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Multiple-bank lending: diversification and free-riding in monitoring*

Elena Carletti[†], Vittoria Cerasi[‡] and Sonja Daltung[§]

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Abstract:
This paper analyzes banks' choice between lending to firms individually and sharing lending with other banks, when firms and banks are subject to moral hazard and monitoring is essential. Multiple-bank lending is optimal whenever the benefit of greater diversification in terms of higher monitoring dominates the costs of free-riding and duplication of efforts. The model predicts a greater use of multiple-bank lending when banks are small relative to investment projects, firms are less profitable, and poor financial integration, regulation and inefficient judicial systems increase monitoring costs. These results are consistent with empirical observations concerning small business lending and loan syndication.

JEL Classification: D82; G21; G32

Keywords: individual-bank lending, multiple-bank lending, monitoring, diversification, free-riding problem

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1 Introduction

Recent empirical findings (e.g., Ongena and Smith, 2000a; Ongena and Smith, 2000b) suggest a widespread use of multiple-bank lending. In almost all countries even relatively small firms borrow from several banks at the same time. The distribution of the number of bank relationships per firm varies substantially across countries, but single-bank lending tends to be quite rare and multiple-bank lending often consists of many banks.[1]

Explaining the great use of multiple-bank lending requires an understanding of what advantages it can provide to both firms and banks. This widespread phenomenon seems somewhat puzzling and contrasts with the "classical" theory of banks as delegated monitors originating from Diamond (1984). This theory argues that exclusive bank-firm relationships are optimal as they avoid duplication of screening and monitoring efforts as well as free-riding.[2] Recent contributions have put forth some potential explanations of firms' choice of multiple-bank lending. These include firms' desire to mitigate hold-up and overmonitoring problems as well as the liquidity risk affecting exclusive bank-firm relationships (Sharpe, 1990; Rajan, 1992; Von Thadden, 1992; Carletti, 2004; and Detragiache et al., 2000). Concerning banks' choice, multiple-bank lending enables banks to commit not to extend further inefficient credit, thus solving the soft-budget-constraint problem of single-bank lending and reducing firms' strategic defaults (Dewatripont and Maskin, 1995; Bolton and Scharfstein, 1996). Also, the mitigation of the hold-up problem improves firms' incentives to make proper investment choices, thus increasing banks' profits (Padilla and Pagano, 1997).

The above mentioned explanations do not provide an answer, however, to the apparent contradiction between the great use of multiple-bank lending and the predictions of the theory of banks as delegated monitors. If monitoring is one of the main functions −if not *the* main function− that banks exert, especially in small and medium business lending, why should they decide to share firms' financing if this reduces their monitoring function? Does the great use of multiple-bank lending suggest that the role of banks as delegated monitors is of minor importance? Or does multiple-bank lending entail some −previously unnoticed− benefits for banks' incen-

[1] Ongena and Smith (2000b) find that 20% of the firms in their sample of 1079 firms from 20 European countries use eight or more banks. Detragiache et al. (2000) report that 89 percent of Italian small firms borrow from multiple banks with the median number of relationships being five. They report also a median number of two relationships for US small firms.

[2] See Freixas and Rochet (1997) for a review of the modern theory of financial intermediation and Boot (2000) for a more specific review of the literature on relationship banking.

tives to monitor? These questions are critical especially in lending where monitoring is important, banks retain some bargaining power and can decide the preferred lending structure. They are also timely as the ongoing process of deregulation expands loan markets, and it confronts banks with the issues of how to enter into new markets and monitor new clients.

This paper argues that, when one considers explicitly banks' incentives to monitor, multiple-bank lending may become an optimal way for banks with limited lending capacities to commit to *higher* monitoring levels. Despite involving free-riding and duplication of efforts, sharing lending allows banks to expand the number of loans and achieve greater diversification. This mitigates the agency problem between banks and depositors and reduces the cost of funding. Thus, differently from the classical theory of banks as delegated monitors, the paper suggests that multiple-bank lending may positively affect overall monitoring and increase firms' profitability. The result provides a possible theoretical rationale for the finding in Houston and James (1996) that firms borrowing from multiple banks (but not from other multiple creditors) have greater growth opportunities.

Building on Holmstrom and Tirole (1997), we address these issues in a one-period model which endogenizes banks' incentives to monitor. There are three types of agents: Firms, banks and investors. Firms need external funds to undertake investment projects and can privately decide whether to exert effort and increase project success probabilities. Banks can ameliorate this moral hazard problem through monitoring, which is however costly and not observable. This unobservability introduces another moral hazard problem between banks and depositors. Banks' incentives to monitor depend on whether they lend to firms individually or share lending with other banks. Multiple-bank lending improves banks' monitoring incentives by allowing banks to finance more projects and reach greater diversification; but it entails also free-riding and duplication of efforts. Banks choose to share lending whenever the benefit of greater diversification in terms of higher per-project monitoring dominates the costs of free-riding and duplication of efforts. The attractiveness of multiple-bank lending decreases with the amount of inside equity and project profitability, and it increases with the cost of monitoring. Thus, the model predicts a greater use of multiple-bank lending when banks are small relative to the projects they finance, when firms are less profitable, and when poor financial integration, strict regulation and inefficient judicial systems make monitoring more costly. These predictions find empirical support in Ongena and Smith (2000b) and in Detragiache et al. (2000).

The key aspects of the analysis are banks' moral hazard problem and limited lending capacities. The incentive mechanism of diversification works only if banks raise deposits. If banks are non-leveraged, greater diversification decreases the variance of the average portfolio return, but it has no effects on banks' monitoring incentives. Then multiple-bank lending entails lower overall monitoring than individual-bank lending due to free-riding and duplication of efforts, and it is no longer optimal.

Banks value greater diversification because they have limited lending capacities. In the model lending is restricted by the presence of capital requirements, but other stories which limit banks' diversification opportunities are in line with our theory. For example, restrictions (regulatory as well as economic) to banks' geographical scope and sector specialization may impose such limits and justify multiple-bank lending.

The novelty of this paper is to explain why banks may prefer to share lending even if this implies free-riding and duplication of efforts in their monitoring activities. Given the need and importance of monitoring, the results of the model are particularly applicable to the financing of small and medium businesses and, to some extent, to the formation of loan syndicates.[3]

This paper is related to a number of others. First, it relates to the literature on banks' incentives to monitor. Besanko and Kanatas (1993) rely on the non-contractibility of monitoring to explain the coexistence of banks and capital markets in a context where only one bank operates and monitors. Carletti (2004) analyzes how banks' incentives to monitor change with the number of bank relationships and how this affects firms' optimal borrowing choice. Similarly, Winton (1993) analyzes the monitoring incentives of multiple shareholders. None of these papers, however, look at the effects of diversification on banks' monitoring incentives and advantages from sharing lending. In this respect, our paper relates to Diamond (1984) and Cerasi and Daltung (2000). However, whereas they focus on how diversification influences monitoring incentives in a single-bank context, we use the incentive effect of diversification to analyze the optimality of multiple-bank lending.[4]

The paper shares insights also with the literature on financial structure as a commitment to monitor. As in Holmstrom and Tirole (1997), Chiesa (2001) and Almazan (2002) we focus on the importance of inside equity and capital requirements, but we enrich the framework by introducing multiple monitors and diversification opportunities. Thakor (1996) analyzes the optimal number of banks firms approach for

[3]Capital requirements, lending limits, banks' need of greater diversification are indeed the main reasons for syndicates (Simons, 1993; Dennis and Mullineaux, 2000), which may lead, however, to free-riding (Esty and Megginson, 2003).

[4]A contrasting view is in Winton (1999), where diversification may worsen a bank's incentive to monitor and increase its chance of failure when loans are sufficiently exposed to sector downturns.

credit in a model where banks perform screening and are subject to capital requirements. Firms always approach multiple banks, as this reduces the probability of being rationed. By contrast, we analyze banks' choice between individual-bank and multiple-bank lending, in a context where banks perform postlending monitoring and entering into multiple-bank relationships is not always optimal.

The remainder of the paper is organized as follows. Section 1 describes the basic model. Section 2 analyzes banks' choice between individual-bank and multiple-bank lending. Section 3 discusses the importance of bank leverage and Section 4 the robustness of the basic model. Section 5 contains the empirical implications. Section 6 concludes.

2 The Basic Model

Consider a two-date economy ($T = 0, 1$) with three classes of risk neutral agents: numerous firms, banks and investors. Firms have access to an investment project each, and need external funds to finance them. Only bank lending is available, and banks can decide either to finance firms on their own −*individual-bank lending*− or to share lending with other banks −*multiple-bank lending.*

Projects are risky and their returns are i.i.d. across firms. Each project i requires 1 unit of indivisible investment at date 0, and yields a return $X_i = \{0, R\}$ at date 1. The success probability of each project i, $p_i = \Pr\{X_i = R\}$, depends on the behavior of its entrepreneur. It is p_H if he behaves well, and p_L if he misbehaves, with $p_H > p_L$. Misbehavior renders entrepreneurs a non-transferable private benefit B, which can be thought of as a quiet life, managerial perks, and diversion of corporate revenues for private use. There is a moral hazard problem because entrepreneurs' behavioral choices are not observable.

Banks have E units of capital each and raise D units of deposits (henceforth, also debt) from dispersed investors. Firms receive financing only if banks expect non-negative profits, i.e., if they expect a return at least equal to the gross proceeds $y \geq 1$ from an alternative investment. To provide a role for bank monitoring, we assume that simple lending is not feasible, i.e.,

$$p_H R > y > p_L R + B, \tag{A1}$$

and

$$\Delta p(R - \frac{y}{p_H}) < B, \tag{A2}$$

where $\Delta p = p_H - p_L$. Assumption (A1) means that projects are creditworthy only if firms behave well. Assumption (A2) implies that private benefits are sufficiently high to induce firms to misbehave even when loan rates are set at the lowest level $\frac{y}{p_H}$ which makes banks break even. Thus, simple lending is not feasible; and, because firms cannot be given monetary incentives to behave well, we assume for simplicity that banks extract the full project returns R.[5]

Suppose now that banks can ameliorate firms' moral hazard problem through monitoring. Each bank j chooses to monitor project i with an intensity $m_{ij} \in [0, 1]$, which determines the probability with which it observes firm i's behavior and improves it in the case of misbehavior. Monitoring is costly; an intensity m_{ij} costs $C(m_{ij}) = \frac{c}{2}m_{ij}^2$. The convex cost function reflects the greater difficulty for a bank to find out more and more about a firm; and it means diseconomies of scale in monitoring. The size of the monitoring costs is determined by the parameter c (henceforth, also referred to as cost of monitoring).

Banks' monitoring intensities are not observable either to investors or to other banks. This introduces another moral hazard problem in the model, and it implies that banks can raise deposits only if they can credibly promise investors an expected return at least equal to the proceeds y from the alternative investment.

To create a role for multiple-bank lending, we assume that banks have restricted lending capacities. One way to think about it is to consider that banks are subject to a capital constraint ratio $\frac{1}{\beta}$ (with $\beta > 1$), which limits their amounts of lending to βE. As a consequence, banks raise an amount of deposits equal to

$$D = (\beta - 1)E, \tag{A3}$$

and may not be able to perfectly diversify by themselves.[6][7]

The timing of the model is as follows. At the beginning of date 0 banks choose between individual-bank lending and multiple-bank lending; their choice is observable to both investors and other banks. Then, each bank offers investors a deposit contract specifying the per-unit deposit rate. If investors accept the contract, each bank j

[5] Of course, this rules out also the possibility of direct lending between firms and investors.

[6] Banks do not have incentives to raise an amount of deposits greater than $(\beta-1)E$ since investing in the alternative safe investment gives them zero profits.

[7] The assumption of limited diversification opportunities creates a potential role for multiple-bank lending. If it was not satisfied, banks could perfectly diversify by themselves and multiple-bank lending would never be optimal. See also the discussion about alternative diversification opportunities in Section 4.

chooses the intensity m_{ij} with which to monitor project i. At date 1 project returns are realized and claims are settled. Figure 1 summarizes the timing of the model if investors accept the deposit contracts.

T=0			T=1
banks decide whether to be individual lenders or enter into multiple-bank relationships	each bank offers a deposit contract to investors	each bank chooses its monitoring intensity m_{ij}	projects mature; claims are settled

Fig. 1. Timing of the model.

3 Banks' Equilibrium Choices

The model is solved as follows. We first take banks' choice between individual-bank and multiple-bank lending as given, and we characterize the equilibrium of each scenario. Second, we analyze banks' optimal lending choice.

3.1 Individual-bank Lending

We start by characterizing the equilibrium of the game with individual-bank lending (henceforth IL). Each bank finances $D + E$ projects and sets the deposit rate at the lowest level at which investors are willing to deposit their funds. Then, each bank chooses the monitoring intensity with which to monitor each project. For simplicity, since banks act independently of each other and we look for symmetric equilibria where they all behave identically, we focus on a single representative bank.

Let r be the deposit rate and m_i be the bank's monitoring intensity. The success probability of each project i is equal to

$$p_i = p_i(m_i) = p_H - (1 - m_i)\Delta p.$$

The deposit contract carries a bankruptcy risk, since the bank may not be able to repay investors the promised deposit rate. The size of such a risk depends crucially on the monitoring intensities $m_1...m_{D+E}$. The higher m_i, the higher the project success probability, and the more the bank can honor its repayment obligations. In case of default, depositors split the realized return of the bank portfolio. We can express the difference between the deposit rate r and the effective repayment that investors receive in terms of expected shortfalls as follows.

Definition 1 *Let the expected shortfalls of the individual-bank lending game be*

$$S = S(\underline{m}, r) = \int_{-\infty}^{\frac{D}{D+E}r} (r - \frac{D+E}{D} z) h(z) dz,$$

where $\underline{m} = m_1 ... m_{D+E}$ *is the* $D+E$*-dimensional vector of the monitoring intensities exerted by the bank on each of the* $D+E$ *projects, and* $z = \frac{1}{D+E} \sum_{i=1}^{D+E} X_i$ *is the average sample return of a portfolio of* $D+E$ *projects distributed according to the Normal density function* $h(z)$ *with mean* $\frac{R}{D+E} \sum_{i=1}^{D+E} p_i$ *and variance* $(\frac{R}{D+E})^2 \sum_{i=1}^{D+E} p_i(1-p_i)$.[8]

Investors' expected return per unit of deposit is then equal to

$$r - S; \tag{1}$$

and the bank's expected profit is given by

$$\pi(\underline{m}, r) = \sum_{i=1}^{D+E} p_i R - yE - [r - S] D - \frac{c}{2} \sum_{i=1}^{D+E} m_i^2, \tag{2}$$

where the first term is the expected return from the $D+E$ projects the bank finances, the second term is the opportunity cost of the bank's capital, the third term is depositors' expected return, and the fourth term is the total cost of monitoring $D+E$ projects.

Proposition 1 characterizes the equilibrium of the individual-bank lending game.

Proposition 1 *The unique symmetric equilibrium of the individual-bank game, in which each bank monitors each project with intensity* $m_i = m^{IL}$ *and offers the deposit rate* r^{IL}, *is characterized by the solution to the following equations:*

$$\Delta p R + \frac{\partial S^{IL}}{\partial m^{IL}} D - c m^{IL} = 0, \tag{3}$$

$$r^{IL} - S^{IL} = y, \tag{4}$$

where $S^{IL} = S(\underline{m}^{IL}, r^{IL})$.

Proof: See the Appendix.

The monitoring intensity m^{IL} and the equilibrium deposit rate r^{IL} depend −both directly and indirectly through the expected shortfalls− on the amounts of deposits D and inside equity E, the project return R, and the cost of monitoring c.

[8] The Binomial distribution of the variable z is well approximated with a Normal distribution when $(D+E)p(1-p) > 10$ (see, e.g., Ross, 1976).

As already mentioned, raising deposits implies the well-known moral hazard problem of external financing. Since monitoring is not observable and the deposit rate is set before monitoring is decided, raising deposits makes the bank lower monitoring to reduce costs and avoid sharing the benefit with the investors. This mechanism is captured by the second term in (3), which is negative as lower monitoring increases the expected shortfalls. The moral hazard problem impacts the equilibrium deposit rate (4), which, in turn, worsens the problem.

The severity of the moral hazard problem depends on the amount of inside equity E, the cost of monitoring c, and the project return R. For a given level of debt, a high E reduces the moral hazard problem and improves monitoring through the effect on the expected shortfalls. As it allows the bank to finance more projects and reach a greater degree of diversification, a high E reduces the variance of the distribution of the average sample return z. This increases the benefit of monitoring accruing to the bank, and it reduces the expected shortfalls. A low c (or a high R) improves the bank's incentive to monitor and decreases the expected shortfalls. Thus, the equilibrium monitoring intensity with individual-bank lending m^{IL} grows with the amount of inside equity and the project return, whereas it falls with the cost of monitoring. The opposite happens for the equilibrium deposit rate.

3.2 Multiple-bank Lending

We now turn to the equilibrium of the game with multiple-bank lending (henceforth ML). As before, the equilibrium requires that each bank j sets the deposit rate r_j to satisfy investors' individual rationality constraint, and that each bank j chooses the monitoring intensity m_{ij} for each project i so as to maximize its expected profit.

The difference with the individual-bank lending game depends on how banks share project financing and interact in their monitoring decisions. We assume that each bank shares financing with other $k-1$ banks so that it invests $1/k$ unit in each of the $k(D+E)$ projects in return for $\frac{R}{k}$ in case of project success. All banks choose how much to monitor each project simultaneously and non-cooperatively. The individual monitoring intensities, however, are interrelated in the impact on the firm's behavior. It is enough that one bank discovers misbehavior to induce good entrepreneurial behavior and increase the success probability of the whole project. The idea is that monitoring delivers a public good, and all banks financing a firm benefits from the higher success probability of the project.

The success probability of project i with multiple-bank lending is then equal to

$$p_i^k = p(M_i(m_{i1}...m_{ik}), k) = p_H - \prod_{j=1}^{k}(1 - m_{ij})\Delta p = p_H - (1 - M_i)\Delta p, \qquad (5)$$

where $M_i = 1 - \prod_{j=1}^{k}(1 - m_{ij})$ is the total monitoring intensity that the k banks exert in project i.

Similarly to before, we can define the expected shortfalls on the deposit contract as follows.

Definition 2 *Let the expected shortfalls of the multiple-bank lending game be*

$$S^k = S(M, r) = \int_{-\infty}^{\frac{D}{k(D+E)}r_j} (r_j - \frac{k(D+E)}{D}v)g(v)dv, \qquad (6)$$

where $M = [M_1...M_{k(D+E)}]$ is the $k(D+E)-$dimensional vector of the total monitoring intensities that all k banks exert on each of the $k(D+E)$ projects, and $v = \frac{1}{k(D+E)} \sum_{i=1}^{k(D+E)} X_i$ is the average sample return of a portfolio of $k(D+E)$ projects distributed according to the Normal density function $g(v)$ with mean $\frac{1}{k(D+E)} \frac{R}{k} \sum_{i=1}^{k(D+E)} p_i^k$ and variance $\left(\frac{1}{k(D+E)}\right)^2 \left(\frac{R}{k}\right)^2 \sum_{i=1}^{k(D+E)} p_i^k(1 - p_i^k)$.

Investors' expected return per unit of deposit is equal to

$$r_j - S^k; \qquad (7)$$

and bank j's expected profit is given by

$$\pi_j^k(M, r) = \sum_{i=1}^{k(D+E)} p_i^k \frac{R}{k} - yE - \left[r_j - S^k\right] D - \frac{c}{2} \sum_{i=1}^{k(D+E)} m_{ij}^2, \qquad (8)$$

where the first term represents the expected return from the $k(D+E)$ projects bank j finances, the second term is the opportunity cost of capital, the third term is depositors' expected return, and the fourth term is the total cost of monitoring $k(D+E)$ projects.

Expressions (5) and (8) show the features of the multiple-bank lending game. First, for given lending capacity, banks can finance more projects and reach a greater degree of diversification than with individual-bank lending. Each bank can finance $k(D+E)$ projects instead of $D+E$. Second, the success probability of each project depends on the monitoring of all k banks. This creates a free-riding problem: because monitoring is privately costly and not observable, each bank has an incentive to reduce its own effort and benefits from the other banks' monitoring. Third, there is a duplication of efforts because banks do not coordinate in the choice of their monitoring intensities.

Proposition 2 characterizes the equilibrium of the multiple-bank lending game.

Proposition 2 *The unique symmetric equilibrium of the multiple-bank lending game, in which each bank monitors each project with intensity $m_{ij} = m^{ML}$ and offers the deposit rate $r_j = r^{ML}$ is characterized by the solution to the following equations:*

$$\frac{\Delta pR}{k}(1-m^{ML})^{k-1} + \frac{\partial S^{ML}}{\partial m^{ML}}D - cm^{ML} = 0, \tag{9}$$

$$r^{ML} - S^{ML} = y, \tag{10}$$

where $S^{ML} = S(M^{ML}, r^{ML})$.

Proof: See the Appendix.

Comparing equations (9) and (10) with (3) and (4) shows how the equilibrium in the multiple-bank game differs from the one in the individual-bank game. Free-riding and duplication of efforts tend to curtail banks' incentives (term $\frac{1}{k}(1-m^{ML})^{k-1}$), thus increasing the expected shortfalls and pushing towards higher deposit rates. Greater diversification pushes, however, in the opposite direction. The equilibrium monitoring intensity m^{ML} and the equilibrium deposit rate r^{IL} balance these contrasting effects. Importantly, because of the greater number of banks monitoring the same project, multiple-bank lending may imply higher per-project total monitoring than individual-bank lending even if the individual monitoring intensity is lower, i.e., even if $m^{ML} < m^{IL}$. As we will show in the next subsection, whether this happens depends crucially on the marginal effect of diversification, which is in turn determined by the amount of inside equity E, the cost of monitoring c, and the project return R.

3.3 The choice between Individual-bank Lending and Multiple-bank Lending

We analyze now banks' choice between individual-bank and multiple-bank lending. Once we substitute in (2) and (8) assumption (A3) and the respective equilibrium monitoring intensities and deposit rates, we can express banks' expected profits as:

$$\pi^{IL} = \beta E\left\{p^{IL}R - y - \frac{c}{2}(m^{IL})^2\right\}, \tag{11}$$

$$\pi^{ML} = \beta E\{p^{ML}R - y - k\frac{c}{2}(m^{ML})^2\} \tag{12}$$

if banks lend individually or share lending, respectively. The terms in parenthesis represent, in order, the expected return of each project, the return from the alternative investment −which is equal from (4) and (10) to the expected repayments to depositors −, and total monitoring costs.

Banks choose the lending structure that maximizes their expected profits. Their choice depends on the relative differences between per-project success probabilities −and, therefore, per-project total monitoring intensities− and each bank's total monitoring costs in (11) and (12). Banks' preferred lending structure is socially optimal, since they internalize all the benefits.

Given the difficult analytical expressions for the equilibrium monitoring intensities and the expected shortfalls, we characterize banks' optimal choice with numerical simulations. We first compare monitoring intensities and monitoring costs with individual-bank and multiple-bank lending; then we look at banks' profits in the two games. In all simulations we fix $p_H = 0.8$, $p_L = 0.6$, $y = 1$ and $\beta = 12$, whereas we allow E, c, and R to vary as specified below. Choosing $\beta = 12$ corresponds to capital requirements equal to 8%.

Figures 2 and 3 illustrate how individual and per-project total monitoring intensities and total monitoring costs change as a function of the number of banks k when the amount of inside equity varies from $E = 0.5$ to $E = 1.5$, the project return is $R = 1.52$, and the cost of monitoring is $c = 0.35$.[9]

Insert Figures 2 and 3

Figure 2 shows that, whereas the individual monitoring intensity always decreases with the number of banks k, the per-project total monitoring intensity increases with k for $k \geq 2$ if $E = 0.5$, whereas it decreases if $E = 1.5$. The intuition is as follows. Banks with little inside equity cannot diversify much when lending individually. All else equal, they are subject to a more severe moral hazard problem and exert a low level of monitoring. Sharing lending allows banks to finance more projects. This reduces their moral hazard problem and tends to increase monitoring. The marginal impact of greater diversification on banks' monitoring incentive is important enough to dominate the drawbacks of free-riding and duplication of efforts and lead to higher per-project total monitoring for $k \geq 2$. On the contrary, banks with a large amount of inside equity can reach a great enough level of diversification also when lending

[9] It is possible to analyze monitoring intensities and total monitoring costs (as well as banks' expected profits below) simply as function of k because for $k = 1$ expressions (9) and (12) coincide with (3) and (11), respectively. That is, $k = 1$ can be seen as a special case of multiple-bank lending.

individually. Thus ,they face a weak moral hazard problem and exert a high monitoring intensity. Sharing lending decreases both individual and per-project monitoring intensities as free-riding and duplication of efforts dominate.

As illustrated in Figure 3, total monitoring costs always decrease with k. The reduction is more pronounced if the amount of inside equity is high because in this case the individual monitoring intensity decreases rapidly with k.

Similar mechanisms link monitoring intensities and total monitoring costs to project return and cost of monitoring. One can show that, even when the amount of inside equity is low, the per-project total monitoring intensity decreases with k if c is low or R is high; and total monitoring costs still decrease with k in all cases. A low c (a high R) implies that banks have a weak moral hazard problem and exert a high level of monitoring also when lending individually (this can be easily seen from equation (3)). Sharing lending reduces monitoring intensities and costs because diversification has a small impact on banks' monitoring incentives. The contrary happens when c is high or R is low.[10]

To summarize all of this discussion:

Lemma 1 *The per-project total monitoring intensity increases eventually with the number of banks k if the amount of inside equity and the project return are low, and the cost of monitoring is high. The individual monitoring intensity always decreases with k.*

Lemma 2 *Total monitoring costs decrease with the number of banks k. Such a reduction is more pronounced if the amount of inside equity and the project return are high, and the cost of monitoring is low.*

We now turn to banks' expected profits. In Figure 4 we fix $R = 1.52$ and $c = 0.35$, and depict how banks' expected profits change as a function of the number of banks k when the amount of inside equity increases from $E = 0.5$ to $E = 1.5$. Then we fix $E = 0.5$ and analyze in Figures 5 and 6 how banks' expected profits change as a function of k when, respectively, the cost of monitoring decreases from $c = 0.35$ to $c = 0.25$ and the project return grows from $R = 1.52$ to $R = 1.62$.

Insert Figures 4, 5 and 6

[10] A positive relationship between monitoring cost and total monitoring intensity is also found by Winton (1993) in the context of shareholders' monitoring. Note, however, that, whereas the result in Winton is due entirely to the convexity of the monitoring cost function, here it depends on the marginal effect of the greater diversification achievable with multiple-bank lending. See also the discussion in Section 3.

Figure 4 shows that banks' expected profits are higher with multiple-bank lending than with individual-bank lending if $E = 0.5$, whereas the opposite happens if $E = 1.5$. Figures 5 and 6 show that multiple-bank lending is more profitable if $c = 0.35$ and $R = 1.52$, whereas individual-bank lending is more profitable otherwise. The intuition behind these results hinges on Lemmas 1 and 2. If E is low, increasing k implies higher per-project total monitoring intensity and thus higher per-project success probability in (12) than in (11). Together with lower total monitoring costs, this makes multiple-bank lending optimal. This result is not due to the diseconomies of scale in monitoring but on the effect of greater diversification on banks' monitoring incentives. In fact, as Lemma 2 states, the reduction in total monitoring costs as k increases is more pronounced when individual-bank lending is optimal.

Similarly, the positive relationship between per-project total monitoring and number of banks k explains the optimality of multiple-lending when the cost of monitoring is high and project return is low. To sum up:

Proposition 3 *Banks prefer multiple-bank lending if the amount of inside equity and firms' profitability are low, and the cost of monitoring is high; they prefer individual-bank lending otherwise.*

4 The Importance of Bank Leverage

The essential idea behind multiple-bank lending is that banks cannot perfectly diversify when acting as single lenders. Greater diversification decreases the variance of the distribution of the average portfolio return and improves banks' incentives to monitor. Higher monitoring reduces the expected shortfalls and the deposit rate promised to depositors. This in turn improves banks' incentives further as it allows them to appropriate a larger fraction of the monitoring benefits. This incentive mechanism works if and only if banks raise deposits, i.e., if they are leveraged. If banks are non-leveraged, diversification does not affect their monitoring incentives through the expected shortfalls and multiple-bank lending is no longer optimal despite implying lower total monitoring costs.

To show the importance of bank leverage, we depict in Figure 7 how the expected profits of leveraged and non-leveraged banks change as a function of the number of banks k for the same parameter configuration as in Figure 4 for which leveraged banks choose multiple-bank lending, i.e., $E = 0.5$, $c = 0.35$, and $R = 1.52$.

Insert Figure 7

Figure 7 shows that the expected profits of non-leveraged banks decrease with k, whereas those of leveraged banks increase. As mentioned above, the reason is that multiple-bank lending always lead to lower per-project total monitoring when banks are non-leveraged. This is shown in Figure 8, where the behavior of the per-project total monitoring intensities of leveraged and non-leveraged banks is depicted as a function of the number of banks k sharing lending.

Insert Figure 8

Figures 8 and 9 together imply that multiple-bank lending is no more optimal when banks are non-leveraged because the "negative" reduction in the per-project monitoring intensity dominates the "positive" decrease in total monitoring costs. The following proposition generalizes this result; and it strengthens Proposition 3 in that it suggests once again that the optimality of multiple-bank lending is not driven by the form of the monitoring cost function.

Proposition 4 *Non-leveraged banks do not have incentives to enter into multiple-bank lending relationships if* $\frac{\Delta pR}{c}$ *is sufficiently large.*

Proof: See the Appendix.

So far we have derived our results under the (somewhat implicit) assumption that when banks are leveraged, they raise the maximum amount of deposits they can lend, i.e., $D = (\beta - 1)E$. After the discussion above, however, one may wonder whether banks would not prefer to raise a lower amount of deposits, if any at all. Raising deposits allows banks to expand their portfolios, but it also worsens their moral hazard problem. We show now that this is not the case. We start with the following proposition.

Proposition 5 *Banks have incentives to raise a positive amount of deposits.*

Proof: See Appendix.

Proposition 7 relies on the idea that financing investment projects is profitable and a small amount of deposits does not originate a severe moral hazard problem. But do banks want to raise the maximum amount of deposits that they can invest given the capital requirements? To see this, we use once again numerical simulations. Figure 9 depicts how banks' expected profits change as a function of the number of banks k when the amount of deposits increases from a case where capital requirements are not binding ($D = 4.5$) to one where they are ($D = 5.5$). All of the other parameters are as in Figure 4 when multiple-bank lending is optimal, i.e., $E = 0.5$, $R = 1.52$, and $c = 0.35$.

Insert Figure 9

Figure 9 shows that banks find it optimal to raise an amount of deposits equal to $D = (\beta - 1)E = 5.5$; their expected profits are increasing in D in the optimal region of multiple-bank lending. The effect of greater diversification dominates, and banks find it optimal to raise the maximum amount of deposits they can invest and diversify as much as possible. One can show that banks want to do this also when individual-bank lending is optimal, since their expected profits are still increasing in D in that case.

5 Discussion of the Basic Model

In this section we analyze various aspects of the basic model. In particular, we discuss the role of capital requirements, other limitations to banks' lending capacities and diversification opportunities, and alternative monitoring technologies and cost functions.

Limits to diversification

Banks' incentives to enter into multiple–bank relationships originate from the need of increasing portfolio diversification and reaching higher per-project monitoring. The main underlying assumption is that banks have limited lending capacities, and they may not be able to diversify enough when lending to firms individually. In the model lending capacities are restricted by capital requirements. This idea is in line with the literature on delegated monitoring and capital-constrained lending (e.g., Holmstrom and Tirole, 1997; Thakor, 1996; Chiesa, 2001; Almazan, 2002).

The concept of capital requirements we have in mind is quite broad. The parameter β of our model encompasses any capital constraint which may limit lending, such as regulatory, effective or also market capital requirements.[11] More generally, any story which limits lending diversification possibilities is in line with our theory. Examples are restrictions on banks' geographical scope and sector specialization. Even

[11] "Effective" capital requirements may include a buffer above the regulatory minimum to cushion banks against unexpected negative shocks and protect them against falling below regulatory minimum (Berger, 1995, Berger et al., 1995); "market" capital requirements refer to the amount of capital the market requires banks to possess as price against default risk (Flannery and Rangan, 2002).

though regulatory restrictions to geographical expansion have been mostly abolished in the last decades, many factors limiting banks' ease to lend in distant regions are still in place. There is evidence that monitoring firms located at distant locations involves higher costs due to information problems, transportation costs, and, especially if located in foreign regions, differences in legal systems, supervisory regimes, corporate governance, language, and cultural conditions (Acharya et al., 2004).[12] The need of expertise may increase monitoring costs (Almazan, 2002) and worsen the effectiveness of monitoring (Winton, 1999), thus limiting banks' lending capacities across sectors. As in our model, in such cases banks may prefer to enter into multiple-bank relationships and increase diversification with a lower fraction of more costly loans.

The choice between individual-bank and multiple-bank lending resembles also the trade-off between specialization and diversification across sectors in terms of correlation among projects (e.g., Hellwig, 1998; Winton, 1999). If specializing implies lower monitoring costs but higher correlations among projects, the choice between individual-bank and multiple-bank lending can be seen as a trade-off between risk and costs. Banks may choose to share lending to achieve greater diversification with lower costs.

Alternative diversification opportunities

So far we have assumed that, for a given level of inside equity, banks can expand their portfolios only by entering into multiple-bank relationships. Of course, there are other ways in which banks could relax capital requirements and increase lending capacities. The most immediate way is raising outside equity. This solution can be, however, quite costly. First, raising outside equity may not improve banks' monitoring incentives, since, differently from raising debt, it does not reduce their incentives to exploit external financiers when diversification increases (Cerasi and Daltung, 2000). Second, in a context where banks act as liquidity providers, raising outside equity worsens such a valuable function (Diamond and Rajan, 2000). Finally, as is well known from the corporate finance literature, raising outside equity implies some costs in terms of foregone tax advantages, asymmetric information, and transaction costs (e.g., Jensen and Meckling, 1976; Myers and Majluf, 1984).[13] Thus, allowing banks to raise outside equity may not change their choice of sharing lending. Whenever individual-bank lending is not optimal, banks would weigh the costs of multiple-bank lending against the costs of raising outside equity, and would still choose to share

[12] See also Degryse and Ongena (2003) for an extensive survey on the geographical scope of banking.

[13] See also Smith (1986) for empirical evidence on the costs of raising equity.

lending if this implies higher profits.

Another alternative way for banks to increase lending is to merge. Mergers lead to higher inside equity and, if occurring across different geographical areas or sectors, allow banks to invest in more distant and more independent projects. This expands lending and improves diversification. However, mergers also involve some costs. By creating larger organizations, they may lead to more severe agency problems, organizational diseconomies and distortions linked to the implicit too-big-to fail guarantee.[14]

Finally, also information sharing may affect banks' incentives to enter into multiple-bank relationships. Regardless of whether this is provided through public credit registers or private bureaus, sharing information about borrowers' performances can substitute −at least to some extent− for private monitoring, thus reducing banks' monitoring costs.[15] This increases the attractiveness of individual-bank lending, but it does not allow banks to increase diversification. Thus, banks may still prefer multiple-bank lending when the incentive effect of diversification dominates.

Alternative monitoring technologies

The monitoring technology we have assumed so far gives banks a direct form of control on firms' behavior. Monitoring allows banks to observe firms' project choices and intervene in case of misbehavior. Other forms of control are, however, plausible. For example, through monitoring banks could observe firms' behavior and liquidate them for a total value of C (e.g., Rajan and Winton, 1995; Park, 2000). Whether this leads to different results for the optimality of multiple-bank lending depends on how the liquidation value C is allocated among banks. The results of the basic model still hold if banks share C equally in case of default independently of whether they monitor. Results may differ, however, if a monitoring bank is the first to seize C. This reduces free-riding, but it may reduce the attractiveness of multiple-bank lending if it leads to excessive duplication of efforts.

Monitoring cost function

So far we have assumed that monitoring costs are convex. As shown in Proposition 4, however, what is crucial for our theory is the fact that banks are leveraged rather

[14]See Carletti et al. (2002) for a discussion of the effects of bank mergers on diversification opportunities and risk taking; Degryse and Ongena (2003) for a more specific discussion of the effects of cross-border mergers; and Cerasi and Daltung (2002) for an analysis of organizational diseconomies.

[15]See Jappelli and Pagano (2002) for a description of the different types of information sharing agreements across countries.

than the exact form of the monitoring cost function. Therefore, although convex costs overestimate the optimality of multiple-bank lending because they imply diseconomies of scale in monitoring, our qualitative results are robust to various modifications of the cost function. Assuming linear costs, overloading costs, or some initial fixed costs would reduce the range of parameters for which multiple-bank lending is optimal, but it would not modify our qualitative insights.

6 Empirical Implications

The model has several empirical implications. First, the amount of inside equity relates to the relative size of banks and firms. Thus, the model predicts a great use of multiple-bank lending when banks are small relative to the projects they finance, since in this case they cannot diversify much when lending individually. This prediction is consistent with the finding in Ongena and Smith (2000b) of little use of multiple-bank lending in more concentrated banking systems.

Second, the model predicts that banks should prefer multiple-bank lending when firms are less profitable. This is in line with Detragiache et al. (2000), who find a positive relationship between individual-bank lending and firms' profitability; and it also suggests that monetary policy may affect banks' lending choices. Even if so far we have considered firms' profitability in terms of return from the risky projects, one can show that similar (but inverse) results hold for the return of the alternative safe investment. An increase in the riskless interest rate makes multiple-bank lending relatively more attractive as it reduces firms' profitability. Thus the model predicts that, by raising riskless interest rates, a tight monetary policy induces banks to enter into multiple bank relationships. If then monetary policy is counter-cyclical, multiple-bank lending should occur more frequently during periods of expansionary economic activity.[16]

Third, the cost of monitoring refers to the ease with which banks can acquire information about firms; and it is linked to disclosure and accounting standards, and the efficiency of the judicial system. Also, to the extent that they affect banks' acquisition information in different sectors or geographical areas, the size of the cost of monitoring depends on the degree of financial integration and the level of regulatory

[16]Several papers have discussed the negative effect of a tighter monetary policy on banks' monitoring incentives and lending (e.g., Holmstrom and Tirole, 1997; Repullo and Suarez, 2000; Chiesa, 2001; and Almazan, 2002). Our paper suggests that banks could avoid lowering credit by entering into multiple-bank relationships. In this respect, our paper is in line with Thakor (1996), who shows that a tight monetary policy does not necessarily lower lending.

restrictions. The more integrated and the less regulated markets are, the lower the cost of monitoring. Thus, the model predicts that multiple-bank lending should occur in countries with laxer accounting and disclosure standards, more inefficient judicial systems, less integrated and less regulated markets. This prediction is partly supported by Detragiache et al.(2000), and Ongena and Smith (2000b), who find greater use of multiple-bank lending in countries with more inefficient judicial systems and poorer enforcement of creditor rights. Also, the finding in Berger et al. (2003) that firms frequently use local host nation banks seems to support our prediction of greater use of multiple-bank relationships, when geographical distance increases the cost of monitoring and makes individual diversification more difficult.

Finally, the model has some predictions concerning diversification opportunities rather than multiple-bank lending. In particular, the model predicts a negative relationship between the use of multiple-bank lending and the strength of equity markets, as found in Ongena and Smith (2000b). Also, the model suggests that banks should make less use of multiple-bank lending after a process of mergers and acquisitions. This seems to be in line with the findings in Sapienza (2002) and Karceski et al.(2003) that banks are more likely to terminate a certain lending relationship after they merge, in particular when borrowers are firms of small size or firms borrowing from multiple banks.

7 Conclusions

This paper analyzes banks' incentives to enter into multiple-bank relationships with other banks in a context where both firms and banks are subject to moral hazard, and monitoring is essential. Banks choose multiple-bank lending whenever the benefit of greater diversification in terms of higher overall monitoring dominates the drawbacks of free-riding and duplication of efforts. The incentive mechanism of diversification works only if banks raise deposits, since otherwise diversification does not affect monitoring incentives. The attractiveness of multiple-bank lending decreases with the amount of inside equity and firms' profitability, whereas it increases with the cost of monitoring.

The main result of the paper, namely that multiple-bank lending can increase overall monitoring, contrasts sharply with Diamond's theory of banks as delegated monitors, and it provides a new alternative to the hold-up and the soft-budget-constraint theories in explaining why banks may want to enter into multiple-bank relationships. The results are particularly applicable to small and medium business lending, but the paper sheds light also on some aspects of syndicated lending. This can be considered as a special form of multiple-bank lending in that a lead bank (and, in many cases, several lead banks) originates a loan and decides to share it with other banks. As in our model, banks syndicate loans to overcome capital constraints and limited lending capacities (Simons, 1993) and are more likely to do so as their capital ratios decline, and when they are unable to originate loans in distant regions or different sectors (Dennis and Mullineaux, 2000).

We develop the analysis under the assumption that all banks share financing equally when they enter into multiple-bank relationships. Allowing for asymmetric shares of financing would lead to results somewhere between those obtained with symmetric shares, and might explain some other important features of banking systems such as the emergence and the role of "housebanks". This analysis constitutes an interesting avenue for future research.

8 Appendix

Proof of Proposition 1

For a given r, the bank chooses m_i to maximize (2). The first order condition gives

$$\frac{\partial \pi}{\partial m_i} = \Delta p R + \frac{\partial S}{\partial m_i} D - c m_i = 0, \qquad \forall i = 1, ..., D+E.$$

Solving for a symmetric equilibrium gives (3). Setting (1) equal to y after substituting m^{IL} gives (4). Q.E.D.

Proof of Proposition 2

For a given r_j, each bank j chooses m_{ij} to maximize (8). The first order condition gives

$$\frac{\partial \pi_j^k}{\partial m_{ij}} = \frac{\Delta p R}{k} \prod_{s \neq j} (1 - m_{is}) + \frac{\partial S^k}{\partial m_{ij}} D - c m_{ij} = 0, \qquad \text{for } = 1...k \text{ and } i = 1, ..., k(D+E).$$

Substituting $m_{ij} = m^{ML}$ in a symmetric equilibrium gives (9). Setting (7) equal to y after substituting m^{ML} gives (10). Q.E.D.

Proof of Proposition 4

For a given k, the expected profit of a non-leveraged bank ($D = 0$) is

$$\pi = \sum_{i=1}^{kE} \left\{ p_i^k \frac{R}{k} - \frac{y}{k} - \frac{c}{2} m_{ij}^2 \right\}. \tag{13}$$

Each bank chooses m_{ij} to maximize (13). The first order condition gives

$$\frac{\Delta pR}{k}\prod_{s\neq j}(1-m_{is})-cm_{ij}=0, \qquad \text{for } j=1,....,k \text{ and } i=1,...,k(D+E).$$

The system has only one symmetric solution, which is given by

$$(1-\hat{m})^{k-1}\Delta pR-kc\hat{m}=0. \tag{14}$$

It follows that the equilibrium monitoring intensity $\hat{m}$ is non-increasing in k. If $k=1$, the bank is lending individually. In this case $\hat{m}=1$, if $\frac{\Delta pR}{c}\geq 1$. For all $k>1$, $\hat{m}<1$.

Substituting $\hat{m}$ into (13) gives the equilibrium expected profit of each bank

$$\hat{\pi}=E\left\{\hat{p}R-y-k\frac{c}{2}(\hat{m})^2\right\}. \tag{15}$$

Neglecting indivisibilities, the first order condition of (15) with respect to k is

$$-\frac{c}{2}(\hat{m})^2+\left[k(1-\hat{m})^{k-1}\Delta pR-kc\hat{m}\right]\frac{\partial\hat{m}}{\partial k}-(1-\hat{m})^k\Delta pR\ln(1-\hat{m})\leq 0. \tag{16}$$

The first term is negative, the second term is non-positive, while the last one is non-negative. The first term is the additional cost of monitoring more projects when banks share lending. The second term represents the effect of the decrease in the individual monitoring intensity of all banks as k increases. This effect is negative if $\hat{m}<1$, and it is zero otherwise. The last term is the increase in the project success probability when an additional bank monitors the project. This effect is positive as long as $\hat{m}$ is less than one; when the project is already fully monitored there is no benefit from having an additional monitor.

For $k=1$ the Envelope Theorem applies to $\hat{m}$, and (16) reduces to

$$-\frac{c}{2}(\hat{m})^2-(1-\hat{m})\Delta pR\ln(1-\hat{m})\leq 0. \tag{17}$$

The left hand side is negative if $\hat{m}=1$. Hence, if the bank chooses to monitor with intensity equal to one, it has no incentive to share lending. If $\frac{\Delta pR}{c}<1$, (14) is binding. Substituting it into (17) gives

$$-\frac{1}{2}\frac{\Delta pR}{c}-(1-\frac{\Delta pR}{c})\ln(1-\frac{\Delta pR}{c})\leq 0,$$

which is fulfilled for $\frac{\Delta pR}{c}>0.72$. Q.E.D.

Proof of Proposition 5

For a given amount of deposits D, banks' equilibrium expected profits are given by

$$(D+E)\left\{\widetilde{p}\ R-y-k\frac{c}{2}(\widetilde{m})^2\right\},$$

where $\widetilde{m}$ is the solution to

$$\frac{\Delta pR}{k}(1-\widetilde{m})^{k-1}+\frac{\partial S}{\partial m}D-c\widetilde{m}=0,$$

and

$$\widetilde{r}-S(\widetilde{m},\widetilde{r})=y,$$

with $\widetilde{p}=p_H-(1-\widetilde{m})^k\Delta p$. The derivative of the expected profits with respect to D gives

$$\left\{\widetilde{p}R-y-\frac{c}{2}(\widetilde{m})^2\right\}+(D+E)\left[k(1-\widetilde{m})^{k-1}\Delta pR-kc\widetilde{m}\right]\frac{\partial\widetilde{m}}{\partial D}\geq 0. \qquad (18)$$

For $k=1$, (18) is strictly positive at $D=0$, since the Envelope Theorem then holds with respect to $\widetilde{m}$. For $k>1$, the Envelope Theorem does not hold because a change in D affects the monitoring intensities of all banks k in the same way. However, a small increase in D has a small impact on $\widetilde{m}$ so that, if project lending is profitable enough, each bank has an incentive to raise deposits. Q.E.D.

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