NIBM WORKING PAPER SERIES

Relationship Banking, Monitoring Costs and Loan Recovery: A Matching Model

Sanjay Basu
Swapnendu Bandyopadhyay (Banerjee)

Working Paper
(WP 14/2022)

NATIONAL INSTITUTE OF BANK MANAGEMENT
Pune, Maharashtra, 411048
INDIA
April 2022

Citation Guideline:
Sanjay Basu and Swapnendu Bandyopadhyay (Banerjee) (2022), "Relationship Banking, Monitoring Costs and Loan Recovery: A Matching Model", NIBM Working Paper Series, WP 14/April 2022.
https://www.nibmindia.org/static/working_paper/NIBM_WP14_SBSB.pdf

Relationship Banking, Monitoring Costs and Loan Recovery: A Matching Model
Sanjay Basu and Swapnendu Bandyopadhyay (Banerjee)
NIBM Working Paper No. 14
April 2022

Abstract

Much of the literature on banking focuses on the value of relationship loans to low-quality firms. However, we show that under private information and incomplete contracts, bank-firm matching may be *positively assortative*. If the costs of monitoring a low quality borrower are higher than the subsequent gain from pairing with it, banks may prefer higher types. The result is reinforced if relationship specific investments and loan recovery rates are noncontractible.

Keywords: Specific investments; asymmetric information; loan recovery.

JEL Classification: C78, G21, G28, L22

We thank Tasneem Chherawala, Partha Ray and Smita Roy Trivedi for their comments and suggestions. The usual disclaimer applies.

Sanjay Basu (corresponding author)
National Institute of Bank Management, Pune, India
e-mail: sanjaybasu@hotmail.com

Swapnendu Bandyopadhyay (Banerjee)
swapnendu@hotmail.com

Relationship Banking, Monitoring Costs and Loan Recovery:
A Matching Model

Introduction

Much of the literature on banking focuses on the value of relationship loans to low-quality firms. Banks interact with firms repeatedly and develop costly expertise, to understand better the nature of their businesses. As a result of such *relationship-specific* investments, they are able to enhance the productivity of their borrowers in good times and reduce the chances of distress. This means that, over time, both parties have a bigger pie to share. Therefore, more efficient banks prefer lower quality firms, from whom they can get higher returns. In other words, bank-firm matching is *negatively assortative*.

However, this fails to explain why the majority of small and medium firms do not have access to bank credit in most developing countries. If they are credit riskier, as the literature suggests, it should be in the interest of the most efficient banks to form durable relationships with them. Similarly, why are banking crises frequently associated with credit crunches? Why can't banks focus on small and medium firms, who are likely to generate higher value for them during troubled times?

We try to answer these questions in terms of *monitoring costs*. We show that, under private information and incomplete contracts, bank-firm matching may be *positively assortative*. In our model, the quality of each borrower has to be evaluated even after banks make relationship-specific investments. If the cost of monitoring a low quality borrower is higher than the subsequent gain from pairing with it, banks may prefer higher borrower types. The result is reinforced if investments are noncontractible as well. If banks are not sure of reaping the marginal returns from their investments, because of a hold up problem, they are likely to underinvest in value added services.

Our paper contributes to three strands of literature. First, we show that negatively assortative matching, between banks and firms, is an artifact of complete information and investment contractability. In countries with chronic information acquisition and contract enforcement problems, mutually beneficial relationships may occur between good banks and firms. This implies a major role for institutional reforms, which improve systems for information transmission and contract enforcement, for increasing access to credit.

As far as we know, this is the first paper to combine relationship lending, bank-firm matching and monitoring costs. The nascent literature on monitoring investigates primarily the factors that determine a bank's ability to monitor, namely distance from the borrower and the number and length of relationships, prior to loan applications. In contrast, our paper examines the impact of contracting problems and monitoring costs, comprising both systemic and borrower-specific factors, on the level of relationship-specific investments and the type of firms chosen by banks.

Secondly, our results shed light on the oft-observed *flight to quality* in stressed markets. In the first-best equilibrium, when borrower type is common knowledge and contracts can be smoothly enforced, banks prefer lower-quality assets which generate higher returns. But, when crisis strikes, the uncertainty about asset quality increases and contracts with counterparties are harder to execute. In such an environment, all banks may prefer the safest assets, despite their lower returns. This is exactly what we observe in the second-best outcome.

We begin with a survey, in section 1, to relate our paper to the existing literature. In section 2, we show how perfect information and contractibility allow good firms and bad banks to form efficient relationships. In section 3, we study the impact of monitoring costs on the relationship loan market. In section 4, we examine the implications of loan recovery and noncontractible investments, on relationship loans between banks and firms. In section 5, we summarize results and discuss policy implications and directions for future research.

1. The Related Literature

A large literature explores why contracts could be *incomplete*, i.e. with gaps or missing provisions subject to future renegotiation (Hart 1995). Our paper is based on both *co-operative*, relationship-specific, investments and asymmetric information. Co-operative investments confer direct benefits on the trading partner but not the investing party. The possibility of ex-post renegotiation could then destroy all investment incentives (Che & Hausch 1999, de Sousa & Fairise 2014). For instance, an investment in quality improvement directly benefits the buyer (who gets a product of better quality) but not the seller himself. If the uninformed buyer is expected to bargain hard, rather than pay as per quality, the informed seller might not want to invest and improve quality at all.

A possible solution to these underinvestment problems is a binding commitment to non-renegotiation, in the form of a fine payable upon breach to a third party. However, since the third party could, in principle, collude with either of the contractants, Maskin & Tirole (1999) suggest that the fine be paid to a community, whose collective temptation to collude is much less. But, the problem (Hart & Moore 1999) is that the community, as a whole, is not a party to the contract. So, it cannot enforce the fine in case of a breach. Any representative, as a signatory or a collector, is also open to collusion.

In this paper, we analyze co-operative investments in the context of relationship banking. There are three salient features of such banking: *(a)* the bank gathers much more customer-specific information, than what is publicly available, *(b)* information is gathered through multiple interactions with the same borrower, over time and/or across financial services, and *(c)* the information remains confidential. In our model, monitoring is the sum total of all costly processes for collecting and processing information on borrower quality. In contrast, transaction banking refers to a single transaction with a customer or multiple identical transactions with different customers, as in brokerage services for investment banking (Boot 2000).

Much of the literature on relationship loans discusses why they are better than arms–length lending: *(i)* superior credibility of banks *vis-à-vis* individuals for processing 'soft' information for benefit of firms, *(ii)* the reputational rents from repeated interactions, and *(iii)* the ability to specialize in renegotiation (Boot and Thakor [2010], Allen and Carletti [2010]). We extend the work of Boot and Thakor (2000), in which a relationship loan is a specialized input by banks, to raise firm productivity[1], in a world of asymmetric information and incomplete contracts.

Many papers argue that banks should offer relationship loans to bad firms and transaction loans to good firms. The logic is that since they focus on loan renegotiation (Chemmanur & Fulghieri 1994) or sectoral expertise (Boot & Thakor 2000) primarily to avoid distress, banks can generate more returns and earn more on relationship loans to bad firms. Similarly, Dam (2014) develops a matching model in which more efficient banks monitor harder, to convert the potential private benefits of low net worth firms into higher returns for themselves. Therefore, in equilibrium, firm-bank matching is *negatively assortative*.

A small literature also claims that relationship banks are better at monitoring borrowers. This could be due to two reasons. First, the physical distance between the bank and the borrower is short, enabling the local bank to collect 'soft' information about the project more easily than distant rivals (Hauswald and Marquez 2006, Agarwal and Hauswald 2010). Secondly, banks may have prior relationships with their customers, e.g. in the form of savings accounts, before they apply for loans. The nature, length and scope of these existing relationships help banks assess borrower types better (Puri et. al. 2013).

There is a large and older literature on credit rationing in developing countries, owing to asymmetric information and contract enforcement problems. Ray (1998, ch. 14) discusses these issues in great detail, highlighting the costly and lengthy monitoring processes in making loans. He shows how high levels of uncertainty about borrower quality can lead to credit rationing, despite excess demand and an opportunity to raise interest rates. He also examines the role of collateral and interlinked transactions as possible solutions.

There is also a large literature on *flight to quality* during financial crises. As uncertainty about asset quality increases, the demand for credit–risky products vanishes and investors hold only on-the-run government bonds, treasury bills and cash. With the collapse of credit-risky assets, secured funding is no longer available and money markets seize up. Indeed, Cechetti (2008), Bernanke (2009) and Acharya et.al. (2009) discuss at length how the Fed Reserve and Bank of England bailout policies tried to restore the credibility of credit-risky collateral and kickstart the money markets. In sum, private information and contracting issues often lead to choice of safe assets with low yields.

2. Symmetric Information and Complete Contracts

There are N banks and K firms in the economy. Without loss of generality, we assume K>N. Both parties are risk-neutral. A firm does not have any fund of its own and must borrow from (at least) one bank to finance a two-period project. The project costs Rs. *I* and can be financed by (a) a relationship loan or by (b) a transaction loan. With a transaction loan, the project returns *Y* with probability θ_i and 0 with probability $(1-\theta_i)$

[1] On the ability of relationship loans to rescue firms from financial crises, help them grow faster and achieve higher profitability, see Cotugno et. al. (2013), Rosenfeld (2014), Dewally and Shao (2014)

where θ_i is the observable quality of the firm. We assume that firms are of K types, i.e. $\theta_i \in \{\theta_1, \theta_2, \ldots.., \theta_K\}$. Without loss of generality we assume that $\theta_1 > \theta_2 > \ldots\ldots.. > \theta_K$.

With a relationship loan, the project returns *Y* with probability $\lfloor \theta_i + v_j(1-\theta_i) \rfloor$ and zero with probability $[1-\theta_i][1-v_j]$. The variable *vj* refers to the value a bank adds to its relationship borrower. It captures the degree of sector specialization i.e. the extent to which a loan is customized. Formally, $v_j = \gamma_j v_H$ where $v_H > 0$. Here, $\gamma_j = 1$ denotes maximum specialization such that $v_j = v_H$ while $\gamma_j = 0$ indicates no specialization such that $v_j = 0$. In other words, for any θ, the income lottery with relationship banking first order stochastically dominates (FOSD) the income lottery without relationship banking[2].

The cost of specialization is given by $C_j(\gamma)$ with $C_j' > 0$, $C_j'' > 0$. Specifically we have $C_j(\gamma_j) = \frac{c_j \gamma_j^2}{2}$ where c_j is the observable type of bank *j*. We assume that banks are of N types, i.e. $c_j \in \{c_1, c_2, c_3, \ldots\ldots, c_N\}$. The more efficient bank *j* is at specialization, the lower is c_j. Again, without loss of generality, we assume that $c_1 < c_2 < c_3 < \ldots\ldots\ldots < c_N$.

In the first-best, we assume that γ_j is contractible. Our focus is on single, rather than multiple, relationships. This assumption of complete lock-in shows that asset specificity is costly for banks. In other words, following Roth and Sotomayor (1989), we denote this process as a case of one-to-one matching. A technical definition of one-to-one matching is given below:

Definition: A **one-to-one matching** is a mapping $\mu : \Theta \cup \xi \to \Theta \cup \xi$ such that (i) $\mu(\theta_i) \in \xi \cup \theta_i$ for all $\theta_i \in \Theta$ (ii) $\mu(c_j) \in \Theta \cup c_j$ for all $c_j \in \xi$ and (iii) $\mu(\theta_i) = c_j$ if and only if $\mu(c_j) = \theta_i$ for all $(\theta_i, c_j) \in \Theta \times \xi$.

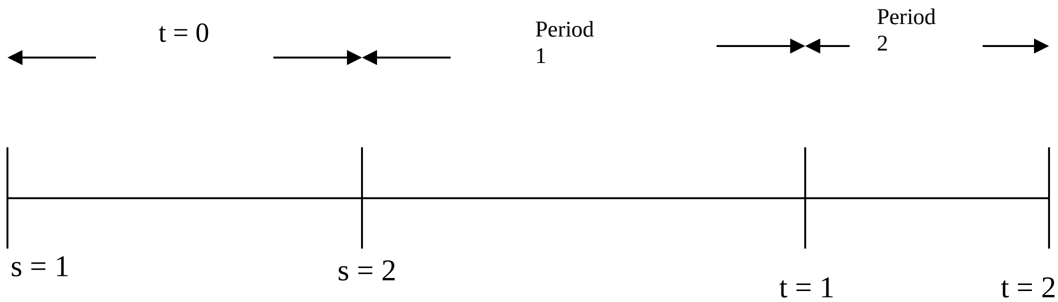
The function μ assigns each firm (bank) to only one bank (firm). It allows for the possibility that a firm (bank) may remain unmatched, in which case it is matched to itself. A firm (bank) is said to be unmatched if $\mu(\theta_i) = \theta_i$ $\{\mu(c_j) = c_j\}$. In our model, when a firm and bank are matched, we say that they trade in a relationship loan. When they are unmatched, we say that they trade in a transaction loan.

2.1. The First-Best Equilibrium:

Ideally, under full information, the project should continue when it is successful and be liquidated when it is not. This means that the bank is able to recover only a liquidation value *L* from an unsuccessful project and *L< I <Y*. Continuation or liquidation occurs at the end of period 1 i.e. at *t=1*. Liquidation will play an important role later in our analysis, when the recovery rate will be assumed as noncontractible. For simplicity we assume that *L=αY*. The project returns *Y* or *L* at the end of period 2 i.e. at *t=2*. Contracting, relationship-specific investments and lending involve a sequential (three-

[2] Alternatively, since $[1-\theta_i]$ is the probability of default (PD) with transaction lending and $[1-\theta_i][1-v_j]$ is the PD with relationship lending, we can say that relationship banking reduces the PD of a loan.

stage) process at the beginning of period 1, i.e. at *t=0*. The time line of events is as follows:



s =1: Banks and firms are matched and parties write loan contracts.

s=2: Banks make relationship-specific investments.

t =1: Project Continuation.

t =2: Payoffs Realized.

Given the specialization costs of banks, the joint surplus between a firm of type θ_i and a bank of type c_j is as follows:

$$S_R(\gamma) = [\theta_i + v_j(1-\theta_i)][Y - I] - [1 - v_j][1-\theta_i][I] - \frac{c_j \gamma_j^2}{2} \qquad (1)$$

From such a surplus function, we get

Result 1: ***With known agent types and contractible investments, cet. par.,***

(i) ***The less efficient a bank, the lower is sector specialization.***

(ii) ***The higher is borrower quality, the lower is sector specialization.***

Proof: Substituting for v_j, the joint surplus function becomes

$$S_R(\gamma) = [\theta_i + \gamma_j v_H(1-\theta_i)][Y - I] - [1 - \gamma_j v_H][1-\theta_i][I] - \frac{c_j \gamma_j^2}{2} \text{ (1a)}$$

Differentiating the surplus function w.r.t. γ_j yield respectively

$$\frac{\partial S_R(\theta_i, c_j)}{\partial \gamma_j} = 0 \Rightarrow \gamma_j{*} = \frac{(1-\theta_i)[v_H][Y]}{c_j}$$

From equation (2) we have results (i) and (ii).

The results are quite intuitive. First, given any surplus-sharing rule, since a relatively inefficient bank (with higher c_j) is more cost-constrained, it has a lower specialization level γ_j*. Secondly, a share of the higher value added to lower quality borrowers is an incentive, for any bank, to increase investment levels as θ_i declines.

It is clear that high-quality banks can make lower-cost investments. But, firms benefit more from transaction loans as well. However, we show that though all firms prefer relationships to transaction loans, better banks will offer relationship loans to low-quality firms, in the first-best equilibrium.

Result 2:

In a world with symmetric information and contractible investments, relationship lending occurs between good quality banks and low-type firms. The best firms get transaction loans.

Proof: See Appendix A.

Result 2 follows from the fact that, for any bank, the optimal excess surplus from a relationship loan rises more than proportionately with a decline in its partner's quality. The marginal gain from a match with a lower type exceeds the loss from a breakup with a higher type. Every bank will then try to pair up with the least efficient firm. Therefore, in equilibrium, the best bank will form a relationship with the worst firm. Given one-to-one matching the second best bank can only pair up with the second worst firm and so on.

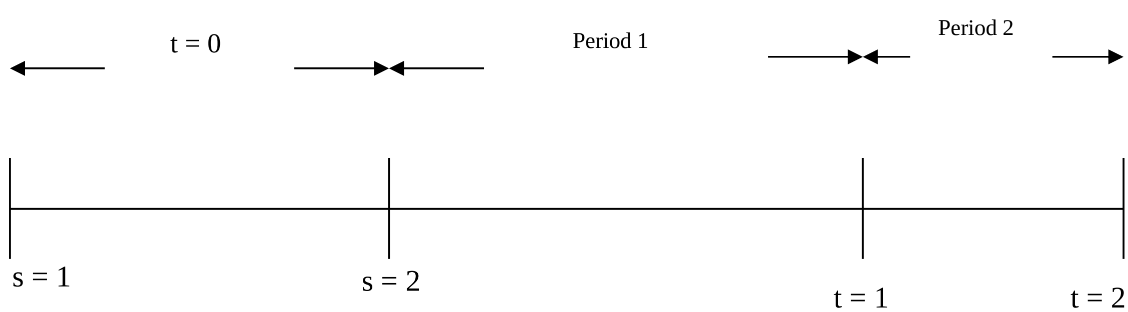
Therefore, in equilibrium, we find,

(i) **Relationship Banking** $\forall\ \theta_i < \theta_{N-K}$ **.**

(ii) **Transaction Loans** $\forall\ \theta_1 > \theta_i \ge \theta_{N-K}$ **[3].**

3. Monitoring Costs

In this section, we introduce the possibility of monitoring borrowers. Monitoring stands for all postcontractual activities (like assessment of borrower quality and collateral value) by banks. In other words, monitoring enables banks to estimate changes in Probability of Default (PD) and Loss Given Default (LGD), after loans are made.



The modified time line appears as follows:

s =1: Banks and firms are matched and parties write loan contracts.
s=2: Banks make relationship-specific investments and monitor loans.
t =1: Project Continuation/Liquidation.
t =2: Payoffs Realized.

[3] We assume that $\theta_K \ge \frac{I}{Y}$, i.e. even the worst firm gets some surplus from a transaction loan.

3.1. Monitoring costs

However, monitoring is a costly process. In our model, the cost of monitoring is given by:

$$m(\theta_i, c_j) = m\gamma_j (1-\theta_i)^2 \quad \forall\, \gamma_j \geq 0 \quad \text{..........................(3)}$$

The monitoring cost function has three components. The first factor, *m*, is common to all banks. It captures the extent of financial market development in a country. As bond and equity markets become deeper and more liquid, the value of *m* falls and all banks find it easier to assess firm quality[4]. Financial sector reforms that reduce *m* confer positive externalities on the entire banking industry.

The second component, γ_j, is bank-specific. This means that a bank invests not only to add value to borrowers, as originally conceived by Boot and Thakor (2000), but also to assess their qualities. Some banks have better credit processing skills than others, just like sector specialization, so they can invest in monitoring at lower cost.

The third factor, $(1-\theta_i)^2$, is firm-specific. It implies that there is an inverse and non-linear relationship between borrower type, θ_i, and monitoring costs. The intuition is that low type borrowers are more difficult to monitor because either their quality is more unstable (and prone to deterioration) or they cannot furnish proper collateral (i.e. higher LGD)[5]. Monitoring cost, in our model, is a proxy for (or proportional to) future losses from different borrower types[6].

3.2. The second-best equilibrium

After including monitoring costs, the joint surplus function[7] between a firm of type θ_i and a bank of type c_j is as follows:

$$S_R(\gamma_j) = [\theta_i + v_j(1-\theta_i)][Y-I] - [1-v_j][1-\theta_i][I] - m\gamma_j(1-\theta_i)^2 - \frac{c_j \gamma_j^{\,2}}{2} \qquad (4)$$

From such a surplus function, we get

[4]There is a large class of models that use bond and equity market data to estimate PD. For a lucid and exhaustive coverage of these models, see Resti and Sironi (2007, Ch. 11).

[5] Rajan (2008, Ch. 3) discuss how small borrowers, who are apparently credit riskier, are rationed bank credit in India, despite the prevalence of priority sector lending norms for many decades.

[6]In the literature, the relationship between borrower PD, $(1-\theta_i)$, and credit risk is nonlinear. As PD rises, the recovery rate declines and Loss Given Default (LGD) goes up. Credit risk increases not only due to a rise in PD, but also a spike in LGD. This makes the credit loss estimates (e.g. Value-at-Risk) convex functions of borrower PD (Resti and Sironi 2007, Ch. 12).

[7] To focus only on the role of monitoring costs, we assume here that banks get all the returns from their investments and leave firms with the reservation utility of zero. We discuss the adverse impact of Nash bargaining, on sector specialization (γ_j), later in this section.

Result 3: ***In a model with monitoring costs, cet. par.,***

(i) The level of sector specialization falls below the first-best equilibrium level.

(ii) The level of sector specialization may increase with borrower quality.

Proof: Substituting for v_j, the joint surplus function becomes

$$S_R(\gamma) = [\theta_i + \gamma_j v_H (1-\theta_i)][Y - I] - [1 - \gamma_j v_H][1-\theta_i][I] - m\gamma_j (1-\theta_i)^2 - \frac{c_j \gamma_j^{\;2}}{2} \qquad (5)$$

Differentiating the surplus function w.r.t. γ_j yield

$$\frac{\partial S_R(\theta_i, c_j)}{\partial \gamma_j} = 0 \Rightarrow \gamma_j^{**} = \frac{(1-\theta_i)\{v_H Y - m(1-\theta_i)\}}{c_j} \quad \ldots\ldots\ldots\ldots\ldots(6)$$

From equation (6) we have the result.

The first result is quite intuitive. Given any surplus-sharing rule, a bank has to invest in costly monitoring before it can reap the benefits from a relationship loan. As its marginal gains from sector specialization decline after monitoring, for all borrower types, so does the optimal investment level. In fact, if the systemic component of monitoring cost (m) is high and/or borrower quality is low enough (i.e. $m(1-\theta_i) \geq v_H Y$), $\gamma_j^* = 0$ and the relationship loan market may collapse.

Next, just as in Section 2, we examine the relationship between borrower quality and bank investment levels. From equation 7, we have

$$\frac{\partial \gamma_j^{**}}{\partial \theta_i} = \left[\frac{(-v_H Y + 2m(1-\theta_i))}{c_j}\right] > 0 \quad iff \quad v_H Y < 2m(1-\theta_i) \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

The intuition for this result is also quite clear. As borrower quality, θ_i, rises, the marginal loss of income to a bank is $v_H Y$. The fall (marginal gain) in monitoring cost is $2m(1-\theta_i)$. If the decline in monitoring cost is more than the fall in income (i.e. $v_H Y < 2m(1-\theta_i)$), marginal profit from sector specialization will increase with borrower quality. Hence, as θ_i improves, γ_j^{**} will rise.

Put together, equations (6) and (7) imply that: (a) very low-quality borrowers, who are not monitored, get only transaction loans and (ii) banks may prefer to make relationship loans to high-quality borrowers who are relatively cheaper to monitor. This leads us to the following result:

Result 4: ***In a world of asymmetric information and monitoring costs, low-type borrowers get transaction loans. Positively assortative relationship lending occurs between intermediate-type banks and firms. Negatively assortative matching may occur between very high-quality banks and firms.***

Proof: See Appendix B.

Result 4 follows from the fact that, for any bank, the optimal excess surplus from a relationship loan may rise with an improvement in its partner's quality, if the monitoring costs are high enough. The marginal gain from a match with a higher type (fall in monitoring costs) exceeds the loss (of income) from a breakup with a lower type. Every bank will then try to pair up with the most efficient firm. Therefore, in equilibrium, the best bank will form a relationship with the best firm. Given one-to-one matching the second best bank can only pair up with the second worst firm and so on. It can be shown that equation (7) gives the sufficient condition for positively assortative matching between banks and firms.

However, with very high quality borrowers, whose monitoring cost is already low, the matching may be negatively assortative. For a bank, the loss of income from a breakup with a lower type firm may not be offset by the fall in monitoring cost from a match with a higher type. This makes the most efficient bank pair up with the *worst among the best* firms, rejecting all other advances. The process of one-to-one matching will then continue, as in Section 2.

Therefore, in the second-best equilibrium, we have[8],

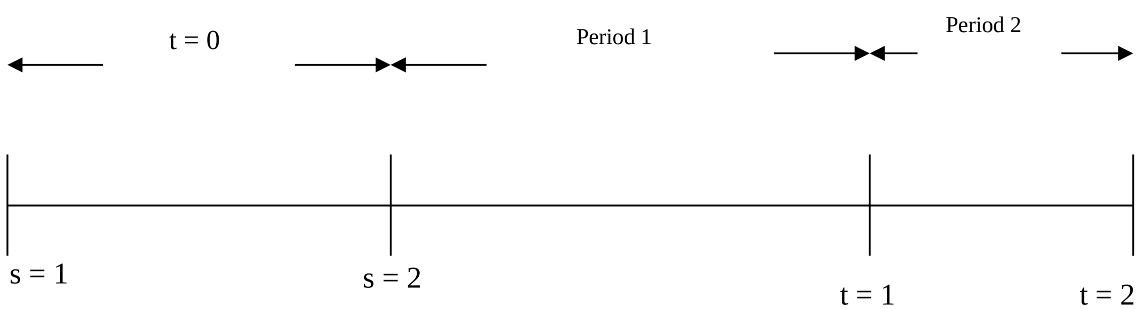
(i) **Transaction Lending:** $\theta_K \le \theta_i \le \underline{\theta} = \dfrac{(m - v_H Y)}{m}$.

(ii) **Positively Assortative Relationship Lending:** $\underline{\theta} \le \theta_i \le \bar{\theta} = \dfrac{(m - (v_H Y/2))}{m}$.

(iii) **Negatively Assortative Relationship Lending:** $\theta_1 \ge \theta_i \ge \bar{\theta}$.

4. MONITORING COSTS AND LOAN RECOVERY

In this section, we study the impact of loan recovery on sector specialization and firm-bank matching. Let the exogenous recovery rate (as a proportion of final output *Y*) be α. We continue to assume that monitoring costs do not depend on the recovery rate. The modified time line is as follows:



[8] The thresholds for transaction lending and positively assortative matching go up with the degree of nonlinearity between PD and monitoring costs. For instance, if $m(\theta_i, c_j) = m\gamma_j (1-\theta_i)^n$, n>2, transaction lending occurs for all $\theta_i \le \dfrac{m-(v_H Y)^{\frac{1}{n-1}}}{m} = \underline{\theta}' \ge \underline{\theta}$ and positively assortative matching occurs for all $\theta_i \le \dfrac{m-\left(\frac{v_H Y}{n}\right)^{\frac{1}{n-1}}}{m} = \bar{\theta}' \ge \bar{\theta}$. In short, as monitoring lower quality borrowers becomes more difficult, negatively assortative matching becomes less attractive to banks. The degree of nonlinearity may increase when collateral value (i.e. recovery rate) falls sharply, with a small rise in PD, and aggravates LGD. As discussed, a meltdown in collateral value has been a common feature of recent financial crises.

s =1: Banks and firms are matched and parties write loan contracts.
s=2: Banks make relationship-specific investments and monitor loans.
t =1: Project Continuation/Liquidation.
t =2: Payoffs Realized and recovery occurs.

4.1. Contractible Recovery Rates

The joint surplus function is given by:

$$S_R(\gamma_j) = [\theta_i + v_j(1-\theta_i)][Y - I] - [1 - v_j][1-\theta_i][\alpha Y - I] - m\gamma_j(1-\theta_i)^2 - \frac{c_j \gamma_j^{\,2}}{2}$$

Substituting for v_j, the joint surplus function becomes

$$S_R(\gamma) = [\theta_i + \gamma_j v_H(1-\theta_i)][Y - I] - [1 - \gamma_j v_H][1-\theta_i][\alpha Y - I] - m\gamma_j(1-\theta_i)^2 - \frac{c_j \gamma_j^{\,2}}{2}$$

$$\frac{\partial S_R(\theta_i, c_j)}{\partial \gamma_j} = 0 \Rightarrow \gamma_j^{***} = \frac{(1-\theta_i)\{(1-\alpha)v_H Y - m(1-\theta_i)\}}{c_j}$$

Result 5: ***In a model with monitoring costs and partial recovery, cet. par.,***

(i) ***The level of sector specialization falls further.***

(ii) ***The level of sector specialization may increase with borrower quality.***

Result 6: ***Positively assortative matching increases with loan recovery rate.***

i.e. $\frac{\partial^2 \gamma_j^{***}}{\partial \theta_i \partial \alpha} > 0$

1. The level of sector specialization reduces, with higher recovery rate after default.
2. The same conclusions, as in the previous section, are reinforced.
3. The amount recovered αY, when a project fails, does not depend on borrower quality. However, there is an inverse relationship between monitoring cost and borrower type. Hence, all banks want to pair with good borrowers and reduce monitoring cost.

4.2 Noncontractible Recovery and Specialization

In this section, we follow the Grossman-Hart-Moore setup in which investment in sector specialization is noncontractible. We start by examining investment behaviour in a given firm-bank relationship, after renegotiation, and then focus on firm-bank matching.

To recapitulate, with a relationship loan, the project returns *Y* with probability $[\theta_i + v_j(1-\theta_i)]$ and *0* with probability $[1-\theta_i][1-v_j]$. Therefore, the ex-post gross joint surplus from relationship banking is $\lfloor \theta_i + v_j(1-\theta_i)\rfloor Y$. However, now the level of investment γ_j is nonconcontractible. An agreement cannot be written on the final output because recovery is also nonconcontractible. Surplus is divided after the investment is sunk and parties are assumed to adopt the Nash bargaining solution. A bank will choose its optimal specialization γ_j^{****} by maximizing

$$\Pi_j^B = \frac{[\theta_i + \gamma_j v_H(1-\theta_i)][Y-I] - [1-\gamma_j v_H][1-\theta_i][\alpha Y - I]}{2} - m\gamma_j(1-\theta_i)^2 - \frac{c_j\gamma_j^{\ 2}}{2}$$

$$\gamma_j^{****} = \frac{(1-\theta_i)\left\{\frac{(1-\alpha)v_H Y}{2} - m(1-\theta_i)\right\}}{c_j}$$

Result 7: ***In a model with noncontractible recovery and specialization, cet. par.,***

(i) ***The level of sector specialization falls further, as banks earn lower incomes.***

(ii) ***The level of sector specialization may increase with borrower quality.***

4.3. Loan Recovery and Monitoring Costs

The exogenous recovery rate continues to be α. We now assume that monitoring costs depend on the recovery rate. LGD = $(1-\alpha)(1-\theta_i)$. If monitoring costs track expected losses, the joint surplus function becomes:

$$S_R(\gamma) = [\theta_i + \gamma_j v_H(1-\theta_i)][Y-I] - [1-\gamma_j v_H][1-\theta_i][\alpha Y - I] - m\gamma_j(1-\alpha)(1-\theta_i)^2 - \frac{c_j\gamma_j^{\ 2}}{2}$$

$$\frac{\partial S_R(\theta_i, c_j)}{\partial \gamma_j} = 0 \Rightarrow \gamma_j^{*****} = \frac{(1-\theta_i)(1-\alpha)\{v_H Y - m(1-\theta_i)\}}{c_j}$$

Result 8: ***In a model with monitoring costs and partial recovery, cet. par.,***

(i) ***The level of sector specialization increases, as monitoring cost declines with higher recovery***

(ii) ***The level of sector specialization may increase with borrower quality.***

Result 9: ***Positively assortative matching decreases with loan recovery rate.***

i.e. $\frac{\partial^2 \gamma_j^{***}}{\partial \theta_i \partial \alpha} < 0$

Since monitoring cost falls with higher recovery rate, there is an incentive to specialize in all kinds of borrowers.

If effort and recovery rates are noncontractible,

$$\Pi_j^B = \frac{[\theta_i + \gamma_j v_H (1-\theta_i)][Y - I] - [1 - \gamma_j v_H][1-\theta_i][\alpha Y - I]}{2} - m\gamma_j (1-\alpha)(1-\theta_i)^2 - \frac{c_j \gamma_j^{\ 2}}{2}$$

$$\gamma_j^{******} = \frac{(1-\theta_i)(1-\alpha)\left\{\frac{v_H Y}{2} - m(1-\theta_i)\right\}}{c_j}$$

Result 10: Level of sector specialization rises and scope for negatively assortative matching increases, compared to the earlier case.

The results for endogenous recovery rates are similar.

5. Conclusion

The key insights from our analysis may now be summarized as follows:

(a) With incomplete information and contracts, banks invest less in relationship loans. They prefer higher-quality borrowers, who are easier to identify, rather than lower-type firms whose need for relationship banking is greater. Negatively assortative matching occurs in the ideal world of complete information and contractible investments. In a setup with private information and contract renegotiation, the matching between firms and relationship banks may be positively assortative. The scope of transaction lending unambiguously increases, in such an environment.

(b) Positively assortative matching may also occur if banks monitor only PD or recovery rates are noncontractible. As long as monitoring costs do not consider recovery rates, all banks tend to favour good borrowers. They need to monitor both PD and LGD, on a regular basis, to increase benefits of collateral reforms and lend more to poorer quality borrowers.

(c) Collateral reform measures are necessary but not sufficient. Banks have to improve the monitoring systems, to reap the benefits of such policies.

Our results have serious implications for financial sector reforms. For instance, Rajan (2008) suggests a number of measures, under financial inclusion, to access small borrowers with higher perceived credit risk. These include the introduction of tailor made savings and insurance products, which mitigate adverse shocks and enhance creditworthiness. He also advocates greater emphasis on local banks and microfinance institutions which are better equipped to assess such borrower quality, at lower cost. Secondly, he recommends a single regulator for trading, greater participation of foreign investors and focus on (both exchange traded and structured) derivative products, to make equity and bond markets more liquid and efficient. In similar vein, Puri (2014) makes several proposals to improve the data format for submitting credit histories to Credit Information Companies in India. In all these cases, the idea is to reduce systemic and borrower-specific monitoring costs, for smoother flow of credit to the deserving candidates.

A crucial assumption in our analysis is the absence of banking competition. This is because such competition might set an upper bound to the interest rates a bank can charge and erode its rents from relationship loans. With perfect (or Bertrand) competition, a greater part of the surplus may have to be transferred, as lower interest rates, to the borrower. Or else, the relationship borrower could prefer rival banks, which charge lower rates. This means that banks may have even lesser incentive for co-operative investments, with financial sector competition. We will explore these issues in future.

In our paper, a holdup problem may hurt relationship banking in three ways. If the incumbent bank has monopoly control over the relationship borrower, at the renegotiation stage, it can demand very high payment by threatening to liquidate its short-term debt. In anticipation, the firm may not exert optimal effort. For instance, with the introduction of CDS markets, losses to a bank from debt renegotiation may be reduced, its bargaining power may improve and its ability to squeeze the borrower may increase. The incumbent firm might also switch over to rival banks and deny the original lender its due surplus. As a result, the bank may not invest in the relationship. In future, we propose to design optimal debt contracts, to deter inefficient renegotiation by opportunistic banks and firms.

References

Acharya, V., T. Phillipon, M. Richardson and N. Roubini (2009): Prologue: A Bird's Eye View, in V. Acharya and M. Richardson (eds.) *Restoring Financial Stability: How to Repair a Failed System*, John Wiley & Sons, New Jersey.

Acharya, V. and P. Schnabl (2009): How Banks played the Leverage Game, Chapter 2 in V. Acharya and M. Richardson (eds.) *Restoring Financial Stability: How to Repair a Failed System*, John Wiley & Sons, New Jersey.

Allen, F. and E. Carletti (2010): The Role of Banks in Financial Systems, in A. Berger, P. Molyneux and J. Wilson (eds.) *The Oxford Handbook of Banking*, Oxford University Press, New York.

Agarwal, S. and R. Hauswald (2010): Distance and Private Information in Lending, Review of Financial Studies, 23, 2757-2788.

Bernanke, B. (2009): *The Fed Reserve's Balance Sheet*, Speech at the Federal reserve Bank of Richmond Credit Markets Symposium, April 3.

Boot, A. (2000): Relationship Banking: What Do We Know? *Journal of Financial Intermediation*, 9(1), 7-25.

Boot, A. and A. Thakor (2000): Can Relationship Banking Survive Competition? *Journal* of *Finance*, 55 (2), 679 - 713.

Boot, A. and A. Thakor (2010): The Accelerating Integration of Banks and Markets and its Implications for Regulation, in A. Berger, P. Molyneux and J. Wilson (eds.) *The Oxford Handbook of Banking*, Oxford University Press, New York.

Cecchetti, S. (2008): Monetary Policy and the Financial Crisis of 2007-08, CEPR Policy Insight no. 21, April.

Che, Y-K and D. Hausch (1999): Co-operative Investments and the Value of Contracting, *American Economic Review*, 89 (1), 125-147.

Chemmanur, T. and P. Fulghieri (1994): Reputation, Renegotiation and the Choice between Bank Loans and Publicly Traded Debt, *Review of Financial Studies*, 7(3), 475-506.

CME (2011): S&P Downgrades US Credit Rating, August 10, CME Group.

Cotugno, M., S. Monferra and G. Sampagnaro (2013): Relationship Lending, Hierachical Distance and Credit Tightening: Evidence from the Financial Crisis, Journal *of Banking and Finance*, 37, 1372 – 1385.

Dam, K. (2014): Lender-Borrower Matching and Incentive Compatible Contracts, in D. Cantala (ed.), *Emile Borel and the Notion of Strategy: Ninetieth Anniversary*, El Colegio De Mexico.

de Sousa, J. and X. Fairise (2014): On the Value of Partial Commitment for Co-operative Investments in Buyer-Supplier Relationships, *Journal of Economics*, 111, 151 – 171.

Dewally, M. and Y. Shao (2014): Liquidity Crisis, Relationship Lending and Corporate Finance, *Journal of Banking and Finance*, 39, 223 - 239.

Duffie, D. and K. Singleton (2005): *Credit Risk: Pricing, Measurement and Management*, Princeton University Press, US.

Farhi, E. and J. Tirole (2012): Collective Moral Hazard, Maturity Mismatch and Systemic Bailouts, *American Economic Review*, 102 (1), 60-93.

Hart, O. (1995): *Firms, Contracts and Financial Structure*, Clarendon Lectures In Economics, Oxford University Press, New York.

Hart, O and J. Moore (1999): Foundations of Incomplete Contracts, *Review of Economic Studies*, 66 (1), 115 - 138.

Hauswald, R. and R. Marquez (2006): Competition and Strategic Information Acquisition in Credit Markets, Review of Financial Studies, 91, 967 – 1000.

Klein, M. (2014): How Our Big Banks Really Make Their Money, www.bloombergview.com.

Kovrijnykh, N. (2013): Debt Contracts with Partial Commitment, *American Economic Review*, 103, 2848-2874.

Laeven, L. and F. Valencia (2008): The Use of Blanket Guarantees in Banking Crises, IMF Working Paper, *WP/08/250*.

Laeven, L. and F. Valencia (2010): Resolution of Banking Crises: The Good, The Bad and the Ugly, IMF Working Paper, *WP/10/146*.

Lando, D. (2005): *Credit Risk Modelling: Theory and Applications*, Princeton University Press, US.

MacDonald, S. and T. Koch (2006): *Management of Banking*, 6th edition, Thomson South-Western, US.

Maskin, E. and J. Tirole (1999): Unforeseen Contingencies and Incomplete Contracts, *Review of Economic Studies*, 66 (1), 83 - 114.

Puri, A. (2014): *Report of the Committee to Recommend Data Format for Furnishing of Credit Information to Credit Information Companies*, Reserve Bank of India, January.

Puri, M., J. Rocholl and S. Steffen (2013): What kind of bank-client relationships matter in reducing loan defaults and why? *SSRN WP # 1572673*, October.

Rajan, R. (2008): *A Hundred Small Steps: Report of the Committee on Financial Sector Reforms*, Planning Commission, GOI.

Ray, D. (1998): *Development Economics*, Oxford University Press, New Delhi.

Resti, A. and A. Sironi (2007): *Risk Management and Shareholders' Value in Banking: From Risk Measurement Models to Capital Allocation Policies*, John Wiley and Sons, England.

Rosenfeld, C. (2014): The Effect of Banking Relationships on the Future of Financially Distressed Firms, *Journal of Corporate Finance*, 25, 403 – 418.

Roth, A.E. and M. Sotomayor. (1989): The College Admission Problem Revisited, *Econometrica*, 57 (3), 559-570.

Song, F. and A. Thakor (2007): Relationship Banking, Fragility and the Asset-Liability Matching Problem, *Review of Financial Studies*, 20, 2129 – 2177.

Stein, J. (2011): The Diversity of Debt Crises in Europe, *Cato Journal*, 31 (2), 199-215.

APPENDIX A

Proof of Result 1: From the optimal investment levels $\gamma_j *$ in (2), we can construct a maximum joint surplus (MJS) function S*, given by

$$S_R^*(\theta_i, c_j) = [\theta_i + \gamma_j^* v_H (1-\theta_i)][Y - I] - [1 - \gamma_j^* v_H][1-\theta_i][I] - \frac{c_j \gamma_j^{*2}}{2}$$

$$\frac{\partial S_R *(\theta_i, c_j)}{\partial \theta_i} = [1 - v_j][Y] > 0 \qquad \text{(A1)}$$

(Ignoring $\frac{\partial S_R *}{\partial \gamma *}.\frac{\partial \gamma *}{\partial \theta}$ by the envelope theorem).

$$\frac{\partial S_R *(\theta_i, c_j)}{\partial c_j} = -\frac{\gamma_j *^2}{2} < 0 \qquad \text{(A2)}$$

(Ignoring $\frac{\partial S *}{\partial \gamma *}.\frac{\partial \gamma *}{\partial c_j}$ by envelope theorem).

The surplus from transaction loan, to a firm of type θ_i, is

$$S_T = \theta_i (Y - I) - (1-\theta_i)(I) \qquad \textbf{(A3)}$$

$$\frac{\partial S_T^*}{\partial \theta_i} = (Y) > 0.$$

Also, we get

$$S_R *(\theta_i, c_j) - S_T *(\theta_i) = \frac{(v_H)^2 (Y)^2 (1-\theta_i)^2}{2c_j} > 0, \forall \theta_i. \qquad \text{(A4)}$$

In other words, all firms prefer relationship loans to transaction loans. For a particular θ, we also know from equation (A2) that $S_R *(\theta, c_1) > S_R *(\theta, c_2) > \ldots\ldots\ldots\ldots > S_R *(\theta, c_N)$ since $\frac{\partial [S_R *(\theta_i, c_j) - S_T *(\theta_i)]}{\partial c_j} < 0$ and $c_1 < c_2 < c_3 < \ldots\ldots\ldots\ldots < c_N$. But does that make the optimal pairing (θ_i, c_j), $i = j$, $\forall \theta_i \geq \theta_N$ and $c_j \leq c_N$ which is positively assortative?

The answer is no since the marginal increment in $[S_R *(\theta_i, c_j) - S_T *(\theta_i)]$ with an increased firm quality increases with a fall in bank quality. In other words we can show that the cross partial $\frac{\partial^2 [S_R *(\theta_i, c_j) - S_T *(\theta_i)]}{\partial \theta_i \partial c_j} > 0$ and this is a sufficient condition for the stability of a negatively assortative matching. Thus, given any bank quality c_j, the magnitude of $\frac{\partial [S_R *(\theta_i, c_j) - S_T *(\theta_i)]}{\partial c_j}$ falls as firm quality increases. Put differently, given a firm quality θ_i the relative gain from relationship banking falls at an increasing rate as bank quality falls (c_j increases). This makes the matching negatively assortative and thus, the most efficient bank will offer relationship loan to the lowest quality firm and the second best bank will offer relationship loan to the second least quality firm and so forth. The optimal matching will be as follows:

$\mu(c_j) = \theta_{K-(j-1)} \quad \forall j = 1,\ldots, N$ (i.e. $\mu(c_1) = \theta_K$, $\mu(c_2) = \theta_{K-1}$, $\mu(c_3) = \theta_{K-2}$ ....). This one-to-one matching is *stable*, because it is immune to the possibility of being *blocked* by any pair or a single firm or bank. It is also Pareto-optimal.

The rest of the top $K - N$ firms will not be matched. They will take transaction loans from any of the N banks. Since we focus on relationships and all banks are same with respect to transaction loans, matching for transaction loans is of lesser importance.

APPENDIX B

The maximum joint surplus function, with monitoring costs and contractible investments, is:

$$S_R^{**}(\theta_i, c_j) = [\theta_i + \gamma_j^{**} v_H (1-\theta_i)][Y - I] - [1 - \gamma_j^{**} v_H][1-\theta_i][I] - m\gamma_j^{**}(1-\theta_i)^2 - \frac{c_j \gamma_j^{**2}}{2}$$

Everything else is the same as in Appendix A. It can be shown that the sufficient condition for positively assortative matching, i.e. $\frac{\partial^2 [S_R^{**}(\theta_i, c_j) - S_T^{**}(\theta_i)]}{\partial\theta_i \partial c_j} < 0$ is equation (8).