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The number and the closeness of bank relationships

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Abstract

We analyze a firm's optimal choice over the number of creditors and the extent of information disclosed to them. By dealing with many creditors and disclosing essential confidential information, a firm can keep its cost of credit low. This, however, is associated with a relatively high probability that valuable information leaks to competitors, leading to lower expected net returns from product market operations. The importance of these two countervailing effects varies with size, time, industry, and the form of the financial sector, which yields a number of empirically testable hypotheses.

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1. Introduction

Private knowledge is a crucial factor in a firm's economic success. Firms that seek financing regularly disclose confidential information to creditors in order to demonstrate their creditworthiness. However, it can be detrimental to borrowers if such information is revealed to third parties like competitors, unions or suppliers. Market financing implies the disclosure of certain information to the public at large because

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of disclosure requirements of the regulatory authorities. In contrast, bank financing does not underlie any formal disclosure requirements and therefore seemingly allows a firm to keep its confidential information from being observed by third parties (see for example Campbell, 1979). Thus, by choosing bank financing, firms seem to be able to avoid any disadvantages related to the revelation of private information. Court proceedings, however, suggest that banks do not always keep information secret, and even may use it to the detriment of their clients. Consider the case of ADT Operations, Inc. vs. The Chase Manhattan Bank. Chase, a creditor of ADT, financed a hostile takeover against ADT. In court, ADT claimed that Chase had abused confidential information ADT provided in the course of obtaining a loan. [1] The court dismissed the charge and stated that "no fiduciary relationship has been created by the mere communication of confidential information from the customer to the bank."

Confidential information may not only be used intentionally by banks but also, and maybe even more likely, may be disseminated incidentally. Information may leak either completely by accident or during a bank's advising activity. [2] Advising a client requires an in-depth knowledge of the client's industry. This knowledge includes estimates of future market demand as well as possible competitive strategies and innovations by competitors as key factors. Banks acquire such in-depth knowledge in part by obtaining information from the firms in the industry they do business with. A banker who obtained confidential information from firms may use this information to provide advice to other firms. This, however, is typically detrimental for the firms whose information is used.

A borrowing firm can manage the expected negative effect from information leaks. First, the firm decides on *how many* relationships to creditors to establish. The more often the firm releases confidential information, the higher is the probability of an information leak. Second, although the release of some proprietary information may be beyond firm control, the firm decides on *how much* confidential information to give to creditors. Naturally, for a given number of creditors the negative effect of information transmission is smaller, if less confidential information is given to them. Therefore, a firm's optimal bank financing policy is characterized not only by the number but also by the closeness of its bank relationships.

Giving away more confidential information to banks and establishing a larger number of bank relationships, however, does not only have adverse effects for a borrower. The more information a bank obtains from a borrower, the better it can evaluate its default risk. This leads to lower costs of credit for high-quality borrowers. A larger number of bank relationships intensifies competition in the credit market which also reduces lending rates.

Thus, when deciding on the number of bank relationships and on the amount of information to disclose to creditors, a firm trades off the benefits of lower expected

[1] A discussion of this lawsuit and related ones can be found in the *New York Law Journal*, June 26, 1997 and August 14, 1997.

[2] Advising typically occurs when a borrower is in or close to financial distress (see for example Edwards and Fischer, 1994).

cost of credit against the expected loss from information leaks. In this paper we derive the optimal decision by firms and perform comparative static analysis. It is shown that highly rated companies tend to deal with many creditors and disclose little private information. Borrowers that are rated highly already cannot improve their rating by much when disclosing information. Disclosing little information keeps the expected cost of information transmission low. In addition, it is optimal to have a substantial number of creditors to induce competition among them. By contrast, a firm whose initial credit rating is low must disclose a substantial amount of private information in order to reduce creditors' uncertainty about its quality. This, however, implies that the effects of information leakage can be severe. Therefore, the firm restricts itself to a relatively small number of creditors.

Highly innovative borrowers incur a high cost if confidential information is transmitted to competitors. If innovative borrowers decide to disclose information, they limit the number of lenders in order to reduce the probability of an informational spillover. Those borrowers, however, also have a strong incentive to limit disclosure of confidential information which in turn allows them to deal with many lenders without facing the risk of information transmission. The model presented here predicts a U-shaped relationship between the degree of innovativeness and the number of bank relationships.

Although there are several ways in which the transmission of confidential information to other persons or institutions via creditors can harm a firm, we restrict ourselves to the situation in which information leakage to competitors impairs output market success. To keep matters simple, we consider a situation in which a firm intends to enter a market in which one established firm is present. These two firms then share the market. To finance its entry, however, the entrant needs a loan. In the course of the loan application process the entrant can decide whether to pass on confidential information to banks or not. The profit of the entrant depends on whether the established firm reacts to entry early on or whether it does not. If a bank has knowledge of the entrant's confidential information it may transmit this information and trigger the incumbent's reaction. This occurs either on purpose or inadvertently. Thus, it may be detrimental for the entrant to pass on confidential information to banks. However, banks learn more about the quality of the entrant if they possess confidential information. This results in better credit terms.

Few papers examine the output market effects of banks collecting valuable information in the process of screening and monitoring borrowers. Gerschenkron (1962) argues that in the late 19th century bank financing led to a cartelization of the German industry. [3] In this time of industrial development, capital was scarce and banks used their influence on borrowers to prevent them from behaving too aggressively in the output market. By doing so, banks limited the extent of competition and the output market returns of all firms increased leading to fewer loan defaults. Poitevin (1989) studies loan pricing of one bank which gives loans to firms of the same oligopolistic industry. Following Brander and Lewis (1986), Poitevin argues that high

[3] For a detailed discussion see Hellwig (1991).

debt repayment obligations lead to a more aggressive behavior in the output market. If the bank's profit depends on the degree of competition in its debtors' output market, it charges relatively low interest rates in order to limit each firm's incentives to choose a risky output. Whereas Gerschenkron and Poitevin emphasize the positive effect bank financing has on the output market return of firms, we stress that banks may abuse confidential information to the detriment of a firm's output market success.

Our model is also related to papers which analyze a firm's optimal number of creditors. Bolton and Scharfstein (1996) consider a model in which creditors renegotiate debt contracts once a firm has gone bankrupt. The costs of the renegotiation process increase in the number of creditors. Thus, a firm's debt structure is a device to discipline management, since a large number of creditors decreases the manager's incentive to default strategically. However, the costs of inefficient renegotiation are also present if the firm defaults for liquidity reasons. Trading off these two effects, Bolton and Scharfstein derive the optimal number of creditors. In von Thadden (1994) banks obtain superior information in the course of a credit relationship which gives them opportunity to subsequently extract rents. Ex ante the firm can limit those rents by maintaining multiple credit relationships. This, however, is associated with larger transaction costs. Detragiache et al. (2000) argue that firms maintain multiple bank relationships to diversify the risk that their bank is affected by a liquidity shock and chokes off credit. None of these papers, however, examine the relationship between the closeness and the number of bank relationships.

Closest in spirit to our analysis are Yosha (1995) and Bhattacharya and Chiesa (1995). Both papers recognize the importance of information transmission to competitors as an important determinant of financing policy. In Yosha (1995), a large number of creditors implies a larger probability of information transmission for the borrower than a small number of creditors. The level of information disclosed, however, is exogenous. Thus, limiting information disclosure as a reaction to potential information transmission is not an option. In Bhattacharya and Chiesa (1995) bank financing enables competing firms to commit to share information in an R&D race. Sharing information is ex ante beneficial when the expected benefits of obtaining information from the competitor outweigh the expected costs of information transmission to the competitor. As in Yosha (1995), limiting information disclosure to banks is impossible.

The remainder of this paper is organized as follows. Section 2 describes the setup of the model which is then analyzed in Section 3. Section 4 is devoted to the implications of our results and to the comparison of our findings to the empirical literature. Section 5 concludes.

2. The model

The model involves one incumbent, one entrant and a large number of banks. The entrant needs a bank loan to finance its entry. We restrict our analysis to standard debt contracts. The entrant can be either of type G (good) or B (bad). A good entrant can be understood as being a company whose entry is viable, for example, supported by a significant product or process innovation. On the other hand, a bad entrant could be a firm that has to exit the market some time after entry. Ex ante, the entrant does not know its type. [4] However, it is common knowledge that the entrant is of type G (B) with probability $\lambda \in (0, 1)$ (with probability $(1 - \lambda)$). The incumbent is already active in the product market the entrant plans to enter.

Banks are assumed to operate in an imperfectly competitive environment. They compete on price but are likely to have different refinancing costs for an eventual loan to the entrant. Differences in refinancing costs of banks can, for example, occur due to banks' different streams of deposits or differences in demands for loans. Without private information disclosed by the entrant, banks cannot observe the entrant's type. In this case they have to rely on the prior distribution of types. [5] However, banks have screening technologies and a sound knowledge of economic prospects. Thus, a bank learns the entrant's type if it performs a creditworthiness test which is only possible if it gets the entrant's private information. This private information could, for example, include a statement on which product will be launched in the market. The entrant decides on whether to give the private information to banks or not; i.e. it controls the banks' cost of information production. [6]

If the incumbent knows about a type-G entrant's exact plans, it will take adequate actions to mitigate the adverse effects on profits which result from entry. Only a bank that obtains the entrant's private information from a creditworthiness test can potentially inform the established firm. The entrant believes that each bank transmits the information with probability $Q \in (0, 1)$. [7] It cannot be observed or verified by outsiders, like courts, that a bank has transmitted the information it got from screening the entrant. [8] If the entrant refrains from giving private information to banks, the established firm cannot react to the entrant's plans. This means that a bank's

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[4] This assumption is, for example, realistic in an environment in which a certain fraction of entrepreneurs are overly optimistic (see Manove and Padilla, 1999). The assumption allows us to abstract from any signaling considerations. The analysis is, however, not restricted to situations in which companies are ignorant about their types. There is a cost of disclosing information for an entrant of type G in the form of reduced net output market revenues (see below). If this cost is sufficiently large, a G-type entrant will forgo any financial advantages from separating itself from a B-type. Thus, for a certain set of parameter values, a pooling equilibrium exists even when the entrant knows its type.

[5] The prior distribution can also be understood as the distribution of types after the minimum of private information required by any bank has been disclosed.

[6] The assumption that the degree of disclosing information is only a two-state variable simplifies the analysis considerably. The conclusions, however, should carry over to more general action spaces.

[7] The information transmission by the bank may, for example, occur directly if the entrant is a (potential) borrower of the bank or indirectly if the bank's information transmission occurs through a third party. The bank may disseminate the information intentionally or inadvertently.

[8] In practice, banks that transmit information may face the risk of a lawsuit or a loss in reputational capital. It is, however, typically difficult to observe by outsiders, whether information transmission has taken place at all and, if so, which of the banks is responsible for it. Even if there is an expected reputational cost of information transmission for banks, the results are unchanged as long as it is sufficiently small.

mere observation of a new firm is not sufficient to provide sufficiently valuable information to the incumbent. Also, the incumbent cannot react upon observation of the entrant's financing arrangement.

If the entrant is of type G, it earns (excluding costs of credit) a return of X^{H} if the established firm does not react and X^{L} if there is a reaction by the established firm ($0 < X^{L} < X^{H}$). The entrant will invest and enter the market if its expected net profits are nonnegative. The entrant obtains a return of zero if it is of type B.

The objective of this paper is to analyze the behavior of the entrant. First, the entrant decides on whether to give private information to banks or not. Then, the entrant chooses the number of bank relationships, n. For tractability reasons, it is assumed that the entrant either gives private information to all or to none of the banks it contacts. This means that the entrant cannot disclose its private information only to a fraction of the contacted banks. Per bank contact the entrant bears transaction costs C. We assume that C are private nonmonetary costs the entrant bears before banks make an offer. For simplicity, we assume that the type-G entrant's loan can always be repaid if two or more banks are competing for extending the loan, i.e. X^{H} and X^{L} are sufficiently large.

We assume that the entrant approaches n banks simultaneously. Then, each of the n banks either refuses to grant a loan or makes an offer. An offer consists of the repayment objective for the loan.

The exact sequence of actions is as follows:

$t = 1$

- The entrant determines the number of bank relationships, n, and whether it discloses confidential information to all of the n banks or none of them. n is publicly observable.
- *If the entrant discloses its plans to all n banks:*
  - Each of the n banks performs a costless credit worthiness test. Then, all banks simultaneously decide on whether to make credit offers and, if so, specify repayments.
  - If the entrant obtains one or more offers, it decides whether or not to accept one and, if so, which one.
  - For each of the n banks it is decided whether it informs the incumbent about the entrant's plans.
  - The incumbent reacts if it learns about the entrant's plans.
- *If the entrant does not disclose its plans to any bank:*
  - All banks simultaneously decide whether to make credit offers and, if so, specify repayment requirements.
  - If the entrant obtains one or more offers, it decides whether to accept one and, if so, which of the offers.
- The entrant enters the market if, and only if, it obtains a loan.

$t = 2$

- If the entrant obtains a loan, it repays the minimum of its return and the amount specified in the loan contract.

For simplicity, we assume a certain function of expected loan repayments for the entrant rather than deriving loan pricing strategies of banks explicitly. Expected loan repayments, $r(n)$, when n banks are approached and an offer is made are assumed to be given by

$$r(n) = \frac{1}{\text{prob}\{G\}}\left[a + \frac{b}{n+1}\right],$$

where prob$\{G\}$ is the probability the banks assign to the entrant of being of type G. This functional form can be derived assuming a first price sealed bid auction in which $n \geqslant 2$ banks have identically, independently and uniformly distributed refinancing costs. In such a setting, a represents the principal payment plus the minimally possible refinancing cost and b is a linear function of the difference between the highest and lowest possible refinancing cost. [9]

3. Analysis

In our analysis, we distinguish two regimes: either the entrant discloses its private information to banks or it does not. Banks learn the entrant's type if, and only if, it gives private information to them. Variables referring to the regime in which the entrant discloses private information are labeled with the subscript c (for "common"). The entrant can also refrain from giving private information to banks. Then banks do not observe the entrant's type. In this regime, we label variables with the subscript p (for "private"). All proofs of our results are relegated to Appendix A.

The expected repayment obligation of the entrant, depends on whether it has given private information to banks and on the number of bank contacts. For the two regimes the expected repayment obligations are

$$r_{\mathrm{c}}(n) = a + \frac{b}{n+1}, \quad \text{if the entrant is of type } G,$$

$$r_{\mathrm{p}}(n) = \frac{1}{\lambda}\left[a + \frac{b}{n+1}\right].$$

The entrant's cost of credit decreases with the number of banks approached. The entrant can improve its credit conditions by giving private information to banks. Then, banks can discriminate between a good and a bad borrower and thus make better offers to a high-quality borrower and refrain from making an offer to a low-quality borrower.

However, disclosing confidential information comes also at a cost. Consider the case of a bank that is processing the entrant's confidential information and maintains a credit relationship with the incumbent. Under the assumptions made, this bank finds it optimal to transmit the information obtained to the incumbent. This

[9] A formal proof is given in the previous versions of this paper and can be obtained from the authors.

information transmission triggers an early reaction of the incumbent which reduces the bank's risk of the incumbent's default. Whereas there is a benefit to transmitting the information for the bank, in this model there is no cost of doing so. Even if the bank wins the competition for extending credit to the entrant, the default probability of the loan is zero. This is due to a sufficiently large X^{L}. Even if the transmission of information created a positive default probability for the entrant and the winning bank has an incentive to prevent information transmission, all other banks would not have this incentive.

The tradeoff between a low cost of credit, high transaction costs and an eventually increasing risk of information transmission determines the number of bank contacts chosen by the entrant and its information disclosure policy. To characterize the entrant's optimal decision, we analyze the two policies of information disclosure in turn.

If the entrant does not give any private information to banks, its expected profit depends on the number of banks, n, it contacts. The optimal number of bank contacts, n_{p}, is given by

$$n_{\mathrm{p}} = \arg\max_{n} \lambda \left(X^{\mathrm{H}} - \frac{1}{\lambda} \left[a + \frac{b}{n+1} \right] \right) - nC. \tag{1}$$

The term in parentheses characterizes the entrant's expected profits, given that it is of the good type. It is multiplied by the entrant's probability of being type G, λ. If the entrant is of type B, its profits are zero. The entrant incurs the transaction cost nC independent of its type.

Expression (1) is a concave optimization problem. From the first-order condition we can derive the number of banks the entrant approaches if it keeps its information private. Neglecting the integer problem, the solution is

$$n_{\mathrm{p}} = \sqrt{\frac{b}{C}} - 1. \tag{2}$$

n_{p} increases with the range of banks' refinancing costs, b, and decreases with the exogenous cost per bank contact, C.

If the entrant provides banks with confidential information to banks, its optimal number of bank contacts, n_{c}, is given by

$$n_{\mathrm{c}} = \arg\max_{n} \lambda \left(X^{\mathrm{L}} + (1-Q)^{n} (X^{\mathrm{H}} - X^{\mathrm{L}}) - \left[a + \frac{b}{n+1} \right] \right) - nC. \tag{3}$$

In this case, information transmission to the incumbent is possible. It occurs with probability $1-(1-Q)^{n}$ and its effect on returns is reflected in the first two parts of the term in brackets. [10]

We are not able to obtain a closed form solution for the number of banks, n_{c}, the entrant approaches if it discloses confidential information. However, the properties

[10] One immediate extension of the model would be to allow for differing Qs among banks. A borrower would then prefer relationships to banks with lower Qs. Thus, a straightforward implication of the approach would be that, for example, bank relationships of firms in one industry should be dispersed among many banks in the economy rather than clustered in one small set of banks.

of the profit function allows us to apply monotone comparative static methods (see Milgrom and Shannon, 1994):

Lemma 1. *The number of banks, n_c, the entrant asks for a loan if it discloses confidential information is*

- *nondecreasing in λ and b,*
- *nonincreasing in C, Q and $X^H - X^L$.*

It is quite intuitive that n_p and n_c are nonincreasing in the transaction costs C. If the costs of approaching banks increase, then the entrant will prefer to go to fewer banks regardless of whether it discloses information or not.

Since there is no cost of information transmission if the entrant does not disclose confidential information, n_p is independent of Q and $X^H - X^L$. However, if banks obtain the entrant's confidential information, information transmission is an issue. If Q or $X^H - X^L$ increase, the expected cost of information transmission increases for any n_c. Thus, n_c is nonincreasing in both Q and $X^H - X^L$.

If the entrant does not provide banks with confidential information, the ex ante expected repayment $\lambda r_p(n)$ is independent of λ. Contrarily, if the entrant gives its confidential information to banks, the ex ante expected repayment decreases in λ. Hence the value of lower repayment obligations, $r_c(n)$ decreases if λ decreases. Thus, n_c is nondecreasing in λ.

It is not difficult to show that the entrant contacts fewer banks about a loan if it provides them with confidential information. The expected cost of information transmission, which is zero if the entrant does not disclose confidential information, increases if n_c increases. In addition, the number of banks the entrant approaches influences the expected repayment of a loan. For a given number of competing banks, the marginal decrease of the expected repayment is lower if the entrant discloses information.

Lemma 2. *If the entrant does not disclose any confidential information, it approaches at least as many banks as when it provides banks with confidential information, $n_c \leqslant n_p$.*

Lemma 2 implies that the positive effect that banks offer better conditions if they are convinced that the entrant is of type G is weakened by a less severe competition between banks. If n_c is small relative to n_p, it is even possible that the repayment the entrant expects if it goes to n_p banks without providing them with confidential information is lower than the expected repayment $r_c(n_c)$.

4. Results and applications

The entrant discloses private information, if the advantage of better credit terms dominates the expected loss due to information transmission. In the following, we utilize the model by deriving and interpreting comparative static results. We outline testable hypotheses and compare the findings to existing empirical evidence.

4.1. High/low costs of information leakage

The expected loss due to information transmission increases in $X^{\mathrm{H}} - X^{\mathrm{L}}$. Thus, for any given n_{p} and n_{c} the difference

$$\Pi_{\mathrm{p}}(r_{\mathrm{p}}(n_{\mathrm{p}}), n_{\mathrm{p}}) - \Pi_{\mathrm{c}}(r_{\mathrm{c}}(n_{\mathrm{c}}), n_{\mathrm{c}})$$

increases, if $X^{\mathrm{H}} - X^{\mathrm{L}}$ increases. In addition, we know that an increase of $X^{\mathrm{H}} - X^{\mathrm{L}}$ also implies that n_{c} decreases. This means that the competition between banks is less severe resulting in higher expected costs of credit. It follows that the entrant prefers not to give confidential information to banks if the incumbent's reaction results in a significant decline in the entrant's profit.

Proposition 1. *There exists $\overline{\Delta} > 0$ such that for all $X^{\mathrm{H}} - X^{\mathrm{L}} < \overline{\Delta}$ the entrant provides banks with confidential information and for all $X^{\mathrm{H}} - X^{\mathrm{L}} > \overline{\Delta}$ the entrant keeps its information private.*

The model predicts that the value of bank financing depends on the entrant's characteristics. Suppose the entrant has made a significant innovation, which means that it possesses a new production technology, a new product design or a new sales strategy which makes it superior to the incumbent. Then, it is reasonable to argue that the entrant can appropriate a considerable market share and thus earn a high profit if the incumbent does not react. However, if the incumbent learns the entrant's plan it can pursue defensive strategies which in the simplest case includes the pure imitation of the entrant's ideas. Alternatively, if the entrant is not very innovative and runs its business in a very similar way to the incumbent, its profit from output market operations is not likely to vary considerably if the incumbent reacts. In sum, innovative firms should be able to potentially earn high returns, X^{H}, but also their cost of information leakage, $X^{\mathrm{H}} - X^{\mathrm{L}}$, is likely to be large.

The absolute value of X^{H} is not a criterion for a firm's choice on information disclosure and number of bank relationships. Instead, only the return lost in case of information transmission, $X^{\mathrm{H}} - X^{\mathrm{L}}$, is relevant for its decision. As long as a firm decides on disclosing private information, a higher innovativeness makes it optimal to maintain fewer bank relationships (Lemma 1). However, in case of a very high sensitivity of profits on information transmission, the firm chooses not to disclose its confidential information in order not to impair output market success (Proposition 1). Then, the firm decides to maintain many bank relationships to keep rates relatively low. Consequently, our analysis predicts a U-shaped relationship between the innovativeness of a firm and the number of banks it deals with (see Fig. 1). [11] This is different from the prediction in Yosha (1995) who obtains that more innovative firms choose to have fewer creditors.

Harhoff and Körting (1998) provide survey evidence of the number of bank relationships of small and medium sized German firms. They approximate the innova-

[11] In the figures, integer issues are neglected.

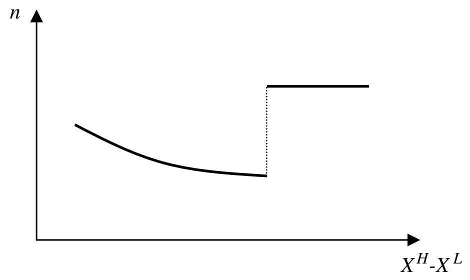

Fig. 1. Number of bank relationships and innovativeness.

tiveness of a firm by using dummy variables indicating whether the firm has recently embarked on innovations and whether the firm performs R&D. Harhoff and Körting (1998) document a positive relation between innovativeness and the number of bank relationships which at first glance seems to contradict the hypothesis of information flows to competitors via banks. However, as our approach demonstrates, very innovative firms have a strong incentive not to confide in creditors about their plans and to maintain many loose bank relationships in order to receive attractive rates. Since Harhoff and Körting (1998) use dummy variables for characterizing innovativeness, they are not able to explicitly test for a U-shaped relationship predicted by our model.

Differences in innovativeness are only one example in which the U-shaped relationship between the number of bank relationships and the expected loss from information transmission is predicted to manifest itself. Other applications are differences in the product and market structures of borrowers. [12] For example, if products in an industry can easily be patented, the cost of information transmission by banks should generally be low, since a patent can be applied for before banks are approached. In contrast, in markets in which patents are more difficult or even impossible to obtain, "lead time" becomes more important and the cost of information leakage as well. $X^{\mathrm{H}} - X^{\mathrm{L}}$ should be relatively large in industries that are expected to be not very competitive after entry has occurred. In such markets, there are considerable rents to be earned and the same percentage loss in profits caused by information transmission translates into a larger absolute loss.

4.2. Cross-sectional and dynamic aspects of bank relationships

If the ex ante probability that the entrant is of type G is low, banks offer unfavorable credit conditions. In such a situation, the entrant has a strong incentive to disclose confidential information. It follows that for λ sufficiently small, the entrant prefers giving confidential information to banks.

[12] We are grateful to an anonymous referee for pointing this out.

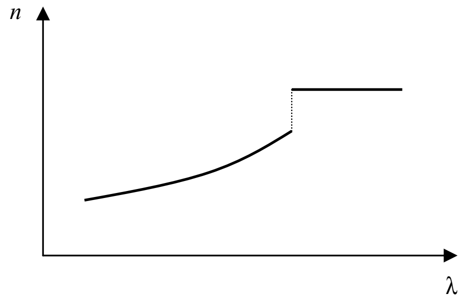

Fig. 2. Number of bank relationships and credit rating.

Proposition 2. *There exists a* $\bar{\lambda} \in (0;1)$, *such that for all* $\lambda < \bar{\lambda}$ *the entrant discloses information and for all* $\lambda > \bar{\lambda}$ *the entrant keeps its information private.*

From Proposition 2 we can derive some implications for growing firms' financing strategies.

4.2.1. Bank relationships over a company's life cycle

Recall that λ denotes the a priori probability that the firm is of high quality and as a consequence is able to repay its loan. Obviously the capability to run a firm profitably depends on the experience of its management. Moreover, firms with a bad management are more likely to go bankrupt in the first years of their existence. Thus, it is reasonable to argue that λ is positively correlated with the age and the size of the entrant. [13]

Then, our analysis suggests that a young firm will find it optimal to give confidential information to only a few banks. From Lemma 1 we know that n_c is nondecreasing in λ. This means that an older firm seeking finance will contact more banks. If λ lies above a certain level, the firm does not have to convince its creditors. Thus, for λ large enough the firm does not give any confidential information to banks. We conclude that over time a firm's relationships to banks should become less close and the number of bank relationships should increase (see Fig. 2). Over the course of their lives firms emancipate themselves from their creditors and then maintain a significant number of loose relationships to induce competition among lenders.

Empirical studies are consistent with the implications of our model. Harhoff and Körting (1998) find that in their sample of smaller German companies the number of creditors increases in firm age and firm size. Ongena and Smith (2000) study the number of bank relationships using a data set including a sample of large European firms. They, as well as Petersen and Rajan (1994), also document a positive relationship between the number of creditors and firm size. Using Portuguese data Farinha

[13] Additional arguments can be made for the negative correlation of age and size with the probability of default. For example, a company of a sufficient size may be "too big to fail" because of government intervention.

and Santos (2002) find that nearly all firms borrow for the very first time in their life from a single bank. Many of them establish multiple lending relationships later on.

4.2.2. Duration of bank relationships

Capturing the concept of closeness of bank relationships directly is difficult, since the information transfer from borrower to lender is normally not observable. The closeness of a bank relationship is, however, related to its duration. Revealing information to a bank makes it more costly to replace this relationship since doing so introduces additional cost of information transmission. Thus, a longer bank relationship is an indicator for a closer one. Ongena and Smith (2001) study the length of bank relationships. They document that firms with multiple bank relationships tend to terminate a relationship sooner than those with single relationships, which is consistent with our results. [14]

4.2.3. Bank relationships in different industries

The ex ante perception of the quality of a prospective borrower does not only depend on individual characteristics of the company but also on the prospects of the industry. Given that industries differ in their prospects, bank relationships should vary systematically with industry. Since λ characterizes ex ante prospects, our approach predicts that in industries with ex ante worse prospects rely on fewer bank relationships than their counterparts with better prospects, all else equal. [15]

4.3. Structure of the banking sector

If the probability that any one bank transmits information to the incumbent, Q, increases, the expected profit of the entrant when disclosing its confidential information decreases. However, we are unable to derive a cutoff level $\overline{Q}$ such that for all $Q < \overline{Q}$ ($Q > \overline{Q}$) the entrant provides (does not provide) banks with confidential information. If λ is sufficiently small, the entrant provides banks with confidential information in case Q is equal to 1.

Proposition 3. *Let $\Theta(Q)$ be the set of parameters $X^{\mathrm{H}} - X^{\mathrm{L}}$, λ, a, b for which the entrant weakly prefers not to provide banks with its confidential information if the probability that any one bank has given a loan to the incumbent is Q. Then,*

$$\Theta(Q_{\mathrm{L}}) \subset \Theta(Q_{\mathrm{H}}) \quad \forall 0 \leqslant Q_{\mathrm{L}} < Q_{\mathrm{H}} \leqslant 1.$$

[14] They also find that small, young and highly leveraged firms tend to switch bank relationships more often. This seems to be inconsistent with our model's implications. This result may, however, be caused by concerns by these firms to find funding at all (see Foglia et al. (1998) and Harhoff and Körting (1998), which we exclude for tractability reasons in our analysis).

[15] Our model assumes that the ex post, i.e., after a creditworthiness test, prospects of good companies are similar. This is generally not the case for companies in different industries. Rather our approach then suggests that companies in industries that can reduce the uncertainty more by disclosing information will choose fewer bank relationships.

The entrant's expected profit when providing banks with confidential information decreases if the probability that any one bank transmits information to the incumbent, Q, increases. If the entrant keeps its information private, its expected profit does not depend on this probability. As a consequence, the willingness to disclose confidential information decreases in Q, which is stated in Proposition 3. Considering the analysis so far, this may not be a surprising result, but it allows us to make a few statements about the optimal structure of the banking sector.

4.3.1. Consequences of bank concentration

The likelihood that a bank transmits information is larger if it has a business relation with the incumbent. The probability that any one bank has given a loan to the incumbent depends on the number of banks in the economy. If there are very few banks in the banking sector, then it is likely that competing firms deal with the same bank. In this case the expected loss due to information transmission will be relatively high. However, if the banking sector is not very concentrated, i.e., if there are a many independent banks providing financing, it is unlikely that competing firms obtain loans from the same banks. Hence, in this case the expected cost of information transmission will be low.

Using these results, the analysis reveals two potential sources of benefits a lesser concentrated banking sector provides to an economy. Firms incur costs if their revenues from output market operations decline in the case of an information transmission. In an economy with relatively few banks, the probability that any one bank transmits information is high. Hence, the entrant's expected profit when disclosing confidential information increases with the number of banks in the economy. However, there is an additional negative effect associated with a concentrated banking sector. If there are only a few banks, the entrant has a strong incentive to not provide banks with confidential information. This means that banks face higher screening costs and find it more difficult to assess the quality of borrowers. This implies that a larger number of projects with a negative net present value are financed which is socially inefficient. Thus, our analysis indicates that a more dispersed banking sector may be better able to perform its role as an institutional arrangement that channels funds into its most productive use, because more information is disclosed to the banking sector. [16]

4.3.2. Information sharing among banks

Our analysis has also implication for the nature of information banks share about their commercial customers. Information sharing among banks has benefits. For example, information sharing tends to homogenize the information on which banks

[16] Please note that this argument is derived in an environment in which credit is available even without disclosing private information to banks. The relevance of the argument is diminished when firms have to disclose information in order to obtain credit at all. Thus, the argument is strongest in better times of an economy. Especially when credit availability is an issue, bank concentration may have positive effects (see Bonaccorsi di Patti and Dell'ariccia, 2001). Black and Strahan (2002) document, however, that a high level of bank concentration has a negative effect on the rate of new business incorporations.

base their lending decisions and thus can increase bank competition (see Padilla and Pagano, 1997). However, as our approach demonstrates, sharing output market sensitive information among banks is counterproductive. Borrowers will in many occasions refuse to disclose confidential information if this is to be shared with other lenders. This might explain why even relatively extensive information sharing arrangements are confined to past defaults and rather general characteristics like business sector, overall debt exposure as well as family and job history (see for example Japelli and Pagano, 1999).

5. Conclusion

In this paper we model important aspects of the financing strategy of a firm which relies on bank debt. We determine not only the number of bank relationships to establish but also how close these relationships should be in terms of providing banks with confidential information. Both decisions are driven by the tradeoff between financial performance and output market success. If a firm discloses confidential information to banks, these can more precisely evaluate its default risk. Disclosing confidential information thus reduces interest rates but possibly impairs output market profitability, since the information may be transmitted to competitors. The analysis implies that ceteris paribus the number of bank relationships increases in firm age and firm size. The model also predicts a U-shaped relationship between innovativeness and the number of bank relationships. In addition to these empirically testable implications, the model sheds some light on the negative effects of a highly concentrated banking sector.

The tradeoff between the benefits and costs of providing banks with confidential information can potentially be used beyond the analysis presented in this paper. The approach may shed some light on why some borrowers prefer a large syndicated loan to several smaller loans. One large loan may allow a borrower to commit to an information disclosure policy that treats lenders differently. For example, the lead manager of the loan syndicate may obtain more information than other lenders in order to minimize the cost of information transmission.

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Appendix A

Proof of Lemma 1. By assumption, n_c is positive. From Eq. (3) follows that the entrant's expected profit goes to minus infinity if n goes to infinity. Hence n_c is an interior solution with $0 < n_c < \infty$.

Now, we redefine $\overline{C} = -C$, $\overline{Q} = -Q$ and $(\overline{X^{\mathrm{H}} - X^{\mathrm{L}}}) = -(X^{\mathrm{H}} - X^{\mathrm{L}})$. Then, for $\theta_{\mathrm{c}} = \lambda, b, \overline{C}, \overline{Q}, (\overline{X^{\mathrm{H}} - X^{\mathrm{L}}})$ the derivative $\frac{\partial^2 \Pi_{\mathrm{c}}(r_{\mathrm{c}}(n),n)}{\partial n \partial \theta_{\mathrm{c}}}$ is strictly positive. This means that $\Pi_{\mathrm{c}}(r_{\mathrm{c}}(n), n)$ has nondecreasing differences in λ, b, $(\overline{X^{\mathrm{H}} - X^{\mathrm{L}}})$, $\overline{C}$ and $\overline{Q}$.

Since there exists a finite n_{c} larger than 0 which maximizes $\Pi_{\mathrm{c}}(r_{\mathrm{c}}(n), n)$ we know from Milgrom and Shannon (1994) that n_{c} is nondecreasing in λ and b, and nonincreasing in C, Q and $(X^{\mathrm{H}} - X^{\mathrm{L}})$. □

Proof of Lemma 2. We neglect that the number of banks, n, has to be an integer value. Given the entrant does not provide (provides) banks with confidential information the marginal effect of an increase of the number of banks is

$$\frac{\partial \Pi_{\mathrm{p}}(r_{\mathrm{p}}(n), n)}{\partial n} = \frac{b}{(n+1)^2} - C, \tag{A.1}$$

$$\frac{\partial \Pi_{\mathrm{c}}(r_{\mathrm{c}}(n), n)}{\partial n} = \lambda (1-Q)^n \log(1-Q)(X^{\mathrm{H}} - X^{\mathrm{L}}) + \lambda \frac{b}{(n+1)^2} - C. \tag{A.2}$$

Compare Eqs. (A.1) and (A.2). The maximization of $\Pi_{\mathrm{p}}(r_{\mathrm{p}}(n), n)$ is a convex optimization problem. Hence $\frac{\partial \Pi_{\mathrm{p}}(r_{\mathrm{p}}(n),n)}{\partial n}\big|_{n=\bar{n}} < 0$ implies that $\frac{\partial \Pi_{\mathrm{p}}(r_{\mathrm{p}}(n),n)}{\partial n}\big|_{n=\hat{n}} < 0$ for all $\hat{n} > \bar{n}$. In (A.2), the term $\lambda(1-Q)^n \log(1-Q)(X^{\mathrm{H}} - X^{\mathrm{L}})$ is smaller than zero for all $n \geqslant 0$. Since λ is smaller than 1, it follows from $\frac{\partial \Pi_{\mathrm{p}}(r_{\mathrm{p}}(n),n)}{\partial n}\big|_{n=\bar{n}} < 0$ that $\frac{\partial \Pi_{\mathrm{c}}(r_{\mathrm{c}}(n),n)}{\partial n}\big|_{n=\hat{n}} < 0$ for all $\hat{n} > \bar{n}$. This implies that n_{c} is smaller than or equal to n_{p}. □

Proof of Proposition 1. If we define $\Delta = X^{\mathrm{H}} - X^{\mathrm{L}}$ as the difference between the expected revenue of the entrant when not disclosing information and disclosing information, $\Pi_{\mathrm{p}}(r_{\mathrm{p}}(n_{\mathrm{p}}), n_{\mathrm{p}}) - \Pi_{\mathrm{c}}(r_{\mathrm{c}}(n_{\mathrm{c}}), n_{\mathrm{c}})$ can be written as

$$\lambda(1 - (1-Q)^{n_{\mathrm{c}}})\Delta - \left(a + \frac{b}{n_{\mathrm{p}}+1}\right) - n_{\mathrm{p}} C + \lambda\left(a + \frac{b}{n_{\mathrm{c}}+1}\right) + n_{\mathrm{c}} C. \tag{A.3}$$

Notice that (A.3) is positive for sufficiently large Δ. Since $\lambda < 1$, (A.3) is negative for $\Delta = 0$. Thus, to show that there exists a cutoff level, $\overline{\Delta}$, such that (A.3) is positive for all $\Delta > \overline{\Delta}$ and negative for all $\Delta < \overline{\Delta}$, it remains to be shown that (A.3) is increasing in Δ.

Given that (A.3) depends only on Δ and not on X^{H} or X^{L} individually, we can w.l.o.g. assume that an increase in Δ is caused by a decrease in X^{L} while X^{H} remains constant. In this case $\Pi_{\mathrm{c}}(r_{\mathrm{c}}(n_{\mathrm{c}}), n_{\mathrm{c}})$ must decrease in Δ, because a firm with a larger X^{L} can always achieve a higher profit than one with a ceteris paribus lower X^{L} by choosing the same n_{c}. Since $\Pi_{\mathrm{p}}(r_{\mathrm{p}}(n_{\mathrm{p}}), n_{\mathrm{p}})$ is unaffected by such an increase in Δ, (A.3) is strictly increasing in Δ. □

Proof of Proposition 2. We demonstrate that for an increase of λ from $\hat{\lambda}$ to $\bar{\lambda}$ the increase of the entrant's expected profit, $\Pi_{\mathrm{p}}(r_{\mathrm{p}}(n_{\mathrm{p}}), n_{\mathrm{p}})$, when not disclosing information is higher than the increase of the entrant's expected profit, $\Pi_{\mathrm{c}}(r_{\mathrm{c}}(n_{\mathrm{c}}), n_{\mathrm{c}})$, if it provides banks with confidential information.

Let $\hat{n}_c$ ($\bar{n}_c$) be the number of banks the entrants approaches if it provides banks with confidential information and if $\lambda = \hat{\lambda}$ (if $\lambda = \bar{\lambda}$). We know from Lemma 1 that $\hat{n}_c \leqslant \bar{n}_c$. If the entrant does not provide banks with confidential information, the number of banks, n_p, the entrant asks for a loan is independent of λ.

If λ increases from $\hat{\lambda}$ to $\bar{\lambda}$, the increase in the entrant's expected profit, if it keeps its information private is

$$(\bar{\lambda} - \hat{\lambda})X^H. \tag{A.4}$$

If the entrant gives its information to banks its expected profit increases by

$$\begin{aligned}&\bar{\lambda}\left(X^L + (1-Q)^{\bar{n}_c}(X^H - X^L) - a - \frac{b}{\bar{n}_c + 1}\right) - \bar{n}_c C\\ &\quad - \hat{\lambda}\left(X^L + (1-Q)^{\hat{n}_c}(X^H - X^L) - a - \frac{b}{\hat{n}_c + 1}\right) - \hat{n}_c C\end{aligned} \tag{A.5}$$

if λ increases from $\hat{\lambda}$ to $\bar{\lambda}$. We now derive an upper bound for this difference. We know that $\hat{n}_c$ maximizes the entrant's optimization problem if $\lambda = \hat{\lambda}$. Thus, it is

$$\begin{aligned}&\hat{\lambda}\left((1-Q)^{\hat{n}_c}(X^H - X^L) - \frac{b}{\hat{n}_c + 1}\right) - \hat{n}_c C\\ &\quad \geqslant \hat{\lambda}\left((1-Q)^{\bar{n}_c}(X^H - X^L) - \frac{b}{\bar{n}_c + 1}\right) - \bar{n}_c C.\end{aligned}$$

From this inequality it follows that

$$\begin{aligned}&\hat{\lambda}\left((1-Q)^{\hat{n}_c}(X^H - X^L) - \frac{b}{\hat{n}_c + 1}\right)\\ &\quad \geqslant \hat{\lambda}\left((1-Q)^{\bar{n}_c}(X^H - X^L) - \frac{b}{\bar{n}_c + 1} - \bar{n}_c C + \hat{n}_c C\right).\end{aligned}$$

From this inequality it follows that (A.5) does not exceed

$$(\bar{\lambda} - \hat{\lambda})\left(X^L + (1-Q)^{\bar{n}_c}(X^H - X^L) - a - \frac{b}{\bar{n}_c + 1}\right). \tag{A.6}$$

It is $(1-Q)^{\bar{n}_c} < 1$ and $-a - \frac{b}{\bar{n}_c+1} < 0$. This implies that (A.6) is smaller than (A.4). Thus, $\Pi_p(r_p(n_p), n_p) - \Pi_c(r_c(n_c), n_c)$ increases if λ increases.

It remains to be shown that λ sufficiently close to 0 (λ sufficiently close to 1) implies that the entrant provides (does not provide) banks with confidential information. The difference $\Pi_p(r_p(n_p), n_p) - \Pi_c(r_c(n_c), n_c)$ is

$$\lambda(1 - (1-Q)^{n_c})(X^H - X^L) - \left(a + \frac{b}{n_p + 1}\right) + \lambda\left(a + \frac{b}{n_c + 1}\right) - (n_p - n_c)C.$$

This expression is negative for λ sufficiently close to zero, which implies that the entrant provides banks with confidential information. If λ is sufficiently close to 1, this difference is positive because the firm can achieve a higher profit when not providing private information to banks by choosing $n_p = n_c$. Then, the difference between the expected repayment for the loan, $r_{\mathrm{p}}(n_{\mathrm{p}}) - r_{\mathrm{c}}(n_{\mathrm{c}})$, goes to zero and $(n_{\mathrm{p}} - n_{\mathrm{c}})C = 0$. However, the cost of information transmission is still positive. □

Proof of Proposition 3. The entrant weakly prefers not to provide the banks with confidential information if the difference between the expected profit of the entrant when not providing banks with confidential information, $\Pi_{\mathrm{p}}(r_{\mathrm{p}}(n_{\mathrm{p}}), n_{\mathrm{p}})$, and the expected profit of the entrant if it discloses confidential information to banks, $\Pi_{\mathrm{c}}(r_{\mathrm{c}}(n_{\mathrm{c}}), n_{\mathrm{c}})$, is larger than or equal to zero. Thus, to prove the proposition it is sufficient to show that for any constellation of parameters $\Pi_{\mathrm{p}}(r_{\mathrm{p}}(n_{\mathrm{p}}), n_{\mathrm{p}}) - \Pi_{\mathrm{c}}(r_{\mathrm{c}}(n_{\mathrm{c}}), n_{\mathrm{c}})$ increases as Q increases. Since $\Pi_{\mathrm{p}}(r_{\mathrm{p}}(n_{\mathrm{p}}), n_{\mathrm{p}})$ does not depend on Q, this holds if $\Pi_{\mathrm{c}}(r_{\mathrm{c}}(n_{\mathrm{c}}), n_{\mathrm{c}})$ is decreasing in Q.

It is $\overline{Q} < \widehat{Q}$. Let $n_{\mathrm{c}} = \bar{n}_{\mathrm{c}}$ ($n_{\mathrm{c}} = \hat{n}_{\mathrm{c}}$) be the number of banks the entrant asks for a loan if $Q = \overline{Q}$ (if $Q = \widehat{Q}$). This implies that

$$\begin{aligned}
\Pi_{\mathrm{c}}(r_{\mathrm{c}}(n_{\mathrm{c}}), n_{\mathrm{c}})|_{Q=\overline{Q}} &= \lambda X^{\mathrm{L}} + \lambda(1-\overline{Q})^{\bar{n}_{\mathrm{c}}}(X^{\mathrm{H}} - X^{\mathrm{L}}) - \frac{\lambda b}{\bar{n}_{\mathrm{c}}+1} - \bar{n}_{\mathrm{c}}C \\
&\geqslant \lambda X^{\mathrm{L}} + \lambda(1-\overline{Q})^{\hat{n}_{\mathrm{c}}}(X^{\mathrm{H}} - X^{\mathrm{L}}) - \frac{\lambda b}{\hat{n}_{\mathrm{c}}+1} - \hat{n}_{\mathrm{c}}C \\
&> \lambda X^{\mathrm{L}} + \lambda(1-\widehat{Q})^{\hat{n}_{\mathrm{c}}}(X^{\mathrm{H}} - X^{\mathrm{L}}) - \frac{\lambda b}{\hat{n}_{\mathrm{c}}+1} - \hat{n}_{\mathrm{c}}C \\
&= \Pi_{\mathrm{c}}(r_{\mathrm{c}}(n_{\mathrm{c}}), n_{\mathrm{c}})|_{Q=\widehat{Q}}.
\end{aligned}$$

We see that $\Pi_{\mathrm{c}}(r_{\mathrm{c}}(n_{\mathrm{c}}), n_{\mathrm{c}})$ is strictly decreasing in Q. □

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