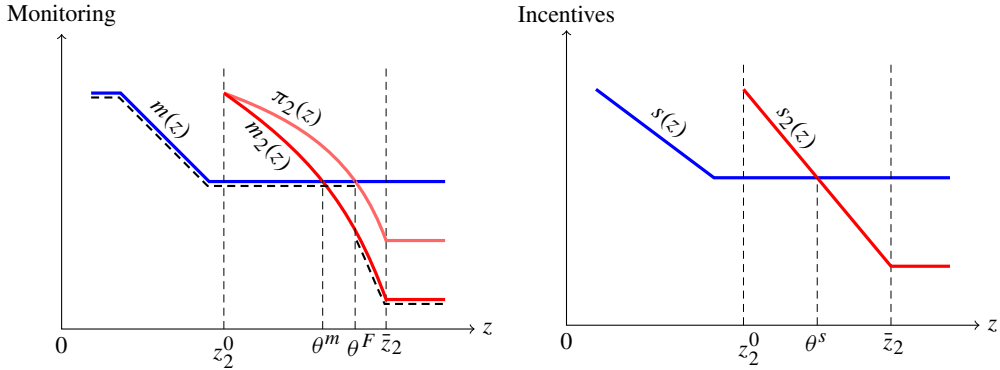


Fig. 4. The equilibrium monitoring and incentives under the single- and two-bank lending structures. Under two-bank lending, each bank elicits higher monitoring effort and provides stronger incentives if and only if firm quality is low.

Proposition 7. *Two bank lending implies larger collusive threats, i.e., the no-collusion constraint of each loan officer binds over a larger range of firm quality (i.e., $\bar{z}_2 > \bar{z}$). Hence, there is inefficient over-monitoring over a larger range of firm quality z . Moreover, for a given loan rate r , there are unique threshold values of firm quality, $\theta^m, \theta^s \in (z_2^0, \bar{z}_2)$ such that*

- (a) *Equilibrium monitoring effort under two-bank lending is higher relative to single-bank lending, i.e., $m_2(z) \geq m(z)$ if and only if $z \leq \theta^m$;*
- (b) *Equilibrium incentives for the loan officers are stronger under two-bank lending, i.e., $s_2(z) \geq s(z)$ if and only if $z \leq \theta^s$.*

The results in Propositions 7 are depicted in Fig. 4. Proposition 7 conveys the central message of our paper—when firm quality is high, two-bank lending elicits lower monitoring effort. Moreover, the banks provide weaker incentives to the loan officers under two-bank lending. By contrast, when firm quality is low, two-bank lending implies more intense monitoring and stronger incentives for the loan officers. These results are driven by the two countervailing channels unearthed in Lemma 1 earlier. The first one is the free-riding effect which gives rise to the strategic substitutability of monitoring efforts, and the second one is the rent-jamming effect that leads to the strategic complementarity. Clearly, the two effects point in opposite directions, and hence, the effects of two-bank lending on monitoring effort and loan officer incentives are ambiguous.

Which one of these two effects dominates depends on borrower quality, z . When firm quality is high, there is no feasible bribe that makes collusion profitable, and hence, the rent-jamming effect plays no role. Only the free-riding effect is at play, leading to lower monitoring effort under two-bank lending. One would have obtained the same result under a common loan rate r had the banks been able to monitor the borrower directly (Carletti, 2004). On the other hand, when borrower quality is low, the no-collusion constraints bind. As we have argued earlier, this leads to over-monitoring under single-bank, as well as two-bank lending. However, under two-bank lending, an additional effect comes into play—namely, the rent-jamming effect which amplifies the effect on m_i arising from a larger m_j . Thus for low levels of z , monitoring effort under two-bank lending exceeds that under single-bank lending. Consequently, the share of repayment must also be higher in an effort to deter collusion. Moreover, as we have noted earlier that a lower z shifts

both the best reply functions defined by (14) and (15) outward, the strategic complementarity is stronger for low values of firm quality causing even a higher equilibrium monitoring effort.

5.2. Disentangling the two countervailing effects

We have demonstrated that a move from one-bank to two-bank lending has ambiguous consequences for monitoring as well as loan officer incentives. We have argued that this ambiguity emerges because of the interaction between two countervailing channels—namely, the free-riding and the rent-jamming effects of two-bank lending. In a bid to disentangle the two effects, in what follows we carry out a purely conceptual exercise. In particular, we shut down one channel at a time, and examine how the closing down of a particular channel affects monitoring and incentives under two-bank lending.

5.2.1. Strategic versus merged banks: the free-riding effect

We first compare the baseline two-bank lending framework analyzed in Section 4.2 with the one where the free-riding channel is shutdown. To this end, we examine a scenario where the two banks merge with the merged bank maximizing joint profits, but still employing two independent loan officers. The fact that the banks coordinate on monitoring ensures that there is no free-riding. However, the rent-jamming effect is still present because the merged entity employs two separate loan officers. In order to ensure that there is no confounding effect from loan size, we assume that the merged bank continues lending \$2 to the firm. Formally, the merged bank solves the following maximization problem:

$$\max_{\{(m_i, s_i) \in \mathcal{F}_i, (m_j, s_j) \in \mathcal{F}_j\}} B_i(m_i, m_j, s_i) + B_j(m_i, m_j, s_j) = \pi(m_i, m_j)pr(2 - s_i - s_j) - 2.$$

Note that the merged entity faces the same participation and no-collusion constraints as in Section 4.2. We compare the optimal solution of the above maximization problem with the one described in Proposition 5. The following proposition analyzes the role of the free-riding effect in determining the optimal monitoring and incentives.

Proposition 8. *Monitoring effort is higher and loan officer incentives are stronger when the two banks act as a merged entity (so that there is no free-riding), rather than when they maximize their own profits independently (when free-riding is present).*

The above results are graphically illustrated in Fig. 5 where we depict the symmetric equilibrium monitoring efforts (in the left panel) and equilibrium shares of repayment (in the right panel). Intuitively, irrespective of whether the banks act as a merged entity or not, they face the same no-collusion constraints (8) and (9). Thus, when the no-collusion constraints bind, the optimal contracts under strategic and merged banks coincide. Whereas if the no-collusion constraints are slack, merged banks are able to offer stronger incentives to their loan officers because the free-riding effect is absent, and hence, the merged entity elicits higher monitoring, i.e., the equilibrium monitoring effort function shifts up from $m_2(z)$ to $m_{mb}(z)$.

5.2.2. Competing versus cooperating loan officers: the rent-jamming effect

Next, we analyze the role played by the rent-jamming effect, comparing the baseline framework in Section 4.2 with the one where the rent-jamming effect is absent. To be precise, we examine a scenario where the loan officers behave cooperatively in the sense that if at least one

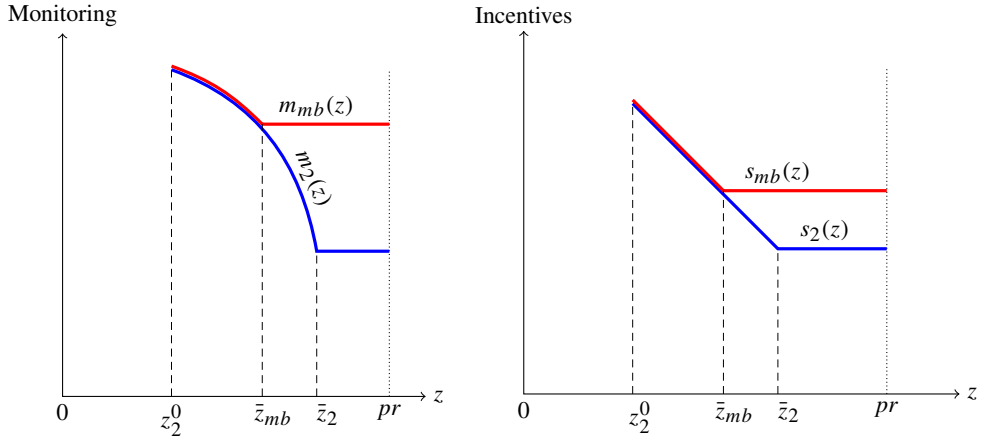


Fig. 5. The equilibrium monitoring efforts and shares under strategic and merged banks. Subscript ‘mb’ denotes the variables under merged banks.

of them succeeds in monitoring, then they share this information among themselves. Further, they jointly collect the bribe in case they decide to collude with the firm.

Suppose at least one of the loan officers has succeeded, and the loan officers together collude with the borrower. The no-collusion constraint in this case is given by (10), i.e.,

$$pr(s_i + s_j) \geq 2(pr - z).$$

Bank i would thus choose (m_i, s_i) to maximize the same objective function as in the case of two-bank lending, (13), subject to the same participation and feasibility constraints, (11) and (12), respectively, and the (joint) no-collusion constraint (10). Comparing the optimal contract in this situation with the one described in Proposition 5, we obtain the impact of the rent-jamming effect on the optimal monitoring and loan officer incentives.

Proposition 9. *The equilibrium monitoring effort is higher and loan officer incentives are stronger when the loan officers compete with each other for bribe rather than behave cooperatively.*

Proposition 9 is illustrated in Fig. 6. Intuitively, when the loan officers cooperate instead of competing with each other for bribe, lower shares are required to deter collusion. When the monitors compete, the minimum share in each bank-loan officer relationship that is required to deter collusion is given by $2(1 - z/pr)$. By contrast, when they cooperate, from (10) it follows that the minimum aggregate collusion-detering share $s_i + s_j$ is $2(1 - z/pr)$. Thus, the rent-jamming effect disappears, and the inefficiency due to incentives for over-monitoring reduces because the equilibrium monitoring effort function shifts down from $m_2(z)$ to $m_{cp}(z)$. Consequently, the required incentives are weaker, i.e., the optimal share reduces from $s_2(z)$ to $s_{cp}(z)$.

Proposition 9 is related to the literature on optimal incentive contracts in a multi-agent situation in which an increase in the capacity of the agents to cooperate leads to more efficient outcomes (e.g. Ramakrishnan and Thakor, 1991; Macho-Stadler and Pérez-Castrillo, 1993). In the present context, if banks could have enforced cooperation between the loan officers, the loss in efficiency due to incentives for over-monitoring would have been minimized. However, in our

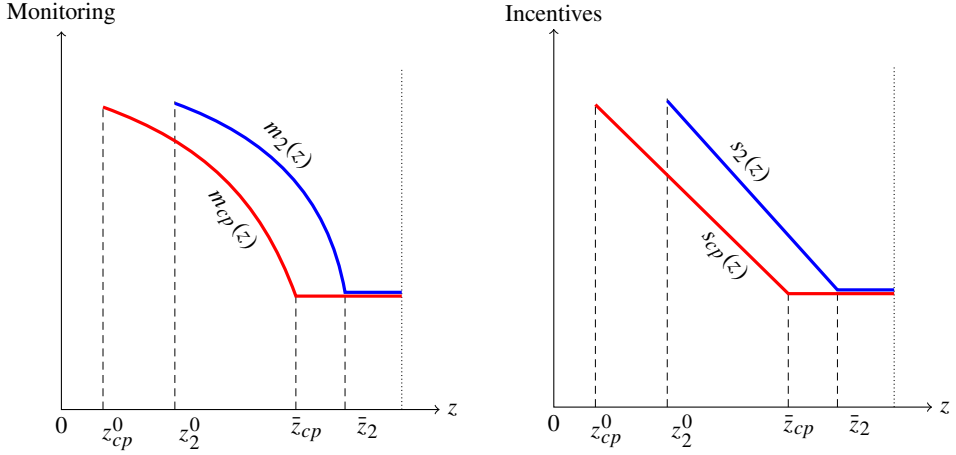


Fig. 6. The equilibrium monitoring effort and share under competing and cooperating loan officers. Subscript ‘cp’ denotes the variables under cooperating loan officers.

framework, banks cannot ensure cooperation between the loan officers because collusion is not publicly verifiable.

5.3. The firm’s choice of lending structure

We now turn to analyze the choice of the borrower between one- and two-bank lending. This analysis will be useful later, in Section 7, when we shall draw some testable implications of our analysis. Recall that one of the differences between the two financing arrangements is that, conditional on prudent behavior, under two-bank lending the firm receives twice the cash-flow if the project is successful, but also repays double the amount. While comparing borrower preferences across the two financing modes, it would therefore be useful to control for the effects arising purely from the difference in loan sizes, so that we can isolate the incentive effects. In a bid to do so, we slightly modify the single-bank lending mode by assuming that the firm maintains two identical single-bank lending relationships (see footnote 13 though). In this scenario, each loan officer monitors exactly one project, and there is no monitoring spillover in the sense that if loan officer i has been successful in monitoring the project his bank funds, monitor j does not benefit from such success. We term this financing arrangement *separate financing* (a regime denoted by S). Clearly, the equilibrium monitoring effort under separate financing, i.e., $m_S(z)$ is the same as with single-bank lending, $m(z)$. In Section 6.1 we shall return to analyze this case again. Recalling that $v \equiv py - z$, the expected payoff of the firm under single-bank lending is

$$F(z) = m(z)p(y - r) + [1 - m(z)]v = py - z - m(z)(pr - z).$$

Therefore, borrower payoff under separate financing is $F_S(z) = 2F(z)$. We compare $F_S(z)$ with the expected payoff of the firm under two-bank lending which is $F_2(z) = 2[py - z - \pi_2(z)(pr - z)]$. The difference in the payoffs between the two modes is given by:

$$F_S(z) - F_2(z) = 2(pr - z)(\pi_2(z) - m(z)),$$

which is positive if and only if $\pi_2(z) \geq m(z)$. Observe that conditional on the firm being prudent, the expected amount to be repaid, $2pr$ is the same under both financing modes. Thus the

borrowing firm, who has incentive to shirk, prefers the financing arrangement that induces lower aggregate monitoring intensity.

Proposition 10. *When firm quality is low, i.e., $z < z_2^0$, only separate financing is feasible, whereas both financing arrangements—namely, separate financing and two-bank lending are feasible for high values of firm quality.*

- (a) *If either $c \leq 2(2 + \sqrt{5})$ and $1 + \frac{c}{2} \leq pr \leq c$, or $c > 2(2 + \sqrt{5})$ and $\frac{1}{2}(\sqrt{5} - 1)c \leq pr \leq c$, then there is a unique $\theta^F \in (z_2^0, pr)$ such that $F_S(z) \leq F_2(z)$ if and only if $z \geq \theta^F$;*
- (b) *Otherwise, $F_S(z) > F_2(z)$ for all $z \in [z_2^0, pr]$.*
- (c) *In both of the above cases, bank monitoring, taking the choice of lending structures by the borrowing firm into account, is non-increasing in firm quality, z .*

To understand the above proposition, consider first a low-quality borrower, i.e., low values of z . Because $\pi_2(z) \geq m_2(z)$, and $m_2(z) > m(z)$ due to the rent-jamming effect, two-bank lending entails higher aggregate monitoring. Consequently, a low-quality firm prefers separate financing because it entails lower aggregate monitoring. By contrast, for high values of z , the free-riding effect dominates. However, the aggregate monitoring under two-bank lending is not necessarily lower than with separate (equivalently single-bank) financing even if the [non-delegation level of] individual monitoring effort is lower under two-bank lending (i.e., $m_2^* < m^*$). To understand this, note that $m^* - m_2^*$ represents the extent of the free-riding problem. Clearly, the non-delegation level of aggregate monitoring under two-bank lending, π_2^* is lower (higher) than that under separate financing, m^* according as the free-riding is severe (mild). Parts (a) and (b) of the above proposition follow from the facts that $m^* - m_2^*$, the extent of the free-riding problem, is decreasing in c and increasing in pr .

When Proposition 10(a) holds, the dashed curve in the left panel of Fig. 4 represents the symmetric equilibrium monitoring effort by taking the choice of financing modes by the borrowing firm into account. For low values of borrower quality, i.e., $z \leq \theta^F$, the firm chooses separate financing, and hence, bank monitoring coincides with $m(z)$ for all $z \leq \theta^F$. By contrast, for $z > \theta^F$, the firm chooses two-bank lending, and bank monitoring thus is given by $m_2(z)$ for all $z > \theta^F$. Therefore, bank monitoring, taking borrower choice into account, is non-increasing in firm quality. If part (b) of the above proposition holds true, then the firm chooses separate financing for all z , and hence, the monitoring effort is $m(z)$ which is also non-increasing in z .¹³

6. Extensions

So far we have analyzed optimal contracts for the loan officers in a scenario where banks have the capacity to deter collusion, and they do so in equilibrium. In this section, we extend this basic premise in two directions. In the first extension, we analyze a financing arrangement called *joint financing* where the firm owns two independent and identical projects which she can bundle into a single corporation, and seek financing from both banks. Under this lending structure, there exist subgames where it is not even feasible for the banks to prevent collusion. In the second extension, on the other hand, we consider the case where banks may strategically decide not to

¹³ A result similar to Proposition 10 can be obtained if we analyze the choice of the firm between the single- and two-bank lending structures when the firm obtains \$1 under the single-bank lending, and \$2 if there are two banks.

implement collusion-free contracts, even though doing so is feasible. This analysis also offers interesting testable implications related to *syndicated lending* in the presence of multiple lenders (see Section 7 later).

6.1. Joint project financing under two-bank lending

Our baseline framework with multiple banks implicitly assumes that there is a *single* indivisible project (asset). While the firm can scale this project up to twice the size when she obtains funds from two banks, she cannot set up a corporation with two *independent* sub-projects, each requiring \$1 of initial outlay. Do the rent-jamming effect and the consequent strategic complementarity of monitoring efforts depend critically on this assumption?¹⁴

In a bid to address this issue, we consider a natural extension where the firm owns two identical projects, each having a setup cost of \$1, and a payoff structure identical to that in Section 4.1. Further, conditional on the firm being prudent, these projects have independent payoff realizations. Each bank can fund at most \$1. Thus, the borrowing firm faces a choice between two different financing arrangements—(a) it can adopt the separate financing arrangement considered in Section 5.3, with each bank financing a single project, or (b) it can bundle the two projects into a single one and ask for \$2 of aggregate funding as a corporation with each bank contributing \$1 (a regime called joint financing, denoted by J). In the first case, a bank has claims only on the cash-flow of the project it finances, whereas in the second case, it has claims on returns from both in a manner detailed later. This analysis is similar in spirit to Winton (1999) and Banal-Estañol et al. (2013).

Under joint financing, the banks coordinate on which project to monitor,¹⁵ and a loan officer receives incentive pay only if the good version of the project he monitors is implemented, and the project succeeds (maximal incentives). Given that the two sub-projects are bundled however, both banks have claims on the cash-flow of both the projects. We assume $r < y < 2r$ which means that if at least one good project is implemented and only one project succeeds, the borrowing firm is not able to repay its debt, $2r$ in full so that each bank receives half of the cash-flow, i.e., $y/2$. Moreover, if the project monitored by bank i yields zero cash-flow, but the one monitored by loan officer j succeeds, then while bank i receives $y/2$, loan officer i does not receive any monetary reward. We also assume the following:

Assumption 2. (i) $v_J^{min} \equiv \frac{1}{2}py < v < py$; (ii) $1 + \frac{c}{2} \leq p\bar{r}$ and $p\hat{r} \leq c$, where $\bar{r} \equiv pr + \frac{1}{2}(1-p)y \in (\frac{1}{2}y, r)$ and $\hat{r} \equiv pr + (1-p)y \in (r, y)$.

We shall establish that Assumption 2(i) gives rise to the possibility that there could be bribery in equilibrium which, as we shall find in Propositions 11 and 12 later, has important implications for the rent-jamming effect. Assumption 2(ii), on the other hand, is the counterpart of Assumption 1.

The bribery subgame. First, suppose that loan officer i has not succeeded in monitoring, and consider the aggregate surplus to the firm and loan officer i . It is given by $v - C(m_i)$ in

¹⁴ We thank an anonymous reviewer for raising this issue.

¹⁵ A more complex scenario would be where each loan officer monitors both projects as analyzed in Carletti et al. (2007). However, they do not consider delegated monitoring, and hence, the possibility of collusion does not emerge. We leave the analysis of the case when each loan officer monitors both projects for future research.

case of collusion, whereas it is $\frac{1}{2}pys_i - C(m_i)$ in case there is no collusion. Hence, given Assumption 2(i), collusion between the firm and loan officer i cannot be deterred. Assuming that $(1 - \beta, \beta)$ is the distribution of bargaining power between the firm and the loan officer, we take it that the optimal bribe, $b(s_i)$ when the firm and loan officer i collude is determined by the Nash bargaining solution, so that $b(s_i) = \beta v + \frac{1}{2}(1 - \beta)pys_i$.

Next, consider the case where both loan officers have succeeded in monitoring. We first argue that one cannot sustain an outcome where only one loan officer colludes. Suppose to the contrary, only one loan officer, say j , has decided to collude. In this case, the aggregate surplus to loan officer i and the firm is $2v - C(m_i)$ in case of collusion, and $v + pys_i/2 - C(m_i)$ if loan officer i does not collude. Given Assumption 2(i), clearly loan officer i would collude as well. Thus, the only scenario that has a no-collusion outcome must involve both loan officers succeeding in monitoring, and moreover neither colluding. Let $F(\sigma_i, \sigma_j)$, $M_i(\sigma_i, \sigma_j)$ and $M_j(\sigma_i, \sigma_j)$ respectively be the payoffs of the firm and monitors i and j where $\sigma_i, \sigma_j \in \{0, 1\}$ with 0 representing collusion and 1 representing no-collusion. Thus, if no loan officer colludes with the borrower, then we have $F(1, 1) = 2p^2(y - r)$, $M_i(1, 1) = p^2rs_i + p(1 - p)(y/2)s_i - C(m_i)$ and $M_j(1, 1) = p^2rs_j + p(1 - p)(y/2)s_j - C(m_j)$. On the other hand, in case both the loan officers colluding with the borrower, we have $F(0, 0) = 2v - b_i - b_j$, $M_i(0, 0) = b_i - C(m_i)$ and $M_j(0, 0) = b_j - C(m_j)$. Thus, collusion can be deterred if and only if

$$F(1, 1) + M_i(1, 1) + M_j(1, 1) \geq F(0, 0) + M_i(0, 0) + M_j(0, 0) \\ \iff p\bar{r}(s_i + s_j) \geq 2[v - p^2(y - r)].$$

We would call the above inequality the *minimum share constraint* instead of no-collusion constraint because, as we just argued, given Assumption 2 it is not always feasible for the banks to deter collusion between the loan officer(s) and the borrowing firm.

Equilibrium monitoring. Bank i solves the following problem:

$$\max_{\{m_i, s_i\}} m_i m_j \left(p\bar{r}(1 - s_i) + \frac{1}{2}p(1 - p)y \right) - 1, \quad (16)$$

$$\text{subject to } m_i m_j p\bar{r}s_i + m_i(1 - m_j)b(s_i) - \frac{1}{2}cm_i^2 \geq 0, \quad (17)$$

$$p\bar{r}(s_i + s_j) \geq 2[v - p^2(y - r)]. \quad (18)$$

The proof of Proposition 11 has further details regarding the derivation of the bank's objective function, (16) and the participation constraint of loan officer i , (17). It is worth mentioning that the equilibrium variables cannot be expressed as functions of borrower quality, $z \equiv py - v$; we rather express them as functions of the firm's private moral hazard, v . We state the following result.

Proposition 11. *Under joint financing, a unique symmetric equilibrium exists with the following properties¹⁶:*

¹⁶ When the minimum share constraint is slack, there is a unique equilibrium with strictly positive monitoring efforts and repayment shares which is symmetric, i.e., $m_i = m_j$ and $s_i = s_j$. On the other hand, when the constraint binds, any combination (s_i, s_j) satisfying $p\bar{r}(s_i + s_j) = 2[v - p^2(y - r)]$ constitutes an equilibrium. However, the symmetric equilibrium in which $s_i = s_j$ and $m_i = m_j$ is unique.

- (a) There are threshold values of borrower moral hazard, \bar{v}_J and v_J^0 with $p(y-r) < \bar{v}_J < v_J^0$ such that the minimum share constraint, (18) binds at the optimum if and only if $v \geq \bar{v}_J$. In this case, there is a unique threshold value of the bargaining power of each loan officer, $\bar{\beta} \in (0, 1)$ such that monitoring efforts m_i and m_j are strategic complements (resp. substitutes) as $\beta < \bar{\beta}$ (resp. $\beta \geq \bar{\beta}$);
- (b) The symmetric equilibrium monitoring effort is given by:

$$m_J(v, \beta) = \begin{cases} \frac{2\beta v\bar{r} + (1-\beta)py\hat{r}}{2\beta v\bar{r} + (1-\beta)py\hat{r} + 2\bar{r}(c-p\hat{r})} & \text{for } v < \bar{v}_J, \\ \frac{2\beta v\bar{r} + (1-\beta)y(v-p^2(y-r))}{2\beta v\bar{r} + (1-\beta)y(v-p^2(y-r)) + \bar{r}(c-2(v-p^2(y-r)))} & \text{for } v \geq \bar{v}_J. \end{cases}$$

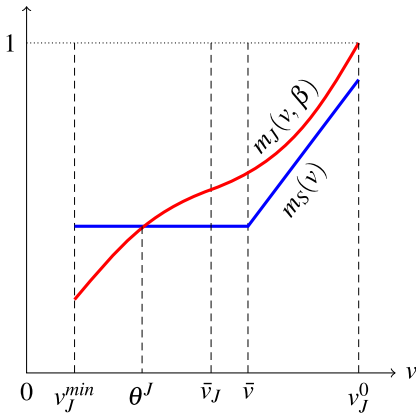
Note the qualitative differences between the incentive contract under two-bank lending analyzed in Section 4.2 and that under joint financing—under the latter, a loan officer colludes with the borrower in exchange for a bribe whenever the other loan officer fails in monitoring. This possibility does not emerge in Section 4.2, which in turn ensures that under two-bank lending m_i and m_j are strategic complements whenever the no-collusion constraints bind. We then demonstrate that the possibility of bribery under joint financing plays an important role in the analysis. In particular, it opens up the possibility that monitoring efforts may or may not be strategic complements even if the minimum share constraint binds. Under joint financing, a binding minimum share constraint fixes the shares at a minimum level, analogous to the role played by the no-collusion constraint in the case of two-bank lending. It is easy to show that the participation constraint of loan officer i (as well as j) binds at the optimum, and hence, under a fixed share s , (17) reduces to

$$m_j p\bar{r}s + (1-m_j)b(s) = \frac{1}{2} cm_i. \quad (19)$$

An increase in m_j may either increase or decrease the left-hand-side of the above expression depending on whether the incentive pay of the loan officer, $p\bar{r}s$ is greater or less than the bribe $b(s)$. When the bribe is small (which happens if the bargaining power of the borrowing firm is large), monitoring efforts are strategic complements, with the equilibrium converging to that under the two-bank lending mode when $\beta = 0$ (when there is no bribery at all). By contrast, when the bribe amount is large (which happens for β close to 1), monitoring efforts are strategic substitutes. Intuitively, there are two effects at play here. One is the familiar rent-jamming effect which generates strategic complementarity. The other one arises from the possibility of bribery. With an increase in the monitoring by loan officer j , say, gains from bribery are less likely for officer i (because bribery only happens when officer j fails in detecting borrower misbehavior), thereby reducing his monitoring incentives, so that this effect tends to make monitoring efforts strategic substitutes. When the bribe amount is small, any change in monitoring incentives arising from this channel is small, so that the first effect dominates. Whereas if the bribe amount is large, the second effect is significant and may overturn the first.

Fixing p and y , borrower moral hazard, v is inversely proportional to firm quality, z , and hence, monitoring is increasing in v when the minimum share constraint binds. However, monitoring effort is also increasing in v even if the constraint is slack because the expected utility of each loan officer now depends on the optimal bribe which increases with the private moral hazard of the firm.

Monitoring



Borrower utility

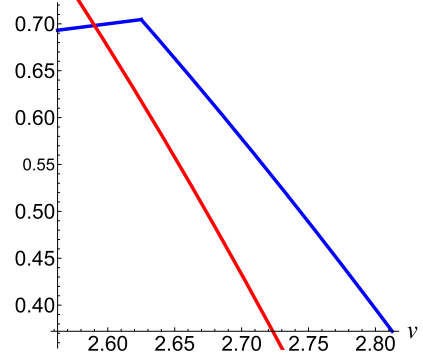


Fig. 7. The left panel depicts the equilibrium monitoring efforts under separate and joint financing, whereas the right panel depicts the choice of the firm between the two lending modes. For low values of v , joint financing implies lower monitoring, and hence, the firm prefers joint financing. For high values of v , on the other hand, the borrower consumes more utility under separate financing because this lending mode elicits less intense monitoring.

Comparison between separate and joint financing. We first compare the equilibrium monitoring efforts under the two financing structures. Next, we discuss which structure the borrowing firm would choose. The first analysis is qualitatively very similar to the one presented in Proposition 7.

Proposition 12. *Consider the unique symmetric equilibrium under joint financing described in Proposition 11. Further, assume that the bargaining power of each loan officer is not very high, i.e., $\beta < \tilde{\beta}$ for some $\tilde{\beta} \in (0, 1)$. Then, there is a unique $\theta^J > 0$ such that monitoring under separate financing is higher than that under joint financing if and only if $v \leq \theta^J$.*

Proposition 12 is depicted in the left panel of Fig. 7, where both monitoring functions are plotted against v instead of z . Note that $m_S(v)$, the monitoring effort under separate financing is the same as that under single-bank lending, $m(z)$. When the minimum share constraint does not bind (for $v < \bar{v}_J$), equilibrium monitoring under joint financing is increasing in v , whereas that under separate financing is constant (because $\bar{v}_J < \bar{v}$). Next suppose that the minimum share constraint binds under joint financing. Then, for low values of β , the rent-jamming effect is strong, and hence, m_i and m_j are strategic complements. Consequently, for high values of v , joint financing leads to higher monitoring.¹⁷

Next, we compare the expected utilities of the firm under the two lending modes. The borrower utility under separate financing is $F_S(v) = 2m_S(v)p(y-r) + 2[1-m_S(v)]v$, whereas that under joint financing is given by:

¹⁷ Note that the minimum value v could assume is $p(y-r)$; however, we have restricted $v \geq v_J^{\min} \equiv \frac{1}{2}py > p(y-r)$. Therefore, it may be the case that $p(y-r) < \theta^J < v_J^{\min}$, i.e., $m_J(v, \beta)$ dominates $m_S(v)$ for the entire range of values of borrower moral hazard. What is crucial to the above proposition is a condition for single-crossing between $m_J(v, \beta)$ and $m_S(v)$. Note also that Proposition 12 does not say that θ^J lies on the horizontal portion of $m_S(v)$, it can as well be on the upward-sloping part of $m_S(v)$.

$$F_J(v, \beta) = 2(m_J(v, \beta))^2 p^2 (y - r) + 2[1 - (m_J(v, \beta))]v \\ - 2m_J(v, \beta)(1 - (m_J(v, \beta))) \underbrace{(\beta v + \frac{1}{2}(1 - \beta)pys_J(v, \beta))}_{=b(s_J(v, \beta))},$$

which is derived as follows. If both loan officers succeed in monitoring, an event which occurs with probability $(m_J(v, \beta))^2$ in equilibrium, the borrower receives $2p^2(y - r)$ because with only one project succeeding, the banks receive the entire cash-flow, y . When at least one loan officer fails in detecting borrower misbehavior, an event with probability $(m_J(v, \beta))[1 - (m_J(v, \beta))]$, the borrowing firm earns $2v - b(s_J(v, \beta))$. Finally, when both loan officers fail, the borrower enjoys the entire private benefits, $2v$. The above expression depends on many parameters in a non-linear fashion, and hence, an analytical result similar to Proposition 10 is difficult to derive. We instead put forward the following numerical example.

Example 1. We take $\beta = 0.4$, $p = 0.5$, $c = 5.5$, $r = 10$, $y = 10.25$ and vary v over the interval $[2.563, 2.813]$ so that the parameter values conform to Assumption 2. We obtain that there is a unique $\tilde{\theta}^F \approx 2.589$ such that the firm prefers joint financing if and only if $v < \tilde{\theta}^F$. This result is depicted in the right panel of Fig. 7. For low values of v , joint financing elicit lower monitoring, and hence, the borrowing firm prefers joint financing. By contrast, for high values of borrower moral hazard, there is more intense monitoring under joint financing. Consequently, the borrower prefers separate financing.

Banal-Estañol et al. (2013) analyze the optimal choice of the firm between separate and joint financing of two independent projects. When the projects have binary returns, and the cash-flow in the event of success is large, i.e., $y > 2r$, joint financing leads to “coinsurance” as only one successful project is able to cover the aggregate repayment obligations. The borrower prefers joint financing because coinsurance obliges the creditors to lower the loan rates. By contrast, when the cash-flow in case of success is low, ($y < 2r$), joint financing leads to “risk contamination”, i.e., one failed project impedes the firm to meet her repayment obligations, and hence, separate financing dominates because the banks charge higher loan rates when projects are financed jointly. Our results in this regard are different because the monitoring intensity is the principal determinant of borrower choice of the funding mode.

To summarize, some interesting novel insights emerge in the event the borrowing firm can invest in two independent projects (which it can bundle into a single corporation). In particular, there exist parameter configurations such that there is a positive probability that bribe payments are made in equilibrium. Further, there is an intuitive link between the magnitude of such bribes and whether monitoring efforts are strategic complements or substitutes. Interestingly, despite the fact that the firm can now invest in two separate independent projects, the rent-jamming effect exists, though it now holds for a smaller set of parameter values relative to our baseline framework. In particular, the analysis suggests that it is more likely to exist if the actual amount of bribe paid in equilibrium, if any, is not too large. Further, similar to Proposition 10 earlier, the firm is more likely to prefer joint financing if private moral hazard, v is small.

6.2. The collusion-proofness principle under two-bank lending

Tirole (1986) proves the *collusion-proofness principle* which asserts that there is no loss of generality in restricting attention to collusion-free contracts. In the baseline model, we have

abstracted from the issue of whether the collusion-proofness principle holds or not.¹⁸ For completeness however, we now take up this issue. Under single-bank lending, this principle holds true because if the contract does not deter collusion, then the loan officer surely colludes in equilibrium, and the bank never breaks even. A subsequent strand of literature (e.g. Kofman and Lawarrée, 1993, 1996; Strausz, 1997; Khalil and Lawarrée, 2006) considers a single principal-supervisor-agent hierarchy where the principal can contract on a signal that is imperfectly correlated with the occurrence of collusion (e.g. an independent auditor). If the informativeness of the signal is high, then it is not in principal's interest to commit to collusion-free contracts as the expected gains from deterring collusion are small.

We shall find that the collusion-proofness principle may fail to hold in the present context as well. However, the reason is different because, in contrast with much of the literature, in our framework no bank can rely on an external signal as the outcome of monitoring is not publicly verifiable. We shall rather show that one bank may find it optimal to free-ride on the information gathered by the other, and thereby saving on the cost of incentive provision by not hiring a monitor because the monitoring technology is a public good.

We show that if firm quality z is sufficiently large, then, for both banks, it is optimal to offer collusion-free contracts to their loan officers. However, if z is small, then optimally while one bank implements the collusion-free contract, the other bank does not; it free-rides on the monitoring being done by its rival bank. In Section 7, we shall also argue that the analysis links naturally to financing arrangements such as *syndicated lending*. For ease of exposition, we shall classify all possible equilibria under three headings:

- (1) An equilibrium strategy profile is said to be (NC, NC) if both banks implement the collusion-free contracts so that neither loan officer colludes;
- (2) An equilibrium strategy profile is said to be (C, NC) if one bank does not implement the collusion-free contract, whereas the other bank does;
- (3) An equilibrium strategy profile is said to be (C, C) if neither of them implements the collusion-free contract.

Clearly, one cannot have the (C, C) equilibrium because each bank would incur a loss of \$1. So, we analyze equilibria of types (NC, NC) and (C, NC) . We assume, without any loss of generality, that in a (C, NC) equilibrium bank i does not implement the collusion-free contract, but bank j does. Note that for high values of firm quality, i.e., $z > \bar{z}_2$ the no-collusion constraint of neither loan officer binds [cf. Proposition 5], and hence, the equilibrium (C, NC) can only occur for $z \leq \bar{z}_2$. We first state the main result of this subsection.

Proposition 13. *There are threshold values $\tilde{\theta}$ and $\hat{\theta}$ of firm quality, with $z^{\min} < \tilde{\theta} < \hat{\theta} \leq \bar{z}_2$, such that an (NC, NC) equilibrium exists for any $z \geq \tilde{\theta}$, whereas a (C, NC) equilibrium exists for any $z \leq \hat{\theta}$. In an (NC, NC) equilibrium, both banks set strictly positive levels of monitoring*

¹⁸ In the United States, the Sarbanes Oxley Act was introduced in 2002 in order to protect investors by improving the accuracy and reliability of corporate disclosures. Sections 801 to 807 of this act, which are collectively known as the *Corporate and Criminal Fraud Accountability Act*, describe penalties for manipulation, destruction or alteration of financial records, while providing protections for whistle-blowers. Hertzberg et al. (2010) analyze the mandated policy of banks to rotate loan officers frequently, and show that such policy incentivizes loan officers to report more accurately. Thus, banks clearly have interests in deterring collusion.

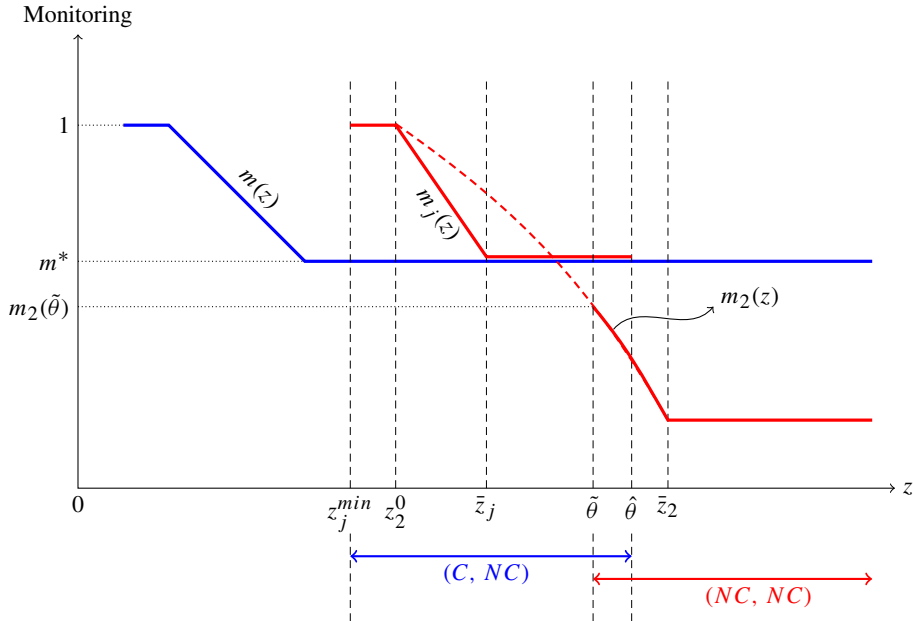


Fig. 8. The equilibrium monitoring efforts under two-bank lending has two segments— $m_j(z)$ corresponds to (C, NC) equilibrium, and $m_2(z)$ corresponds to (NC, NC) equilibrium. While the segment $m_j(z)$ lies above $m(z)$, the monitoring under single-bank lending, the segment $m_2(z)$ lies below $m(z)$. Also, for $\tilde{\theta} \leq z \leq \hat{\theta}$ there are multiple equilibria.

efforts for their loan officers. By contrast, in a (C, NC) equilibrium, bank i does not hire a monitor, while bank j implements strictly positive monitoring effort for its loan officer.

Note that the (NC, NC) equilibrium corresponds to the equilibrium analyzed in Section 4.2, which is the unique equilibrium for any $z > \hat{\theta}$. In other words, the collusion-proofness principle holds for all $z > \hat{\theta}$. For intermediate values of borrower quality, i.e., $\tilde{\theta} \leq z \leq \hat{\theta}$, there are multiple equilibria—one of type (NC, NC) , and another of type (C, NC) , and hence, over this range of firm quality, the collusion-proofness principle holds weakly. For low z , it is optimal for bank i not to deter collusion. Fig. 8 depicts the results in Proposition 13.

Intuitively, in a (C, NC) equilibrium where bank i does not intend to deter collusion, it optimally sets $s_i = 0$. Moreover, given that loan officer i colludes, no bank gains from any monitoring this loan officer might do, so that in this case we have $\pi(m_i, m_j) = m_j$. This situation is thus equivalent to the scenario in which bank i does not employ any loan officer, i.e., $m_i = 0$, thereby saving on the cost of incentive provision, and free-riding on the monitoring effort exerted by loan officer j . From Fig. 8, it is also clear that both banks implementing the collusion-free contracts is an equilibrium strategy only if they face a high-quality borrower, i.e., $z \geq \hat{\theta}$. The reason is that, under two-bank lending, the cost of providing incentives to deter collusion is low when firm quality is high (it is zero if firm quality is sufficiently high, i.e., $z > \bar{z}_2$) as higher values of z imply lower incentive for vertical collusion.

Remark. How does the analysis change if one loan officer is *honest*, i.e., he never intends to collude with the borrowing firm even if no incentives are provided (as in Kofman and Lawarrée, 1996), whereas the other one is *strategic*? Suppose that loan officer j is honest, whereas loan

officer i is strategic. Even in this case, Proposition 13 holds true. Note that a (C, C) equilibrium never emerges because loan officer j never colludes. There is, however, one quantitative difference between this case and the one analyzed above where both loan officers are strategic. The threshold $\tilde{\theta}$, below which (C, NC) is the unique equilibrium, is lower if he is honest implying that the collusion-proofness principle holds over a larger range of firm quality. The reason is that when the loan officer is honest, bank j does not have to adhere to the no-collusion constraint, and hence, the monitoring effort is low relative to the case when both loan officers are strategic. As lower monitoring means lower probability of repayment, and hence, bank i has greater incentives to implement the collusion-free contract. In the proof of Proposition 13, we also analyze this case in details.

7. Empirical relevance

In this section, we offer two testable implications of our results—the first one is related to the empirically observed counter-cyclical nature of bank monitoring, and the second, to the nature of association between borrower moral hazard and syndicated lending.¹⁹

Business cycles and monitoring. A long-standing literature (e.g. Holmström and Tirole, 1997; Keys et al., 2010; Cerqueiro et al., 2016) has analyzed the role of ‘borrower quality’ (e.g. net worth, creditworthiness, collateral value) in determining the nature of lending relationships. More recently, both theoretical and empirical research (e.g. Dell’Ariccia and Marquez, 2006; Lisowsky et al., 2017) studied how lending standards change with business cycle fluctuations. We first argue that borrower quality, $z \equiv py - v$, which is our key parameter, should be high during booms and low during recessions. Expected firm value, py (proxied by verifiable cash-flow) in general behaves pro-cyclically, since projects can be expected to have higher cash returns during booms. However, whether the firm’s private moral hazard, v moves pro- or counter-cyclically is less obvious. On the one hand, Bernanke and Gertler (1989) argues that economic downturns tend to undermine borrower net worth, which in turn exacerbates incentive problems. This suggests that v moves counter-cyclically. On the other, it may also be argued that v represents the fraction of surplus that the controlling shareholders and managers divert from the firms, and could therefore be expected to be monotonic with respect to the firm surplus, and thus behave pro-cyclically as well. To illustrate, if $v = \alpha py$ with $\alpha \in (0, 1)$, then $\text{sign}[dz] = \text{sign}[d(py)]$. Even so, v should be relatively less responsive to business cycles fluctuations, given that it represents activities that are likely to be regulated.²⁰ Taking all aspects into account, it therefore seems natural to assume that z behaves pro-cyclically.

We can now combine the lessons in Propositions 2, 5 and 10 to offer the following testable implication pertaining to how bank monitoring responds to economic fluctuations.

Implication 1. Bank monitoring is counter-cyclical. Moreover, the counter-cyclicality of bank monitoring is more pronounced under two-bank lending.

¹⁹ We thank an anonymous reviewer and the associate editor for encouraging us to write this section.

²⁰ To the best of our knowledge there are little empirical works that speak to this issue. While the relationship banking literature uses various measures of the quality of lending, e.g. the temporal length of the relationship (Petersen and Rajan, 1994), exclusivity of the relationship (Ongena and Smith, 2000), and the degree of mutual trust between the bank and the borrowing firm (Harhoff and Körting, 1998), they do not track how these measures change with the business cycle.

Recall, from Propositions 2 and 5, that for a given financing arrangement—single- or two-bank lending, both bank monitoring effort and the aggregate monitoring intensity are decreasing in borrower quality, z . Therefore, holding the lending structure fixed, our model predicts counter-cyclical movements in bank monitoring. This prediction holds true even if we endogenize the lending structure, which directly follows from Proposition 10(c). The borrowing firm would choose separate financing if z is low (i.e., $z \leq \theta^F$) and two-bank lending otherwise.²¹ Therefore, as is clear from the left panel of Fig. 4, per bank monitoring after taking regime switching into account (depicted by the dashed curve), behaves counter-cyclically. The extant literature provides (in)direct empirical evidence of this prediction. In any lending relationship, lenders generally apprise loans based on hard information such as credit scores (e.g. FICO score). Keys et al. (2010) show that during an upswing in the business cycle, mortgage lenders reduce intensity of screening and monitoring of more creditworthy borrowers. They argue “... because investors purchase securitized loans based on hard information, the cost of collecting soft information is internalized by lenders when screening borrowers at FICO score 620⁺ to a lesser extent than at 620[−]”. Lisowsky et al. (2017), using data from the construction industry in the United States during 2002–2011, examine whether bank monitoring as measured by the use of financial statement verification varies with economic growth. They find that banks have substantially reduced the collection of ‘unqualified audited financial statements’ from construction borrowers in the U.S. regions with the highest construction growth.

The second implication that the counter-cyclicality of bank monitoring is more pronounced under two-bank lending follows from Proposition 7 as two-bank lending entails higher per bank monitoring relative to single-bank lending if and only if borrower quality is low (i.e., $z \leq \theta^m$). In other words, during booms, free-riding prevails and depresses monitoring, whereas in bad times there is excessive monitoring due to rent-jamming. A few related papers draw similar conclusions in the context of borrower screening (as opposed to performance monitoring in our model) in a competitive banking market. In Petriconi (2016), banks face a trade-off between improving loan quality by enhanced screening and protect customers, who can be poached away by the uninformed lenders (who free-ride on the informed lenders), by relaxing screening standards. During booms, more uninformed lenders are lured into the credit market, and more intense bank competition exacerbates lenders’ incentives for lax screening. As a result, screening deteriorates in good times. In a static model of competition between informed and uninformed lenders, Sengupta (2007) shows that uninformed lenders, when their cost-advantage is significantly high relative to the informed banks, screen more intensely in the segment of the market that consists of a high proportion of low-quality borrowers. Clearly, this result can be interpreted as the counter-cyclical movements of borrower screening. Asriyan et al. (2021) argue that, for banks, collateralization and costly screening are two instruments to prevent diversion of funds by borrowers. Borrower screening becomes counter-cyclical because during credit booms driven by high collateral values, banks reallocate funds towards productive projects; however this also leads to lenient screening.

Finally, we discuss the extent to which firm quality and bank monitoring can be quantifiable. While the expected return, py can easily be estimated from financial statements of public corporations as well as private equity companies, measuring v is not straightforward. One indicator that should be positively related to v is the difference between control and cash-flow rights (see Lin et al., 2012, for the precise estimation techniques). This is because within a borrowing firm,

²¹ This happens if either monitoring costs are low or the expected loan rate is high. Otherwise, there is necessarily single-bank lending, and monitoring is counter-cyclical across the board.

agency problem often arises due to the wedge between control and cash-flow rights. Controlling shareholders and managers, who enjoy control rights but have insignificant cash-flow rights, often engage in tunneling and other moral hazard activities by diverting corporate wealth for private benefits (see Johnson et al., 2000). Thus, for a typical corporation, the larger the difference between the two, the lower is the firm quality. Finally, the frequency of borrower reviews by the lending institutions can be considered as a broad proxy for monitoring (see Cerqueiro et al., 2016; Lisowsky et al., 2017; Gustafson et al., 2021).

Syndicated lending. Modern banking with multiple lenders is often organized as *lending syndicates* with asymmetric distribution of roles among the participating banks with the lead bank doing the bulk of monitoring (among other differences). This is in contrast with the traditional consortium lending with many banks where each bank independently appraises and monitors the borrower (i.e., they assume more symmetric roles). The analysis in Section 6.2, in particular Proposition 13, offers a set of testable implications regarding the organizational structure of multiple-bank lending. Observe that the lending structure under a (C, NC) equilibrium, which exists if firm quality z is low, is akin to a lending syndicate in which bank j plays the role of the lead arranger to whom the responsibility of monitoring is delegated.²² By contrast, the structure of the (NC, NC) equilibrium, which exists for z large, resembles a traditional multiple-bank lending.

Controlling for the expected cash-flow, py we have that z and v are inversely related. Then, Proposition 13 can be recast in terms of v , the extent of private moral hazard of the borrowing firm. Further, as we have discussed earlier, the divergence between control and cash-flow rights can be taken as a proxy for v . Thus, our analysis implies

Implication 2. Firms with significant difference between control and cash-flow rights, i.e., large v , are financed by syndicated loans, whereas firms for whom this difference is small, i.e., small v , are funded by traditional multiple-bank loans, e.g. consortium lending.

This prediction is consistent with the literature which suggests that the organizational structure of a lending syndicate often depends crucially on the characteristics of its borrower. Sufi (2007) and Gustafson et al. (2021) find that syndicates are more concentrated and monitoring is more intense for more informationally opaque borrowers. Lin et al. (2012) use a dataset of 14,350 syndicated loans across 22 countries during 1996–2008 in order to analyze the effect of borrower moral hazard on the syndicate structures. Firms with large difference between control and cash-flow rights are funded by more concentrated syndicates. By contrast, firms for whom this difference is low borrow from syndicates with more diffuse structure. Because a lead bank retains a larger share of the loan in a more concentrated syndicate, it is expected that the loan originator monitors more intensely when the syndicate is more concentrated.

Moreover, because the (C, NC) equilibrium widens the range of firm quality over which lending is feasible compared with the traditional two-bank lending (i.e., $z_j^{min} < z_2^0$ in Fig. 8), low-quality borrowers who do not have access to traditional bank lending can still obtain funds from lending syndicates. This finding thus goes in line with the facts that loan syndication arguably expands credit supply, and financial intermediaries, who would not lend as independent lenders

²² In a loan syndicate, the lead bank typically has larger participation in the loan, which we cannot capture because the firm requires \$2, and each bank lends only \$1. Moreover, the lead bank, apart from earning the interest payments on its fraction of the loan, also earns a fee for arranging the syndicated loan, which we have normalized to zero.

to borrowers requiring more intense monitoring, are willing to finance such borrowers through syndicates (e.g. Holmström and Tirole, 1997). Thus, our model of delegated monitoring in the presence of multiple lenders provides a micro-foundation of loan syndication and the empirically documented asymmetric distribution of roles in such syndicates.

8. Concluding remarks

In situations where borrower misbehavior can only be verified through costly monitoring by lenders, multiple-bank lending is in general viewed as detrimental to efficiency in the sense that it can lead to a free-riding problem in monitoring (e.g. Khalil et al., 2007), thereby lowering the monitoring effort of each lender. The present paper identifies an additional source of inefficiency if monitoring activities must be delegated and there is a possibility of vertical collusion between a loan officer and the borrower, leading to what we term the rent-jamming effect. Under multiple-bank lending, the rent-jamming effect ensures that if borrower quality is low, then incentives offered to the monitors are stronger in order to deter collusion, leading to a higher level of monitoring. Our analysis also offers interesting testable implications—first, bank monitoring is counter-cyclical, and second, high-quality borrowers are financed by traditional multiple-bank lending, whereas the low-quality ones borrow from lending syndicates.

In Dam and Roy Chowdhury (2020), we consider several extensions of our baseline model. We first show that our results remain valid even if we endogenize the loan rates, and the banks in principle can charge different rates. Second, our results also hold under fairly weak assumptions when monitoring effort is not contractible (monitor moral hazard). Finally, Proposition 7 continues to hold when (a) under two-bank lending, the firm borrows \$0.50 from each bank instead so that the aggregate loan size is constant across the two lending modes, and (b) there are $n > 2$ banks who invest in a single firm.

This paper focuses on two important characteristics that many organizations share—that they have a hierarchical structure, and that they interact with other organizations at various levels. The hierarchical structure suggests that collusion may be a problem. On the other hand, the fact that organizations interact leads to contractual externality. While, in the interest of imposing some structure on the problem, we have examined these issues in a specific context—one where there are two banks, both of which lend to a single firm—our framework can find applications, either directly or with some modifications, in many other scenarios with multiple hierarchies. For one, consider a scenario where multiple international organizations provide various kinds of help to a country—one providing aid, another providing technical knowhow, etc., with officers in these organizations overseeing the proper use of these inputs. As a topical example, we can think of a Covid-affected country getting financial aid from the World Bank, loan from a developed nation, and health expertise from the WHO. For another, consider two firms cooperating on a technology-driven project, outsourcing at least a part of technology development to an independent laboratory, with the middle managers in the firms keeping tabs on the laboratory.²³

Finally, our results and intuitions generalize to vertically related markets that also involve competing hierarchies. The contractual outcome is similar to a situation where vertically related firms choose between *integration* through vertical merger and *separation* through a delegation contract (e.g. Bonanno and Vickers, 1988). In a vertically integrated firm, the conflict of interest between two production units ceases to exist, and the units take decisions as a single entity. By

²³ Majewski (2004) shows that when firms are direct competitors in the product market, outsourcing collaborative R&D is more likely to occur.

contrast, under vertical separation, incentive problem becomes non-trivial. Note that the stake in collusion mandates a minimum incentive pay via the no-collusion constraint of each loan officer. When the no-collusion constraint binds in a given bank-loan officer relationship, the incentive pay or equivalently the revenue share is tilted towards the loan officer, and an outcome similar to vertical separation results in. On the other hand, when the no-collusion constraint is slack, loan officer share is low, and we obtain an outcome similar to vertical integration. Under two-bank lending, the stake in collusion increases, and so does the minimum incentive pay. As a result, vertical separation-like outcomes become more likely.

Appendix A. Proofs

Proof of Proposition 2. Consider the maximization problem (5). We first argue that at the optimum neither $m = 0$ nor $s = 1$ is an optimal solution. Both at $m = 0$ or at $s = 1$, $B(m, s) = -1 < 0$, and hence, the bank is better-off by not lending. Moreover, $s = 0$ cannot be optimal too because this would violate the participation constraint of the loan officer at any $m > 0$. Thus, the only relevant feasibility constraint we are left with is $m \leq 1$. The Lagrangean is given by:

$$\mathcal{L} = \underbrace{mpr(1-s) - 1}_{B(m,s)} + \mu_P \underbrace{\left(mprs - \frac{1}{2}cm^2\right)}_{g^P(m,s)} + \mu_N \underbrace{(prs - (pr - z))}_{g^N(m,s)} + \mu_F \underbrace{(1-m)}_{g^F(m,s)},$$

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

$$\frac{\partial \mathcal{L}}{\partial m} = pr(1-s) + \mu_P(prs - cm) - \mu_F = 0, \quad (20)$$

$$\frac{\partial \mathcal{L}}{\partial s} = m(\mu_P - 1) + \mu_N = 0, \quad (21)$$

$$\mu_k g^k(m, s) = 0 \quad \text{for } k = P, N, F,$$

$$g^k(m, s) \geq 0 \quad \text{for } k = P, N, F,$$

$$\mu_k \geq 0 \quad \text{for } k = P, N, F.$$

First, we consider the case when $\mu_F > 0$, which implies that $m = 1$. We argue that, in this case, the no-collusion constraint (2) must bind. Suppose not, i.e., $\mu_N = 0$. Substituting, $m = 1$ and $\mu_N = 0$ into (21), we obtain that $\mu_P = 1$. Substituting $\mu_P = 1$ into (20), we obtain $pr - c = \mu_F > 0$ which contradicts our assumption that $pr \leq c$. Therefore, (2) binds, and $prs = pr - z$. With $m = 1$ and $prs = pr - z$, for each bank to break even we require $mpr(1-s) - 1 = z - 1 \geq 0 \iff z \geq 1 \equiv z^{\min}$. On the other hand, the participation constraint reduces to $pr - z - \frac{c}{2} \geq 0$, which is equivalent to $z \leq pr - \frac{c}{2} \equiv z^0$.

Next, consider the case when $m < 1$, and hence, $\mu_F = 0$. We argue that, in this case, the participation constraint (3) must be binding. If, on the contrary, (3) does not bind, then $\mu_P = 0$, and hence, (20) implies $s = 1$, and $B(m, s) = -1 < 0$. Thus, the bank is better-off by not lending. Given that the participation constraint binds at the optimum, there are two sub-cases.

First, suppose that the no-collusion constraint (2) binds, i.e., $prs = pr - z$. Substituting the value of s into the binding participation constraint (3), we obtain

$$m = \frac{2(pr - z)}{c}.$$

Because (4) is slack, i.e., $m < 1$, we have that $z > z^0$. Substituting $m = 2(pr - z)/c$, $prs = pr - z$ and $\mu_F = 0$ into (20) and (21), we obtain

$$\mu_P = \frac{z}{pr - z} \quad \text{and} \quad \mu_N = \frac{2(pr - 2z)}{c}.$$

Now, $\mu_N \geq 0$ implies $z \leq pr/2 \equiv \bar{z}$.

Next, consider the sub-case when the no-collusion constraint (2) is slack, i.e., $\mu_N = 0$. Thus, substituting $\mu_N = \mu_F = 0$ into (20) and (21), we obtain

$$pr(1 - s) + \mu_P(prs - cm) = 0, \quad (22)$$

$$m(\mu_P - 1) = 0. \quad (23)$$

From (23) it follows that either $\mu_P = 1$ or $m = 0$. The solution $m = 0$ is not feasible because $B(0, s) = -1 < 0$, and hence, $\mu_P = 1$. Substituting $\mu_P = 1$ into (22), we obtain $m = pr/c$. From the binding participation constraint we get $s = 1/2$. Because the no-collusion constraint is slack, we have $pr/2 > pr - z \iff z > \bar{z}$.

Finally, we verify that, in the collusion-free equilibrium, the bank makes non-negative expected profit. Bank's equilibrium profit is

$$B(z) = \begin{cases} B^{\min}(z) \equiv z - 1 & \text{for } z^{\min} \leq z \leq z^0, \\ B^0(z) \equiv \frac{2z(pr - z)}{c} - 1 & \text{for } z^0 < z \leq \bar{z}, \\ B^* \equiv \frac{p^2 r^2}{2c} - 1 & \text{for } \bar{z} < z \leq pr. \end{cases}$$

The equilibrium profit function, $B(z)$ is linearly increasing on $[z^{\min}, z^0]$, strictly increasing and strictly concave on $(z^0, \bar{z}]$, and constant on $(\bar{z}, pr]$. Because $B(z_{\min}) = B^{\min}(z_{\min}) = 0$, we have $B(z) \geq 0$ for all $z \in [z^{\min}, pr]$. Note that $1 + c/2 > \sqrt{2c}$ for any $c > 2$, and hence, Assumption 1 implies that $\max_z B(z) = B^* > 0$. In fact, $B^0(z)$ is a strictly concave function which attains a maximum at $z = \bar{z}$. However, instead of considering the downward-sloping part of $B^0(z)$ for $z > \bar{z}$, we consider $B(z) = B^*$ because the expected profit for the bank is higher, i.e., $B^* > B^0(z)$ for all $z > \bar{z}$.

Proof of Lemma 1. Consider the maximization problem of Bank i . As in the proof of Proposition 2, it is easy to argue that the only relevant feasibility constraints are $m_i \leq 1$ and $m_j \leq 1$. Thus, the Lagrangean of bank i is given by:

$$\begin{aligned} \mathcal{L}_i = & \underbrace{\pi(m_i, m_j)pr(1 - s_i) - 1}_{B_i(m_i, m_j, s_i)} + \underbrace{\mu_P^i \left(\pi(m_i, m_j)pr s_i - \frac{1}{2}cm_i^2 \right)}_{g_i^P(m_i, m_j, s_i)} \\ & + \underbrace{\mu_N^i (pr s_i - 2(pr - z))}_{g_i^N(m_i, m_j, s_i)} + \underbrace{\mu_F^i (1 - m_i)}_{g_i^F(m_i, m_j, s_i)}, \end{aligned}$$

where μ_P^i , μ_N^i and μ_F^i are the associated Lagrange multipliers. The Karush-Kuhn-Tucker conditions (for bank i) are

$$\begin{aligned} \frac{\partial \mathcal{L}_i}{\partial m_i} &= (1 - m_j)pr(1 - s_i) + \mu_P^i [(1 - m_j)pr s_i - cm_i] - \mu_F^i = 0, \\ \frac{\partial \mathcal{L}_i}{\partial s_i} &= \pi(m_i, m_j)(\mu_P^i - 1) + \mu_N^i = 0, \end{aligned} \quad (24)$$

$$\begin{aligned}
\mu_k^i g_i^k(m_i, m_j, s_i) &= 0 \quad \text{for } k = P, N, F, \\
g_i^k(m_i, m_j, s_i) &\geq 0 \quad \text{for } k = P, N, F, \\
\mu_k^i &\geq 0 \quad \text{for } k = P, N, F.
\end{aligned} \tag{25}$$

Bank j has similar optimality conditions. We first show that, at the optimum, we must have both $m_i < 1$ and $m_j < 1$. Suppose to the contrary that $m_j = 1$. Then, (24) reduces to

$$-\mu_P^i \cdot cm_i = \mu_N^i.$$

Given that $m_i > 0$, the above equation implies that μ_P^i and μ_N^i are of opposite signs which contradicts the non-negativity conditions in (25). Therefore $m_j < 1$ and $\mu_F^j = 0$. Likewise, we have $m_i < 1$ and $\mu_F^i = 0$.

Next, we show that both the participation constraints must bind at the optimum. Suppose at least one of them, say (11), is slack, and hence, $\mu_P^i = 0$. Given that $\mu_F^i = 0$, (24) reduces to

$$(1 - m_j)pr(1 - s_i) = 0.$$

Given that $m_j < 1$, we must have $s_i = 1$; but this implies $B_i(\cdot) = -1$ which is not feasible. Therefore, the participation constraints bind. The binding participation constraint of loan officer i yields

$$prs_i = \frac{cm_i^2}{2\pi(m_i, m_j)}. \tag{26}$$

Substituting for s_i into the objective function (13) and the no-collusion constraint (8), the above maximization problem of bank i reduces to:

$$\begin{aligned}
&\max_{m_i} \quad \pi(m_i, m_j)pr - \frac{1}{2} cm_i^2 - 1, \\
&\text{subject to} \quad \frac{cm_i^2}{2\pi(m_i, m_j)} \geq 2(pr - z).
\end{aligned}$$

When the no-collusion constraint of neither loan officer binds at the optimum, the first-order conditions of the maximization problems of banks i and j yield the best reply functions $m_i(m_j)$ and $m_j(m_i)$ that solve the following two equations, respectively:

$$pr(1 - m_j) - cm_i = 0, \tag{27}$$

$$pr(1 - m_i) - cm_j = 0. \tag{28}$$

Note that $m_i'(m_j) = m_j'(m_i) = -pr/c < 0$, and hence, m_i and m_j are strategic substitutes.

Finally, we prove that when both the no-collusion constraints bind, m_i and m_j are strategic complements for $m_i, m_j \in [0, 1]$. In this case, the best reply functions $m_i(m_j)$ and $m_j(m_i)$ solve the following two equations, respectively:

$$cm_i^2 = 4(pr - z)\pi(m_i, m_j), \tag{29}$$

$$cm_j^2 = 4(pr - z)\pi(m_i, m_j). \tag{30}$$

Analyzing the behavior of $m_i(m_j)$ suffices to prove the assertion as the behavior of $m_j(m_i)$ is symmetric. Note first that (29) can be written as

$$\frac{m_i^2}{m_i + m_j - m_i m_j} = \frac{4(pr - z)}{c}$$

The left-hand-side of the above equation is always less than 1 because $m_i^2 \leq m_i + m_j - m_i m_j$ is equivalent to $(1 - m_i)(m_i + m_j) \geq 0$. Therefore, in equilibrium we must have $c \geq 4(pr - z)$. Solving for m_i from (29) we get

$$m_i(m_j) = \frac{2 \left((pr - z)(1 - m_j) \pm \sqrt{(pr - z)[cm_j + (pr - z)(1 - m_j)^2]} \right)}{c}.$$

Note that for any $m_j \geq 0$, the smaller root is non-positive, and hence, we discard this root. On the other hand, the larger root is positive for all $m_j \in [0, 1]$. Differentiating the above expression (ignoring the smaller root) we obtain

$$m'_i(m_j) = \frac{2(pr - z)}{c} \left(\frac{c - 2(pr - z)(1 - m_j)}{\sqrt{4(pr - z)^2(1 - m_j)^2 + 4c(pr - z)m_j}} - 1 \right).$$

The above expression is positive if $c \geq 4(pr - z)$.

Proof of Proposition 5. The proof is very similar to that of Proposition 2, and hence, we would omit many details. Instead, we shall describe the threshold values z_2^0 and \bar{z}_2 , and the optimal values of (m_i, m_j) and (s_i, s_j) . We have already shown that both the participation constraints are binding. We have two cases—(a) both the no-collusion constraints (8) and (9) bind, and (b) neither of them binds.²⁴ First, consider the case when the no-collusion constraints bind. The optimal m_i and m_j are solutions to the system (29) and (30), which has two symmetric solutions

$$(0, 0) \quad \text{and} \quad \left(\frac{8(pr - z)}{c + 4(pr - z)}, \frac{8(pr - z)}{c + 4(pr - z)} \right),$$

and no asymmetric solutions. At $m_i = m_j = 0$, each bank's expected profit equals -1 , and hence, this solution is not optimal. The optimal monitoring efforts m_i and m_j are thus given by the other symmetric solution. Using (26), we get the optimal share which is given by:

$$s_i = s_j = 2 \left(1 - \frac{z}{pr} \right).$$

Note that because the feasibility constraints must be slack, we require

$$m_2(z) = \frac{8(pr - z)}{c + 4(pr - z)} < 1 \quad \Longleftrightarrow \quad z > pr - \frac{c}{4} \equiv z_2^0.$$

It is worth noting that, at $z = z_2^0$, each bank's expected payoff is $pr - c/2 - 1$ which is positive under Assumption 1.

Next, consider the case when neither (8) nor (9) binds. Because both $m_i(m_j)$ and $m_j(m_i)$ defined by (27) and (28) are linear and downward-sloping, there is a unique solution to the system of equations, which is also symmetric. This is given by:

²⁴ There is an asymmetric equilibrium where only one of the two no-collusion constraints binds. Suppose (8) binds, but (9) does not. It is easy to show that the equilibrium payoff of bank i is lower than that under the symmetric equilibrium, whereas the payoff of bank j can be lower or higher than that under the symmetric equilibrium depending on the parameter values. The detailed analysis of the asymmetric equilibrium is available upon request. Moreover, such an equilibrium is dominated by the contracts in the (C, NC) equilibrium described in Section 6.2.

$$m_i = m_j = m = \frac{pr}{c + pr}.$$

Using (26), we get the optimal share which is

$$s_i = s_j = s = \frac{c}{2(2c + pr)}.$$

The non-binding no-collusion constraints imply

$$\frac{c}{2(2c + pr)} > 2(pr - z) \iff z > \frac{pr(7c + 4pr)}{4(2c + pr)} \equiv \bar{z}_2.$$

Finally, we verify that, in the collusion-free equilibrium, no bank makes negative expected profit. Each bank's symmetric equilibrium profit is

$$B_2(z) = \begin{cases} B_2^0(z) \equiv \frac{16c(2z-pr)(pr-z)}{[c+4(pr-z)]^2} - 1 & \text{for } z_2^0 < z \leq \bar{z}_2, \\ B_2^* \equiv \frac{p^2r^2(3c+2pr)}{2(c+pr)^2} - 1 & \text{for } \bar{z}_2 < z \leq pr. \end{cases}$$

Recall that two-bank lending is not feasible for any $z < z_2^0$ because for optimality we require $m_i, m_j < 1$. So, $B_2(z)$ starts at $z = z_2^0$; it is given by $B_2^0(z)$ on $(z_2^0, \bar{z}_2]$, which is strictly concave—increasing on $[z_2^0, z_2^*]$, decreasing on $(z_2^*, \bar{z}_2]$ where $z_2^* = \arg\max_z B_2^0(z)$. On the other hand, $B_2(z)$ is constant on $(\bar{z}_2, pr]$ at the level B_2^* . Also, $B_2(\bar{z}_2) = B_2^0(\bar{z}_2) = B_2^*$. Note first that $B_2(z_2^0) = pr - \frac{c}{2} - 1 \geq 0$ by Assumption 1. In order to show that each bank earns non-negative expected profits, it suffices to prove that $B_2^* \geq 0$. Note that

$$B_2^* - B_2^0(z_2^0) = \frac{c^3}{2(c + pr)^2} > 0$$

for any $c > 0$, and hence, $B_2^* > 0$. Therefore, $B_2(z) \geq 0$ for all $z \in (z_2^0, pr]$. It is worth noting that, unlike the single-bank lending case, $B_2(z)$ is not maximized at \bar{z}_2 as it is the case that $z_2^* < \bar{z}_2$. This is because of the free-riding problem due to the presence of strategic banks. In fact, if the two banks merge to form a single entity (see Section 5.2.1), this loss of profit due to the free-riding problem disappears because the no-collusion constraint of each loan officer is slack for all $z > z_2^*$.

Proof of Proposition 6. Note that $m_2^{**}(z)$ is strictly increasing and concave on $[z_2^0, pr]$, whereas $m_2(z)$ is non-increasing in z . Because $m_2^{**}(z_2^0) = 1 - \frac{2c}{c+4pr} < 1 = m_2(z_2^0)$, and $m_2^{**}(\bar{z}_2) - m_2(\bar{z}_2) = \frac{pr(7c+4pr)}{4c^2+9cpr+4p^2r^2} - \frac{pr}{c+pr} = \frac{cpr(3c+2pr)}{(c+pr)(4c^2+9cpr+4p^2r^2)} > 0$, the result follows.

Proof of Proposition 7. We first show that $\bar{z}_2 > \bar{z}$ which is equivalent to $3c + 2pr > 0$. The last inequality always holds because both pr and c are strictly positive. To be consistent with Fig. 4, it is also necessary to show that $\bar{z} < z_2^0$ which is equivalent to $pr > c/2$, which holds because of Assumption 1.

To show part (a), note that because $\bar{z} < z_2^0$, we have $m_1(z_2^0) = pr/c$. Thus, $m_2(z_2^0) = 1 \geq pr/c = m_1(z_2^0)$. On the other hand, $m_2(\bar{z}_2) = pr/(c + pr) < pr/c = m_1(\bar{z}_2)$. Because $m_2(z)$ is strictly decreasing on $[z_2^0, \bar{z}_2]$, there is a unique $\theta^m \in (z_2^0, \bar{z}_2)$ such that $m_2(z) > m(z)$ if and only if $z < \theta^m$. The proof of part (b) is similar because $s_2(z_2^0) = c/2pr \geq 1/2 = s(z_2^0)$, $s_2(\bar{z}_2) = (c/2)(2c + pr) < 1/2 = s(\bar{z}_2)$ and $s_2(z)$ is a strictly decreasing function.

Proofs of Propositions 8-13. See the Online Appendix.

Appendix B. Supplementary material

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.jet.2021.105320>.

References

- Aoki, Masahiko, 1994. Monitoring characteristics of the main bank system: an analytical and developmental view. In: Aoki, Masahiko, Patrick, Hugh (Eds.), *The Japanese Main Bank System: Its Relevance for Developing and Transforming Economies*. Oxford University Press, chapter 4.
- Asriyan, Vladimir, Laeven, Luc, Martín, Alberto, 2021. Collateral booms and information depletion. *Rev. Econ. Stud.*, accepted.
- Banal-Estañol, Albert, Ottaviani, Marco, Winton, Andrew, 2013. The flip side of financial synergies: coinsurance versus risk contamination. *Rev. Financ. Stud.* 26, 3142–3181.
- Bernanke, Ben, Gertler, Mark, 1989. Agency costs, net worth, and business fluctuations. *Am. Econ. Rev.* 79, 14–31.
- Bolton, Patrick, Scharfstein, David, 1996. Optimal debt structure and the number of creditors. *J. Polit. Econ.* 104, 1–25.
- Bonanno, Giacomo, Vickers, John, 1988. Vertical separation. *J. Ind. Econ.* 3, 257–265.
- Boot, Arnoud, Thakor, Anjan, 2000. Can relationship banking survive competition? *J. Finance* 55, 679–713.
- Burlando, Alfredo, Motta, Alberto, 2015. Collusion and the organization of the firm. *Am. Econ. J. Microecon.* 7, 54–84.
- Carletti, Elena, 2004. The structure of bank relationships, endogenous monitoring, and loan rates. *J. Financ. Intermed.* 13, 58–86.
- Carletti, Elena, Cerasi, Vittoria, Daltung, Sonja, 2007. Multiple-bank lending: diversification and free-riding in monitoring. *J. Financ. Intermed.* 16, 425–451.
- Cerqueiro, Geraldo, Ongena, Steven, Roszbach, Kasper, 2016. Collateralization, bank loan rates, and monitoring. *J. Finance* 71, 1295–1322.
- Dam, Kaniška, Roy Chowdhury, Prabal, 2020. Race to collusion: Monitoring and incentive contracts for loan officers under multiple-bank lending. *Economics and Planning Unit Discussion Paper 20-05*. Indian Statistical Institute, Delhi. Available at https://www.isid.ac.in/~epu/dispapers/dp20_05.pdf.
- Dell’Ariccia, Giovanni, Marquez, Robert, 2006. Lending booms and lending standards. *J. Finance* 61, 2511–2546.
- Detragiache, Enrica, Garella, Paolo, Guiso, Luigi, 2000. Multiple versus single banking relationships: theory and evidence. *J. Finance* 55, 1133–1161.
- Dewatripont, Mathias, Maskin, Eric, 1995. Credit and efficiency in centralized and decentralized economies. *Rev. Econ. Stud.* 62, 541–555.
- Diamond, Douglas, 1984. Financial intermediation and delegated monitoring. *Rev. Econ. Stud.* 51, 393–414.
- Farinha, Luísa, Santos, João, 2002. Switching from single to multiple bank lending relationships: determinants and implications. *J. Financ. Intermed.* 11, 124–151.
- Goldmann, Peter, 2010. *Financial Services Anti-Fraud Risk and Control Workbook*. John Wiley & Sons, Inc.
- Gustafson, Matthew, Ivanov, Ivan, Meisenzahl, Ralf, 2021. Bank monitoring: evidence from syndicated loans. *J. Financ. Econ.* 139, 452–477.
- Harhoff, Dietmar, Körting, Timm, 1998. Lending relationships in Germany: empirical results from survey data. *J. Bank. Finance* 22, 1317–1353.
- Hertzberg, Andrew, Liberti, José Maria, Paravisini, Daniel, 2010. Information and incentives inside the firm: evidence from loan officer rotation. *J. Finance* 65, 795–828.
- Holmström, Bengt, Tirole, Jean, 1997. Financial intermediation, loanable funds, and the real sector. *Q. J. Econ.* 112, 663–691.
- Johnson, Simon, La Porta, Rafael, López-de-Silanes, Florencio, Shleifer, Andrei, 2000. Tunneling. *Am. Econ. Rev. Pap. Proc.* 90, 22–27.
- Keys, Benjamin, Mukherjee, Tanmoy, Seru, Amit, Vig, Vikrant, 2010. Did securitization lead to lax screening? Evidence from subprime loans. *Q. J. Econ.* 125, 307–362.
- Khalil, Fahad, Lawarrée, Jacques, 2006. Incentives for corruptible auditors in the absence of commitment. *J. Ind. Econ.* 54, 269–291.
- Khalil, Fahad, Martimort, David, Parigi, Bruno, 2007. Monitoring a common agent: implications for financial contracting. *J. Econ. Theory* 135, 35–67.
- Kofman, Fred, Lawarrée, Jacques, 1993. Collusion in hierarchical agency. *Econometrica* 61, 629–656.
- Kofman, Fred, Lawarrée, Jacques, 1996. On the optimality of allowing collusion. *J. Public Econ.* 61, 383–407.

- Laffont, Jean-Jacques, Martimort, David, 1999. Separation of regulators against collusive behavior. *Rand J. Econ.* 30, 232–262.
- Lin, Chen, Ma, Yue, Malatesta, Paul, Xuan, Yuhai, 2012. Corporate ownership structure and bank loan syndicate structure. *J. Financ. Econ.* 104, 1–22.
- Lisowsky, Petro, Minnis, Michael, Sutherland, Andrew, 2017. Economic growth and financial statement verification. *J. Account. Res.* 55, 745–794.
- Macho-Stadler, Inés, Pérez-Castrillo, David, 1993. Moral hazard with several agents: the gains from cooperation. *Int. J. Ind. Organ.* 11, 73–100.
- Majewski, Suzanne, 2004. How do consortia organize collaborative R&D? Evidence from the national cooperative research act. Harvard Law School John M. Olin Center for Law, Economics and Business Discussion Paper Series.
- Mookherjee, Dilip, Png, Ivan, 1995. Corruptible law enforcers: how should they be compensated? *Econ. J.* 105, 145–159.
- Ongena, Steven, Smith, David, 2000. What determines the number of bank relationships? Cross-country evidence. *J. Financ. Intermed.* 9, 26–56.
- Ono, Arito, Uesugi, Iichiro, 2009. Role of collateral and personal guarantees in relationship lending: evidence from Japan's SME loan market. *J. Money Credit Bank.* 41, 935–960.
- Padilla, Jorge, Pagano, Marco, 1997. Endogenous communication among lenders and entrepreneurial incentives. *Rev. Financ. Stud.* 10, 205–236.
- Petersen, Mitchell, Rajan, Raghuram, 1994. The benefit of lending relationships: evidence from small business data. *J. Finance* 49, 3–37.
- Petriconi, Silvio, 2016. Bank competition, information choice and inefficient lending booms. Mimeo, Bocconi University.
- Ramakrishnan, Ram, Thakor, Anjan, 1991. Cooperation versus competition in agency. *J. Law Econ. Organ.* 7, 248–283.
- Repullo, Rafael, Suárez, Javier, 2000. Entrepreneurial moral hazard and bank monitoring: a model of the credit channel. *Eur. Econ. Rev.* 44, 1931–1950.
- Scheepens, Joris, 1995. Financial Intermediation and Corporate Finance: an Analysis of Agency Problems and Optimal Contracts. Ph.D. thesis. Tilburg University.
- Scheepens, Joris, 1997. Collusion and hierarchy in banking. CentER for Economic Research Discussion Paper No. 9701.
- Sengupta, Rajdeep, 2007. Foreign entry and bank competition. *J. Financ. Econ.* 48, 502–528.
- Sharpe, Steven, 1990. Asymmetric information, bank lending, and implicit contracts: a stylized model of customer relationships. *J. Finance* 45, 1069–1087.
- Sinkey Jr., Joseph, 1992. Commercial Bank Financial Management. MacMillan.
- Strausz, Roland, 1997. Collusion and renegotiation in a principal-supervisor-agent relationship. *Scand. J. Econ.* 99, 497–518.
- Sufi, Amir, 2007. Information asymmetry and financing arrangements: evidence from syndicated loans. *J. Finance* 62, 629–668.
- Tirole, Jean, 1986. Hierarchies and bureaucracies: on the role of collusion in organizations. *J. Law Econ. Organ.* 2, 181–214.
- Tressel, Thierry, Verdier, Thierry, 2011. Financial globalization and the governance of domestic financial intermediaries. *J. Eur. Econ. Assoc.* 9, 130–175.
- Vives, Xavier, 2016. Competition and Stability in Banking: The Role of Regulation and Competition Policy. Princeton University Press.
- von Thadden, Ernst-Ludwig, 1992. The commitment of finance, duplicated monitoring and the investment horizon. CEPR discussion paper No. 27.
- Williams, Michael, de Silva, Harindra, Koehn, Michael, Ornstein, Stanley, 1991. Why did so many savings and loans go bankrupt? *Econ. Lett.* 36, 61–66.
- Winton, Andrew, 1995. Costly state verification and multiple investors: the role of seniority. *Rev. Financ. Stud.* 8, 91–123.
- Winton, Andrew, 1999. Don't put all your eggs in one basket? Diversification and specialization in lending. Working paper. University of Minnesota.