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QUALITY OF INSTITUTIONS, CREDIT MARKETS AND BANKRUPTCY

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Abstract

The number of firm bankruptcies is surprisingly low in economies with poor institutions. We study a model of bank-firm relationship and show that the bank's decision to liquidate bad firms has two opposing effects. First, the bank receives a payoff if a firm is liquidated. Second, it loses the rent from incumbent customers that is due to its informational advantage. We show that institutions must improve significantly in order to yield a stable equilibrium in which the optimal number of firms is liquidated. There is also a range where improving institutions may decrease the number of bad firms liquidated.

JEL Code: D82, G21, G33, K10.

Keywords: credit markets, institutions, bank competition, information sharing, bankruptcy, relationship banking.

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1. Introduction

Bankruptcy is an important mechanism for inefficient firms to exit the market and this threat provides important incentives *ex ante*. During the recent economic stagnation, the number of corporate bankruptcies reached a new all time high in Western Europe. In contrast, the number of bankruptcies remained very low in Eastern Europe throughout the 1990s when the region was plagued by the transition recession (Linne, 2001).¹ Deficient institutions contribute to the low number of corporate bankruptcy in transition economies. A cross-country study has shown that the number of bankruptcies increases as judicial efficiency increases (Claessens and Klapper, 2002). The following questions arise when one wants to explain the empirical facts: How do institutions influence the incentive of creditors to liquidate defaulting debtors? Which are the institutions that matter for this decision? To answer these questions, we have to clarify the economic effects of bankruptcy. First, it is supposed to create a return for the lenders; second, “[...] bankruptcy information is publicly disseminated to alert present creditors and potential lenders” (Jappelli and Pagano, 2002, p. 2028).

In this paper we study both effects of bankruptcy. For our analysis, we set up a model of bank-firm relationship in order to study the incentive of a bank to liquidate its defaulting customers. The banking sector consists of two banks that compete in Bertrand fashion and that have different market shares. The firms asking for credit are either so-called “new firms” without a credit history or so-called “old firms” that have received credit in the past. Only the incumbent bank knows the quality of the old firms; thus, it has superior information compared to the outside bank. As the banks cannot efficiently screen the firms applying for credit, the repayment they require for making zero expected profit depends on the average quality of borrowers applying for credit at this bank for the first time. In equilibrium, the good old firms stay with the incumbent bank and the bad old firms switch the bank. As the good old firms cannot signal their type to an outside bank, the incumbent bank demands the same repayment as an outside bank. This is a typical hold-up problem.

¹This exceptional recession was characterized by a tremendous decline of GDP, which has reached 50 per cent in some countries. The reason for the transition recession was the systemic change taking place in these countries. The systemic change was accompanied by a vacuum in institutions because the institutions for the planned economy have no longer been appropriate for economic interactions and institutions for market transactions have been in the process of developing.

The incumbent bank decides whether to accept that bad old firms postpone their repayments firm or to liquidate the firm. In making this decision, there is a trade off between two different effects. If the firm's assets are liquidated, the bank receives a liquidation payoff. If the firm is not liquidated, it will reapply for credit at an outside bank. As more bad old firms apply for credit, the repayment which an outside bank needs to break even increases. Due to the hold-up problem which each good old firm faces, the incumbent bank can extract rents from its incumbent customers. The rent extracted decreases as the number of firms liquidated increases. The better the legal institutions are, the higher is the payoff in the case of liquidation. However, improving the institutions does not necessarily increase the number of firms liquidated. Since the decision of each bank depends on the decision of its competitor, multiple equilibria occur. In one equilibrium, it takes significant improvements until the number of firms liquidated increases and reaches the optimal level. In the other equilibrium, the initial increase in the number of liquidated firms is reversed if institutions further improve. Although some setback with respect to the number of firms liquidated is possible, our analysis shows that a continuation of reforms in the end yields an efficient liquidation decision.

This paper is related to three area in the literature: interdependence between law and finance, creditor passivity and information exchange through credit bureaus. The superordinated research question is the interdependence between law and finance. There is a growing body of literature that asserts a positive influence of creditor protection on the development of credit markets (La Porta et al., 1998).² One important aspect of credit rights is corporate bankruptcy. Similar to all creditor rights, the effectiveness of bankruptcy, which determines the payoff a creditor receives, is influenced by both the law in the books and its enforcement. Claessens and Klapper (2002) show that the number of bankruptcies is higher the better the institutions are. However, they also find that in combination with stronger creditor rights greater judicial efficiency leads to fewer cases of bankruptcy. In the theoretical literature, the effect of formal bankruptcy rules on *ex ante* and *ex post* incentives have been studied intensively (for a discussion see Stiglitz, 2001). In addition, the relationship between bankruptcy codes and the capital structure of firms has been investigated in several papers, for instance, Berglöf et al., 2002. We do not restrict attention to formal rules but to all factors that influence the payoff for the creditor. This payoff can be reduced because

²Jappelli et al. (2002) show that credit is less widely available in Italian provinces that have longer trials or larger backlogs of pending trials.

the rules are formulated ambiguously, the legal system works inefficiently or the secondary markets are not functioning very well. As a consequence, the incentive of a creditor to declare a firm bankrupt decreases as institutions deteriorate.

Two explanations are given in the literature for this phenomenon of creditor passivity. First, if banks are poorly capitalized, they are gambling by rolling over debts to defaulting customers if there is a chance they would repay (Perotti, 1993). Second, it is argued that banks are reluctant to liquidate firms because they do not want to provide information on the share of non-performing loans in their portfolio (Aghion et al., 1999; Mitchell, 2001).³ In the latter two papers, asymmetric information between the bank and the regulator only matters if the policy decision of bank recapitalization is considered. However, in our model, the resulting adverse selection problem has an important impact on the bank's daily business, namely, the decision to liquidate inefficient firms.

As information about incumbent customers is disseminated by both bankruptcy and credit registers, they can be seen as substitutes.⁴ Generally, information can either be on the borrower's type or the performance in the past, such as the project outcome or default. The exchange of information about borrower type through private credit registers is studied by Pagano and Jappelli (1993). In the basic setup, the banks, which are local monopolies, benefit from an information exchange through declining default rates. Introducing bank competition makes information sharing less likely because it reduces the informational rent a bank can extract. Padilla and Pagano (1997) use a slightly different setup where banks also generate rents from high quality borrowers in the first period of a two-period lending relationship. In this setup, the bank has an incentive to reveal information about the firm's type after the first period. The reason is that banks compete more fiercely in the case of information sharing. Thus, the firm gets a higher return and, therefore, it has a better incentive to exert effort. This increases its quality and thereby the rent a bank extracts in the first period rises. In a companion paper, Padilla and Pagano (2000) study the case where rents are competed away *ex ante*. In that case, it is better to show information only about the outcome of a project because the firm's incentive to work hard is thereby the biggest. The extent to which information is revealed about its customers can also be used by

³For example, if the manager shows that his bank has accumulated a huge proportion of bad debts, he faces the threat of being replaced by the supervisory body, which wants to recapitalize the banking system (Aghion et al., 1999).

⁴Therefore, it is not too surprising that credit risk is lower and bank lending is higher in countries that have credit registers (Jappelli and Pagano, 2002).

a bank to deter entry (Boukaert and Degryse, 2002). For intermediate degrees of adverse selection, the incumbent bank can limit the scope of entry by revealing the outcome of the first period, but not the type of the firm.⁵

So far, the literature on relationship banking and the resulting adverse selection problem has not addressed the role of corporate bankruptcy. Like information provided by a private credit bureau, the fact that a firm has to file for bankruptcy reveals that a firm is unsuccessful. This fact becomes public information. In our model, the decision on bankruptcy reveals the borrower's type. In contrast to displaying information to a credit bureau, the bank's decision to let a firm go bankrupt yields a payoff to the bank. Therefore, our model explains why even competitive banks have an incentive to display information about their borrower's type. In contrast to most papers in this area, the banks do not face a commitment problem concerning the display of information.

The paper is organized as follows: In section 2, we first develop the credit market game and study the impact of corporate bankruptcy on interest rates. In section 3, we analyze the bank's incentive to liquidate a defaulting borrower. Comparative statics allows us to show how institutions influence the bank's decision. In section 4, we discuss alternative policies that improve the bank's decision about firm bankruptcy.

2. Credit Market

2.1. Model

To capture the specific relationship between firms and banks, we use a two-period model. The setup of our credit market model is similar to that of Dell'Ariscia et al. (1999). Before starting the analysis, we describe the characteristics of the borrowers and the banking sector.

In the first period, the old firms receive a loan in the amount of I_1 and thereby establish a bank-firm relationship in which the incumbent bank learns their type. In the second period, the firms want to finance an indivisible investment project. Therefore, they need credit in the amount of I_2 because they do not have their own liquid funds. There are two different groups of firms. First, there are the so-called old customers, which have already established a bank-firm relationship in

⁵In this case, the entrant bank poaches borrowers which were successful in the first period. But it is not attractive to finance the unsuccessful firms, which can but not necessarily will be successful.

the first period. Second, there are so-called new customers, which seek to establish a bank-firm relationship for the first time. The number of firms is normalized to 1; the share of old customers is μ and those of new customers is $(1 - \mu)$.⁶ All old customers default on the loans, which they have received in the first period from the incumbent bank.⁷ This bank is their only creditor. However, in the second period, only a proportion p of them will be successful, generating a return of X . These are the good old customers; they could be thought of as late-starters which need some additional finance in the second period to complete a project successfully. We assume that the second period repayment X is high enough to cover all investments made, i.e. $X > I_1 + I_2$. Thus, it is optimal to refinance the good old firms. Among the old customers a proportion of $(1 - p)$ will fail in the second period, they are called “bad old customers”. Only the incumbent bank can observe the risk type of the old firms before the second period starts. If a bad old firm manages to receive credit from an outside bank, it invests the credit inefficiently. Hence, the bad old firm cannot repay the incumbent bank although it is refinanced by the outside bank.

No bank has information on the risk type of the new firms. It is, however, common knowledge that there is a probability q they will be successful. In the case of success, a new firm generates a payoff X . It is socially optimal to finance new firms as $qX \geq I_2$. For notational convenience I_2 is denoted by I in the following analysis.

The firms are endowed with assets of A . After period 1, the incumbent bank decides about forcing defaulting customers to undergo a bankruptcy procedure. We assume that the bank cannot be forced by law to initiate a bankruptcy procedure if it knows that a firm will not be successful in the future.⁸ We do not model the different routes taken in a bankruptcy procedure, i.e. liquidation or reorganization, but assume that a firm is liquidated. If a firm is liquidated, it becomes common knowledge that it is a bad firm. The liquidation value is denoted by αA . The liquidation value of one unit of asset is determined by the quality of secondary markets and the costs of enforcing contracts, captured by the assumption that $\alpha < 1$. The liquidation value increases as the quality of the institutions, such as the legal framework, improves. By the end of period 2, the

⁶Through this assumption we focus our analysis on those firms that have an incentive to announce being a new firm.

⁷Old firms that have a project with a positive return could signal their type to an outside bank and do not face the hold-up problem described here.

⁸Instead, a bank can, for instance, decide to simply write off the outstanding loan.

assets become worthless. We assume that the proceeds from liquidation do not cover the amount of credit granted in the first period, i.e. $\alpha A < I_1$ and that the liquidation is socially optimal because the loss of liquidation is lower than the misallocation of capital in the second period, i.e. $(1 - \alpha) A < I$.

The banking sector consists of two banks. Bank 1 has a market share in the credit market of s_1 , bank 2 of $s_2 (= 1 - s_1)$, where we assume that $\frac{2}{3} > s_1 > s_2$.⁹ There is no entry and no exit at the beginning of period 2. The costs of raising funds is normalized to zero. With regards to the distribution of information, we assume that the incumbent bank can observe the type of its old firms. Moreover, the banks cannot screen the credit applicants efficiently and cannot distinguish whether a firm has received credit before, i.e. they cannot discriminate between old and new customers. As a consequence, they offer a pooling contract. We assume that firms apply for credit at each bank in proportion to their share in the total population. Moreover, we assume that bank 2 has an incentive to lend because the return generated by new firms is high enough to cover the losses made with bad old customers, i.e. $(qX - I)(1 - \mu) > \mu s_1 I(1 - p)$.

The timing of events is as follows: At the end of the first period, the incumbent bank decides about liquidating defaulting customers. Credit is granted in the beginning of the second period. We assume that banks have two sequential moves. First, they simultaneously choose the repayment for new applicants. Second, they determine repayment by their old customers. Finally, firms demand credit from the bank with the best credit offer. We assume that an old customer continues to lend from the incumbent bank if it is indifferent between the offers of incumbent and outside banks. Old customers that are not staying with their incumbent bank and new customers apply at the bank which offers the lowest repayment. If both banks offer the same repayment, the market is tied between the two banks.

The time structure is summarized in the following figure:

2.2. Credit Contract

The game is solved by backward induction. In this section, we describe the credit contract if neither bank liquidates its bad old customers. Good old firms always stay with their incumbent bank. Therefore, we first characterize the repayment made by the firms that apply at an outside bank in the second period, which we

⁹The market shares of bank 1 and bank 2 differ from each other in order to facilitate deriving the repayment. The market share of the bigger bank, bank 1, is bound above because we want to exclude that it monopolizes the market.

Proof: See the Appendix.

When offering the terms of a credit contract, the outside bank makes the first move. The incumbent bank always has the chance to offer a credit contract to a good old customer that is as favorable as the one offered by the outside bank. Thus, in equilibrium, the good old customers stay with their incumbent bank and repay as much as all other customers. The banks offer a pooling contract for the remaining customers, namely the bad old firms and the new firms, because they cannot discriminate between them.

However, there is no equilibrium in pure strategies for the repayment terms. In equilibrium, the banks mix continuously on the range $[\underline{R}, X)$ or do not bid at all. The lowest repayment \underline{R} is determined by the condition that the expected profit of bank 2, which has had a lower market share in the previous period, is zero. Due to the resulting informational disadvantage compared to bank 1, bank 2 stays out of the market with positive probability and, therefore, makes zero expected profit from the newly applying customers. Bank 1 makes an expected profit of $I\mu(1-p)(s_1 - s_2)$ from new applicants for credit in period 2. The profit is based on bank 1's informational advantage on old firms compared to bank 2 (Dell'Ariccia et al., 1999). Therefore, there exists an adverse selection problem between banks.

The incumbent bank can extract a rent from all its good old customers. The rent is described in the following proposition.

Proposition 2. *Each bank finances its good old customers and extracts from each of these firms a rent of $\frac{s_1\mu\left(\ln\left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)}\right)+1\right)(1-p)+(1-q)(1-\mu)}{(1-\mu)q}I$.*

Proof: See the Appendix.

The good old customers face a hold-up problem because they cannot signal their type to an outside bank. Therefore, the incumbent bank extracts some rent from each of these firms. A comparative static analysis provides some important insights on the composition of the rents. The rent to be extracted is the higher, the higher the market share of bank 1, s_1 , is. The adverse selection problem between the two banks increases since bank 1 releases more bad old firms into the pool of borrowers that then apply at an outside bank in period 2. Therefore, the expected repayment increases because bank 2 puts a higher probability on higher repayments and denies credit with a higher probability. If bank 2 denies credit,

the incumbent bank 1 can extract the whole payoff generated by the investment, X , from its good old customers.

The share of bad old firms decreases if the share p of good old firms increases. Thus, the quality of firms applying at an outside bank in the second period increases. As a result, the severeness of the adverse selection problem decreases, and therefore, the average repayment paid at an outside bank decreases. This reduces the hold-up problem that good old firms face. Finally, the distribution of new customers matters. The higher the proportion of good new firms, i.e. q , the lower the repayment. The intuition is equivalent to a change in the make-up of the population of old firms.

The discussion so far has shown that the size of the rent depends on the degree of adverse selection between the two banks. We have assumed that banks do not perform any screening and that they are not able to distinguish between old and new firms.¹⁰ Clearly, the degree of adverse selection between banks decreases if information about applying firms can be generated, be it through screening or through credit registers. However, as long as information is imperfect, the adverse selection problem will remain.

3. Incentive of Banks to Liquidate Defaulting Firms

In the analysis so far, we have not explicitly modelled the decision of a bank to liquidate its bad old customers. Before deriving the optimal liquidation decision, it is important to remember that the decision to liquidate reduces the degree of asymmetric information between banks. We model the liquidation decision by introducing a new variable \hat{s}_i that measures the outflow of bad old firms from the incumbent bank i to the outside bank. \hat{s}_i is defined as follows:

$$\begin{aligned}\hat{s}_i &= 0 \text{ if bank } i \text{ liquidates the bad old firms in its portfolio} \\ &= s_i \text{ if bank } i \text{ does not liquidate the bad old firms in its portfolio}\end{aligned}$$

The degree of asymmetric information influences the rent extracted from the incumbent customers. If bank 1 does not liquidate its bad old customers, the rent which bank 1 as well as bank 2 generate from *each* good old firm is given by

$$\frac{s_1 \mu \left(\ln \left(\frac{(qX - I)(1 - \mu)}{\mu s_1 I(1 - p)} \right) + 1 \right) (1 - p) + (1 - q)(1 - \mu)}{(1 - \mu)q} I, \text{ which for simplicity is denoted by } \Pi^{GO} (s_1, s_2 = 0).$$

¹⁰If the result of the screening process is very poor, it might be optimal not to invest into costly screening (Schnitzer, 1999).

This rent is independent of the decision of bank 2, because the amount of the rent is determined by the market share of the bigger bank, i.e. bank 1. In the case that bank 1 liquidates but bank 2 does not, the expression is $\frac{s_2\mu\left(\ln\left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)}\right)+1\right)(1-p)+(1-q)(1-\mu)}{(1-\mu)q}I$, which for simplicity is denoted by $\Pi^{GO}(s_1 = 0, s_2)$.

Moreover, the degree of adverse selection also influences the profit generated in the free market. If no bank liquidates, only bank 1 makes a *total* profit of $I\mu(1-p)(s_1 - s_2)$, denoted by $\Pi^{FM}(s_1, s_2)$. If bank 1 liquidates but bank 2 does not, bank 2 gets a payoff of $I\mu(1-p)s_2$, denoted by $\Pi^{FM}(s_1 = 0, s_2)$. If both banks liquidate, both make zero expected profit from the free market.

Taking the effect of liquidation on the adverse selection problem between banks into account, a bank decides to liquidate its customers, which yields a payoff of αA per customer, if

$$\begin{aligned} & \mu s_i(1-p)\alpha A + \mu s_i p \Pi^{GO}(s_i = 0, s_j \geq 0) + \Pi^{FM}(s_i = 0, s_j \geq 0) \\ \geq & \mu s_i p \Pi^{GO}(s_i > 0, s_j \geq 0) + \Pi^{FM}(s_i > 0, s_j \geq 0) \end{aligned}$$

This comparison shows that the optimal decision of each bank depends on the liquidation decision of its competitor. Each bank faces the following trade-off. On the one hand, it gains the liquidation payoff. On the other hand, it may lose some rent because its relative position (in terms of the number of firms it has positive information about) changes. The rent is lost through two effects. First, the bank loses the profit which it could have made with newly applying firms in the second period because it would have had a higher market share. Assume that bank 2 has liquidated its bad old firms. Now, if bank 1 liquidates its bad old customers, there is no longer an adverse selection problem between bank 1 and bank 2. In this case, there is perfect competition for the newly applying firms. Therefore, bank 1 no longer makes a profit out of financing the new firms. Second, each bank loses some rent from the good old customers. As the average repayment from the newly applying firm decreases, the rent that can be extracted from the good old firms decreases, too.

As an example for the bank's liquidation decision, consider the payoffs of bank 2 provided that bank 1 does not intend to liquidate:

$$\begin{aligned} \mu s_2(1-p)\alpha A + \mu s_2 p \Pi^{GO}(s_1, s_2 = 0) & \geq \mu s_2 p \Pi^{GO}(s_1, s_2) \\ \text{or } \mu s_2(1-p)\alpha A & \geq 0 \end{aligned}$$

Bank 2 does not receive any profit from the free market because by assumption it has the lower market share. Moreover, its liquidation decision does not influence the rent generated from the good old firms, i.e. $\Pi^{GO}(s_1, s_2 = 0) = \Pi^{GO}(s_1, s_2)$. Therefore, bank 2 will always liquidate its bad old firms. The following proposition on the equilibrium liquidation decision is derived from the trade-off facing both banks:

Proposition 3. *The banks' liquidation decisions depend on the payoff obtained from liquidating the firm's assets.*

- (1) *If the liquidation value is very low, i.e. $\alpha A < \frac{(s_1 - s_2)}{s_1} \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I$ or if the liquidation value is intermediate, i.e. $\left(\frac{ps_2\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right) + 1 \right) + 1 \right) I \leq \alpha A < \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I$, bank 1 does not but bank 2 does liquidate its bad old customers.*
- (2) *If the liquidation value is low, i.e. $\frac{(s_1 - s_2)}{s_1} \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I \leq \alpha A < \left(\frac{ps_2\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right) + 1 \right) + 1 \right) I$, there are two pure strategy equilibria:*
- (EQ1) *bank 1 liquidates but bank 2 does not liquidate its bad old customers*
- (EQ2) *bank 1 does not liquidate but bank 2 liquidates its bad old customers.*
- (3) *If the liquidation value is high, i.e. $\alpha A \geq I \frac{1}{(1-\mu)q} \left(ps_1\mu \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + q(1-\mu) \right)$, both banks liquidate their bad old customers.*

Proof: See the Appendix.

If the liquidation value is very low, bank 1 never liquidates its bad old customers and therefore it is optimal for bank 2 to liquidate. If the liquidation value is low, multiple equilibria occur. First, if bank 1 expects that bank 2 liquidates the bad old firms, it prefers to keep its market power, which, in fact, even increases by bank 2's decision to liquidate. Second, if bank 1 expects that bank 2 does not liquidate, it is optimal to liquidate. If the liquidation value is intermediate, bank 2 will always liquidate and the best response of bank 1 is not to liquidate. In the case that the liquidation value is high, both banks have an incentive to liquidate their bad old customers.

From a social welfare perspective, it is desirable that all bad old firms as possible are liquidated. Thus, a situation in which only bank 1 liquidates, such as equilibrium 1 in case 2, is preferable to one in which only bank 2 liquidates because bank 1 has more bad old firms in its credit portfolio. The most desirable situation is one in which both banks liquidate (case 3). The comparison between case 1

and 2 is difficult because there is a coordination problem in case 2. Suppose first that bank 1 expects bank 2 to liquidate its bad old firms. Then, bank 1 will not decide to liquidate. Thus, the allocative result in both cases 1 and 2 is equivalent. However, if bank 1 expects that bank 2 does not liquidate, it then decides to liquidate; under these circumstances the allocation improves in case 2 compared to case 1.

The following two propositions summarize how the equilibrium liquidation decision is influenced by a parameter change.

Proposition 4. *Suppose that in case 2 equilibrium 2 is obtained. Then the number of bad old firms liquidated (non-strictly) increases as the liquidation payoff, α , increases, as bank competition increases, i.e. s_1 decreases, and as the adverse selection problem decreases, i.e. μ and p decrease.*

Proof: See the Appendix.

Better institutions increase the liquidation value and therefore provide better incentives for liquidation. Moreover, if bank 1 has a lower market share, which renders the banking sector more competitive, the terms of the credit contract are more favorable for the customers, i.e. the expected repayment decreases. Therefore, the rent extracted due to the hold-up decreases. The incentive for liquidation is higher, the lower the rent extracted is. This reasoning also shows that the incentive for liquidation increases as the degree of asymmetric information between banks is reduced. Thus, as the share of old borrowers decreases, μ , the liquidation incentive increases. All other measures reducing asymmetric information, such as the duty to provide information about defaulting customers to a public credit register or better screening capabilities, improve the incentive for liquidation. As the share of good old firms decreases, the liquidation incentives improve, too. Studied in detail, a decrease in p has several effects. First, the number of firms that are liquidated, and thus the liquidation value, increases. Second, the number of firms that are held up decreases. Third, the rent extracted from the good old firms as well as from the new firms increases. In total, the effects of higher liquidation proceeds and the lower number of firms that can be held up dominate the higher rent extracted from the firms.

Interestingly, the decision to liquidate a firm is independent of the outstanding debt, i.e. I_1 . The amount of credit granted in the first period is comparable to a sunk cost that no longer influences the bank's decision. What the bank trades off is the value of the two different functions of bankruptcy - a payoff generated

for the lender and the dissemination of information. The advantage of keeping information about incumbent firms private is expressed by the profit created from incumbent and new firms.

Proposition 5. *Suppose that in case 2 only bank 1 liquidates its defaulting customers, then the effect of a higher liquidation value, α , on the number of firms liquidated is non-monotonic and depends on the initial conditions:*

(i) *if $\alpha A < \frac{(s_1-s_2)}{s_1} \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I$, then the number of firms liquidated (non-strictly) increases because bank 1 instead of bank 2 liquidates its bad old firms.*

(ii) *if $\alpha A < \left(\frac{ps_2\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right) + 1 \right) + 1 \right) I$, then the number of firms liquidated (non-strictly) decreases because bank 2 instead of bank 1 liquidates its bad old firms.*

(iii) *if $\alpha A < \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I$, then the number of firms liquidated (non-strictly) increases because both banks, instead merely of bank 1, liquidate their bad old firms.*

Proof: Compare conditions in Proposition 3.

The trajectory of the number of bad old firms liquidated is path-dependent and not monotonic. Starting from a very low liquidation value (see case (i)), where only bank 2 liquidates, an improvement of the institutions leads to a low liquidation value, which, in turn, increases the number of firms liquidated. In the latter case (see case (ii)), expecting that bank 2 does not liquidate, bank 1 has an incentive to liquidate because bank 2's decision leaves some rent to bank 1 from the incumbent firms in addition to the liquidation payoff. If institutions improve further, leading to an intermediate liquidation value, bank 2 will always liquidate. However, in the parameter range for intermediate liquidation values, bank 1 does not have an incentive to liquidate if bank 2 liquidates because the rents lost from incumbent and new firms cannot be compensated by the liquidation value. The only condition under which both banks liquidate is that the liquidation value is high (see case (iii)).

Even if some progress is made (low instead of very low liquidation value), a further improvement of the institutions, which yields an intermediate liquidation value, leads to lower allocative efficiency because the number of firms liquidated decreases. However, if progress continues, the allocation of capital will improve again.

Similar results are obtained if the other parameters change marginally. However, the setback can be avoided if the change is not small but huge. This would be the case if the adverse selection problem decreases drastically or institutions improve significantly. If it is possible to exclude all the bad old firms, the adverse selection problem would disappear and the bank's decision to liquidate would no longer be distorted.

4. Conclusion and Discussion

Our analysis provides an explanation for the interdependence of institutions and the number of bankruptcies. We have shown that the incentive to liquidate defaulting firms depends on the quality of institutions. They, in turn, determine the payoff a creditor gets from liquidating a firm. Therefore, our analysis further explains why creditors in countries with deficient institutions are passive. Moreover, another interesting result of our analysis is that, depending on the initial conditions, better institutions might even decrease the number of bad old firms liquidated. Even if there is no setback, it will take significant changes until the bankruptcy decision is made efficiently. The transition process in Eastern Europe shows that the process of establishing institutions, which function reasonably well, takes a long time, much longer than most experts expected at the beginning of transition (Schnitzer, 2003).

The changes needed are the improvement of institutions and the reduction of the adverse selection problem. With respect to our analysis, the main institution that has to improve is the legal framework. The liquidation of a firm's assets is expensive from a social welfare point of view because seizing the assets is costly and the secondary markets work inefficiently. The social loss will decrease if the legal systems function better. Reform in two respects are necessary. Laws have to be drafted more carefully in order to avoid ambiguities. Even more importantly, the law enforcement must be faster and its results more predictable.¹¹

The adverse selection problem between banks can be mitigated through several measures. First, if the number of new firms in the credit market increases, neither of the banks has information about the type of these firms. Decreasing the share of borrowers for which the banks face the adverse selection problem decreases the repayment and therefore the hold-up problem. Consequently, the incentive to

¹¹Djankov et al. (2003) empirically analyze law enforcement through courts. The problems of the bailiffs service in Russia are described by Kahn (2002).

liquidate bad old firms increases. The necessary measures are to improve access to credit for firms that have not been financed by banks in the past. In countries with a poor institutional environment, the degree of bank intermediation often remains rather low. As a substitute for bank credit, informal credit arrangements emerge. Measures that facilitate the firm's access to bank finance include, for instance, the establishment of agencies that assist firms in drafting business plans. Second, the bank's incentive to liquidate bad firms increases if the quality of new firms improves. Third, improving the screening skills of the bank staff also reduces the possibility of incumbent banks to hold-up good old firms. Fourth, bank competition should be fostered. This implies that the banks should have similar market shares because the market structure of the banking sector matters for the effectiveness of the legal system. For countries that had to dissolve a monopolistic (state) bank, such as the transition countries in Eastern Europe, this implies that the carved out banks should be as similar as possible in terms of market share and quality of the loan portfolio inherited.

Finally, public credit registers could potentially serve as a means to publish information about inefficient firms. Pagano and Jappelli (2000) observe that public credit registries are more frequent in countries where law enforcement is less efficient and creditor rights are not very well protected. At least in theory, the degree of adverse selection between banks decreases through credit registers, and the incentive to liquidate firms increases. However, it is not obvious why banks are willing to provide information about a firm. From our analysis it is clear that they will not give information about a firm's type if they are not compensated by a sufficiently high liquidation payoff. Alternatively, banks can simply be forced to do so. But in countries with a poor legal environment, the legal commitment to provide information should be rather difficult to enforce and, therefore, it is easy for the bank to act opportunistically. This may explain why public credit registers mostly contain information about defaults, arrears, loan exposure, interest rates and guarantees but not information about the borrower's type. Moreover, they usually cover only a subset of borrowers, for example, those with relatively large loans (Jappelli and Pagano, 2002). Consequently, the potential incentive problem in revealing information to public credit registers and the informational role of bankruptcy open new questions for research: Why do (private or public) credit bureaus exist if information about the type of borrower are displayed by a bankruptcy procedure? Are they mainly used for providing information about the firms' past outcomes, as predicted by Boukaert and Degryse (2002), in contrast to their types?

5. Appendix

5.1. Proof of Proposition 1

Step 1: We show that old customers stay with their incumbent bank.

- Bad old customers are denied credit by their incumbent bank because they generate a payoff of $0 < I$.
- Due to the sequential nature of offers, bank 1 underbids bank 2 marginally (and vice versa) and keeps its good old firms, i.e. $R_1 = R_2$, because the old firms have a slight preference for the incumbent bank.

Step 2: We show that no equilibrium in pure strategies exists.

\underline{R} denotes the repayment that bank 2 needs for making zero expected profit.

Suppose there exists a symmetric equilibrium with $R_1 = R_2 > \underline{R}$. Bank 1 has an incentive to marginally undercut R_2 and still make a positive expected profit. Suppose that $R_1 = R_2 = \underline{R}$. Bank 1 has an incentive to undercut bank 2 and still make positive expected profit. In this case, bank 2 would make an expected loss and, thus, it would be better to make no offer at all.

Suppose there exists an asymmetric equilibrium in pure strategies. Suppose that $R_1 > R_2 > \underline{R}$. Bank 1 has an incentive to marginally undercut bank 2 and make positive expected profit. Suppose that $R_1 > R_2 = \underline{R}$. Bank 1 has an incentive to undercut bank 2 and still make positive expected profit. In this case, bank 2 would make an expected loss and, thus, it would be better to make no offer at all. Suppose that $R_2 > R_1 \geq \underline{R}$. Bank 2 has incentive to demand a marginally lower repayment than bank 1 and make a non-negative profit.

Step 3: We show that $F_i(R)$ and $F_j(R)$ are continuous and strictly monotonously increasing on an interval (\underline{R}, X) .

Suppose that F_j is discontinuous at R^* , i.e. there exists an atom in F_j , then bank i 's action of playing $R^* - \epsilon$ strictly dominates playing $R^* + \epsilon$, $\epsilon > 0$. Therefore, bank i will not bid a free-market repayment $[R^*, R^* + \epsilon)$. But then bank j can raise its repayment without losing customers, so R^* cannot be an optimal action for bank j . Hence, F_j must be continuous.

Suppose that F_j is non-increasing over some interval, i.e. there exists an interval $(R_a, R_b) \subseteq (\underline{R}, X)$ for which $f_i(R) = 0 \forall R \in (R_a, R_b)$. But then $prob(R_i < R_j \mid R_i = R_a) =$

$\text{prob}(R_i < R_j \mid R_i \in (R_a, R_b))$, but profits are strictly higher for $R_i > R_a$ (conditional on winning), so that bank i maximizes its payoff by playing $R_i = R_b$ and hence would never offer a repayment in the interval. But then bank j can increase its profits by playing $R_j = R_b - \epsilon$ with positive probability, where $\epsilon < R_b - R_a$, since this will lead to strictly higher profits than any interest rate offer in a neighborhood of R_a . However, this contradicts the assumption that $f_i(R) = 0 \forall R \in (R_a, R_b)$.

Step 4: We determine the equilibrium in mixed strategies as described in the proposition.

Consider the profit function of bank i ($i \neq j$ and $i = 1, 2$) conditional on bank j 's offer.

$$\Pi_i(R_i) = (1 - \mu)(1 - F_j(R_i))(qR_i - I) + \mu s_j(1 - p)(-I) \quad \forall R_i \in [\underline{R}, X].$$

Bank i will participate only if $\Pi_i(R_i) \geq 0$ or

$$\lim_{R \rightarrow X} (1 - F_j(R)) \geq \frac{\mu s_j(1 - p)}{(1 - \mu)(qR_i - I)} I$$

There are two ways for getting $\lim_{R \rightarrow X} (1 - F_j(R)) > 0$:

- There is an atom at X in F_j . However, there cannot exist an atom in both F_i and F_j since then neither $R_i = X$ nor $R_j = X$ would be optimal.
- Either bank i or bank j does not always bid on the free market. As shown below, this has to be the smaller bank. This implies that its expected profit is zero because each offer generates the same profit.

Step 5: We determine the minimum repayment \underline{R} . \underline{R} is determined by the condition that bank 2 wins the free market with certainty:

$$\Pi_2(\underline{R}) = (1 - \mu)(q\underline{R} - I) + \mu s_1(1 - p)(-I) = 0$$

$$\underline{R} = \frac{(1 - \mu) + \mu s_1(1 - p)}{(1 - \mu)q} I$$

Step 6: We determine bank 1's expected profit.

Bank 1's return for \underline{R} is:

$$\begin{aligned}\Pi_1(\underline{R}) &= (1 - \mu) (q\underline{R} - I) + \mu s_2 (1 - p) (-I) \\ &= (s_1 - s_2) \mu (1 - p) I \equiv \overline{\Pi}_1 > 0\end{aligned}$$

Thus, it is shown that bank 2 does not always bid on the free market and therefore makes zero expected profit.

Step 7: We determine the mixing probabilities.

Let us use the fact that $\Pi_1(R_1) = \overline{\Pi}_1$ and $\Pi_2(R_2) = 0$ for each repayment.

- For bank 1 we determine $F_1(R)$ by setting

$$\Pi_2(R_2) = (1 - \mu) (1 - F_1(R_2)) (qR_2 - I) + \mu s_1 (1 - p) (-I) = 0$$

Accordingly, $F_1(R) = 1 - \frac{\mu s_1 (1-p)}{(1-\mu)(qR-I)} I \forall R_1 \in \left[\frac{(1-\mu)+\mu s_1(1-p)}{(1-\mu)q} I, X \right)$ and $prob(R_1 = X) = \frac{\mu s_1 (1-p)}{(1-\mu)(qX-I)} I$.

- For bank 2 we determine $F_2(R)$ by setting

$$\Pi_1(R_1) = (1 - \mu) (1 - F_2(R_1)) (qR_1 - I) + \mu s_2 (1 - p) (-I) = \overline{\Pi}_1$$

Accordingly, $F_2(R) = 1 - \frac{\mu s_1 (1-p)}{(1-\mu)(qR-I)} I \forall R_2 \in \left[\frac{(1-\mu)+\mu s_1(1-p)}{(1-\mu)q} I, X \right)$. With probability $prob(D) = \frac{\mu s_1 (1-p)}{(1-\mu)(qX-I)} I$ bank 2 makes no offer at all. Q.E.D.

5.2. Proof of Proposition 2

Each bank gets a rent from the good old firms, denoted by Π_i^{GO} , that is determined as follows:

$$\begin{aligned}\Pi_i^{GO} &= \int_{\underline{R}}^X prob(R) R dR + (1 - F(X)) X - I \\ &= \int_{\underline{R}}^X \left(\frac{q\mu s_1 (1-p) I}{(1-\mu)(qR-I)^2} \right) R dR + \frac{\mu s_1 (1-p) I}{(1-\mu)(qX-I)} X - I \\ &= I \frac{s_1 \mu \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I (1-p)} \right) + 1 \right) (1-p) + (1-q)(1-\mu)}{(1-\mu)q}\end{aligned}$$

where $prob(R)$ is given by $\frac{\partial F(R)}{\partial R} = \frac{q\mu s_1 (1-p) I}{(1-\mu)(qR-I)^2}$. $\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I (1-p)} \right) > 0$ because we assumed that $(qX - I)(1 - \mu) > \mu s_1 I (1 - p)$. Q.E.D.

5.3. Proof of Proposition 3

Step 1: We study the liquidation incentive of each bank.

Bank 2: Let us first study the incentive of bank 2 to liquidate its customers:

(1) Provided that bank 1 intends to liquidate, bank 2 will liquidate if:

$$\begin{aligned}
& \mu(1-p)s_2\alpha A + \frac{(1-q)}{q}\mu ps_2I \\
\geq & \frac{s_2\mu\left(\ln\left(\frac{(qX-I)(1-\mu)}{\mu s_2I(1-p)}\right) + 1\right)(1-p) + (1-q)(1-\mu)}{(1-\mu)q}\mu ps_2I + \mu(1-p)s_2I \\
\text{or } \alpha A \geq & \left(\frac{ps_2\mu\left(\ln\left(\frac{(qX-I)(1-\mu)}{\mu s_2I(1-p)}\right) + 1\right)}{(1-\mu)q} + 1\right)I
\end{aligned}$$

(2) Provided that bank 1 does not intend to liquidate, bank 2 will liquidate if:

$$\begin{aligned}
& \mu(1-p)s_2\alpha A + \frac{s_1\mu\left(\ln\left(\frac{(qX-I)(1-\mu)}{\mu s_1I(1-p)}\right) + 1\right)(1-p) + (1-q)(1-\mu)}{(1-\mu)q}\mu ps_2I \\
\geq & \frac{s_1\mu\left(\ln\left(\frac{(qX-I)(1-\mu)}{\mu s_1I(1-p)}\right) + 1\right)(1-p) + (1-q)(1-\mu)}{(1-\mu)q}\mu ps_2I \\
\text{or } \mu(1-p)s_2\alpha A \geq & 0
\end{aligned}$$

Thus, if bank 1 does not intend to liquidate its bad old firms, bank 2 will always liquidate its bad old firms too.

Bank 1: Let us study the incentive of bank 1 to liquidate its customers next:

(3) Provided that bank 2 intends to liquidate, bank 1 will liquidate if:

$$\begin{aligned}
& \mu(1-p)s_1\alpha A + \frac{(1-q)}{q}\mu ps_1I \\
\geq & \frac{s_1\mu\left(\ln\left(\frac{(qX-I)(1-\mu)}{\mu s_1I(1-p)}\right) + 1\right)(1-p) + (1-q)(1-\mu)}{(1-\mu)q}\mu ps_1I + \mu(1-p)s_1I \\
\text{or } \alpha A \geq & \left(\frac{ps_1\mu\left(\ln\left(\frac{(qX-I)(1-\mu)}{\mu s_1I(1-p)}\right) + 1\right)}{(1-\mu)q} + 1\right)I
\end{aligned}$$

(4) Provided that bank 2 does not intend to liquidate, bank 1 will liquidate if:

$$\begin{aligned} & \mu(1-p)s_1\alpha A + \mu ps_1 I \frac{s_2\mu \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right) + 1 \right) (1-p) + (1-q)(1-\mu)}{(1-\mu)q} \\ \geq & \mu ps_1 I \frac{s_1\mu \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) (1-p) + (1-q)(1-\mu)}{(1-\mu)q} + \mu(1-p)(s_1-s_2)I \\ \text{or } \alpha A \geq & \frac{(s_1-s_2)}{s_1} \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I \end{aligned}$$

Step 2: We compare the different threshold values for the liquidation decision.

In order to determine the equilibrium liquidation decision, we have to compare the different threshold values of αA , where the liquidation decision changes.

- The threshold values in cases 1 and 3 are ranked as follows:

$$\begin{aligned} & \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I > \\ & \left(\frac{ps_2\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right) + 1 \right) + 1 \right) I. \end{aligned}$$

This can easily be shown because for the left hand side we know that

$$\frac{\partial \left(\left(\frac{ps_2\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right) + 1 \right) + 1 \right) I \right)}{\partial s_2} = \frac{\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right)}{(1-s_2)q} pI\mu > 0$$

The threshold values in cases 1 and 4 can be ranked as follows:

$$\begin{aligned} & \left(\frac{ps_2\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right) + 1 \right) + 1 \right) I > \\ & \frac{(s_1-s_2)}{s_1} \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I \end{aligned}$$

$$\text{because the difference is given by: } \frac{\mu s_1 p \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + q(1-\mu)}{q(1-\mu)s_1} I s_2 > 0$$

- The threshold values in cases 3 and 4 can be ranked as follows:

$$\begin{aligned} & \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I > \\ & \frac{(s_1-s_2)}{s_1} \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I \end{aligned}$$

$$\text{as } \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I > \left(\frac{ps_2\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right) + 1 \right) + 1 \right) I$$

Step 3: We derive how the optimal liquidation decision depends on the liquidation value.

The liquidation decision depends on the size of the liquidation value.

(a) If the liquidation value is very low, i.e. $\alpha A < \frac{(s_1-s_2)}{s_1} \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I$, the liquidation incentives are as follows:

- Bank 2 liquidates its bad old firms if bank 1 does not intend to liquidate.
- Bank 2 does not liquidate its bad old firms if bank 1 intends to liquidate.
- Bank 1 never liquidates its bad old firms.

In equilibrium, bank 1 does not liquidate but bank 2 liquidates its bad old customers.

(b) If the liquidation value is low, i.e. $\frac{(s_1-s_2)}{s_1} \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I \leq \alpha A < \left(\frac{ps_2\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right) + 1 \right) + 1 \right) I$, the liquidation incentives are as follows:

- Bank 2 liquidates its bad old firms if bank 1 does not intend to liquidate.
- Bank 2 does not liquidate its bad old firms if bank 1 intends to liquidate.
- Bank 1 liquidates its bad old firms if bank 2 does not intend to liquidate.
- Bank 1 does not liquidate its bad old firms if bank 2 intends to liquidate.

Thus, there are two pure strategy equilibria:

(EQ1) bank 1 liquidates but bank 2 does not liquidate its bad old customers

(EQ2) bank 1 does not liquidate but bank 2 liquidates its bad old customers.

(c) If the liquidation value is intermediate, i.e. $\left(\frac{ps_2\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_2 I(1-p)} \right) + 1 \right) + 1 \right) I \leq \alpha A < \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I$, the liquidation incentives are as follows:

- Bank 2 always liquidates its bad old firms.
- Bank 1 liquidates its bad old firms if bank 2 does not intend to liquidate.
- Bank 1 does not liquidate its bad old firms if bank 2 intends to liquidate.

In equilibrium, bank 1 does not liquidate but bank 2 liquidates its bad old customers.

(d) If the liquidation payoff is high, i.e. $\alpha A \geq \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I$, the liquidation incentives are as follows:

- Bank 2 always liquidates its bad old firms.
- Bank 1 always liquidates its bad old firms.

In equilibrium, both banks liquidate their bad old customers.

Q.E.D.

5.4. Proof of Proposition 4

The result of the comparative static analysis is that the threshold value above which both banks decide to restructure is influenced by parameter changes as follows. The threshold value

- increases in s_1 as $\frac{\partial \left(\left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I \right)}{\partial s_1} = \frac{\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right)}{q(1-\mu)} I p \mu > 0$.

- increases in μ

$$\frac{\partial \left(\left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I \right)}{\partial \mu} = \frac{\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right)}{q(1-\mu)^2} I p s_1 > 0.$$

- increases in p

$$\frac{\partial \left(\left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) I \right)}{\partial p} = \frac{\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) (1-p) + 1}{q(1-p)(1-\mu)} I s_1 \mu > 0.$$

It is obvious from the condition $\alpha A = I \left(\frac{ps_1\mu}{(1-\mu)q} \left(\ln \left(\frac{(qX-I)(1-\mu)}{\mu s_1 I(1-p)} \right) + 1 \right) + 1 \right) - \varepsilon$ that case (3), where both banks liquidate, is more likely if α increases. Q.E.D.

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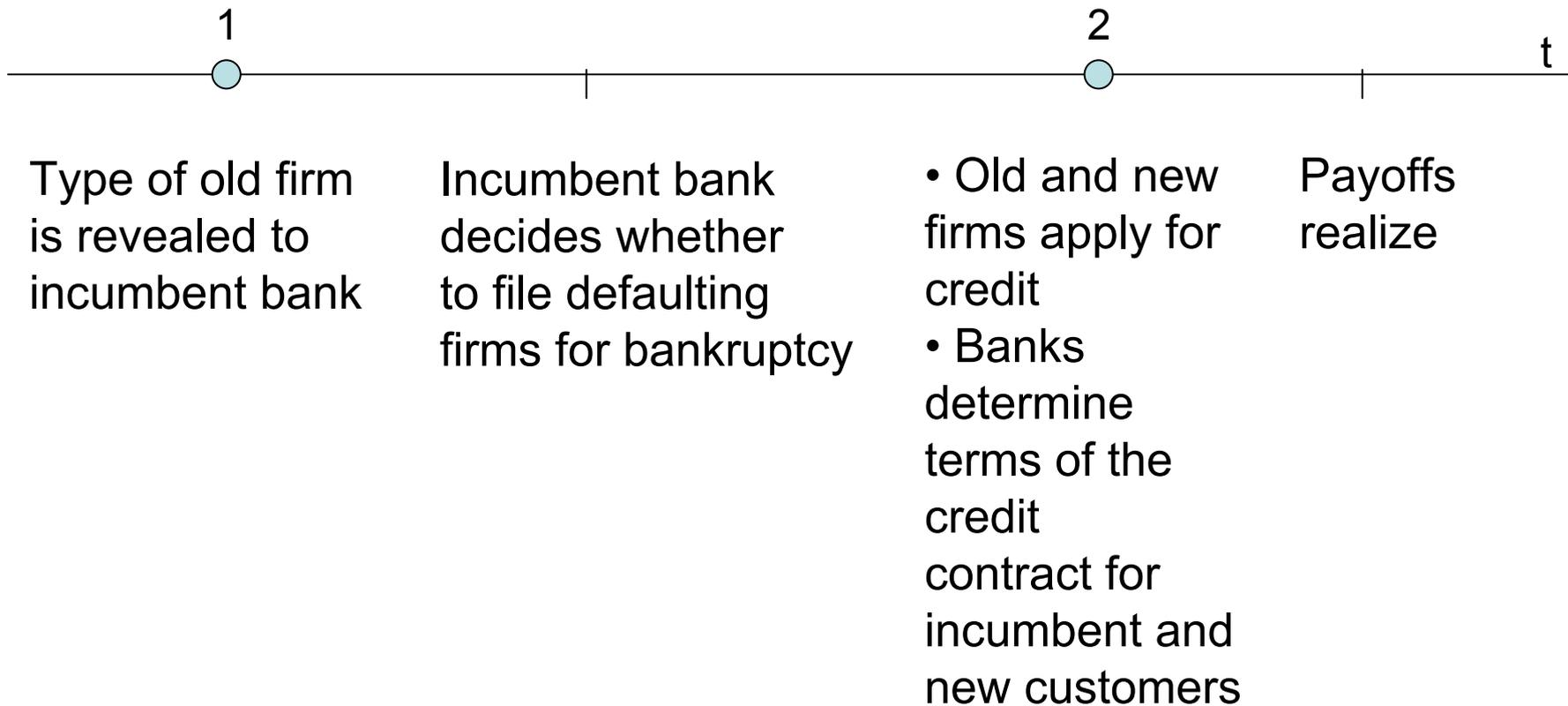


Figure 1: Time line

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