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Essays on Financial Economics

by
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Department of Economics

Submitted in partial fulfilment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Graduate Studies
The University of Western Ontario
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Abstract

This thesis is a collection of four essays in financial economics.

The first essay develops an information-based banking model to examine the choice by lenders between negotiated debt transactions and open-market transactions when the loan market is subject to adverse selection. Due to the borrowers' reputation generated through repeated financial transactions, the model exhibits dynamics of adverse selection, which, in turn, induces the movement towards securitization. The paper also studies how altering the information structure between banks and borrowers affects the dynamics of bank-loan relationships and lending rates.

The second essay applies a version of the information-based banking model developed in the first essay to examine the role of financial deepening in the context of a dynamic model. In the essay, financial deepening is interpreted in two ways: (1) a decrease in the resources spent on negotiation over terms of financial transactions, and (2) the evolution of credit markets from those with substantial degree of adverse selection to those with no adverse selection. The effect of those changes on the rate of growth is studied. It is also shown that some economic policies which affect the bargaining position of the bank may enhance the growth rate.

The third essay attempts to show that the existence of a loan sales market enables the deposit insurance corporation to implement risk-adjusted insurance premiums to banks. In the essay, the exact riskiness of the banks is private information which cannot be observed by the deposit insurance corporation. It is shown that the advent of a loan sales market induces the banks to voluntarily reveal their riskiness, and, hence,

resolves the adverse selection problem between the deposit insurance corporation and banks.

The fourth essay develops a life-cycle model of corporate finance where a variety of ages of borrowers coexist to show that higher default rates in financial markets need not be associated with lower social welfare measured by the level of production by the lenders and the borrowers. The essay demonstrates that, when the brokerage fee charged by securities companies decreases, the default rate in the bond market as well as the one among the borrowers who raise funds through banks rises while the social welfare increases.

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Contents

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Overview

This thesis is a collection of four essays in financial economics. The first three chapters apply the sequential bargaining model to study bilateral financial transactions (Chapter 1 and Chapter 2 study financial transactions between banks and borrowers, while Chapter 3 studies transactions between two banks), and the last chapter extends the model used in the first essay.

In Chapter 1, an information-based banking model is developed to examine the choice by lenders between negotiated debt transactions and open-market transactions when the loan market is subject to adverse selection. Due to the borrowers' reputation generated through repeated financial transactions, the model exhibits dynamics in the degree of adverse selection, which, in turn, generates a movement towards securitization; namely, the transition of financial system from one that is bilateral trading oriented, where the terms of loan contracts are determined via bilateral negotiation, to one that is market-based trading oriented, where the terms of contracts are determined competitively and anonymously. The paper also studies how altering the information structure between the bank and borrowers affects the dynamics of bank-loan relationships and lending rates.

In Chapter 2, a version of the information-based banking model developed in

Chapter 1 is used to examine the role of financial deepening in the context of a dynamic model. In the essay, financial deepening is interpreted in two ways; (1) a decrease in the resources spent on negotiation over terms of financial transactions, and (2) the evolution of credit markets from those with substantial degree of adverse selection to those with no adverse selection. The effect of those changes on the rate of growth is studied. It is also shown that some economic policies which affect the bargaining position of the bank against the borrowers may enhance the growth rate.

Chapter 3 focuses on the movement towards securitisation in financial markets, yet in a way that is different from Chapter 1. In this chapter, securitization is interpreted as the repackaging of loans by banks and other financial institutions into negotiable financial securities secured by the loans. In particular, the essay highlights a benefit of *loan sales*, i.e. the sale by banks of newly originated loans to nonbank financial institutions and other banks. The essay attempts to show that the existence of a loan sales market enables the deposit insurance corporation to implement risk-adjusted insurance premiums to banks. (It is often argued that risk-adjusted deposit insurance is preferable to fixed rate deposit insurance on the ground that the former is more efficient and equitable than the latter.) In the essay, the exact riskiness of the banks is private information that cannot be observed by the deposit insurance corporation. It is shown that the advent of a loan sales market induces the banks to voluntarily reveal their riskiness, and, hence, resolves the adverse selection problem between the deposit insurance corporation and banks.

Chapter 4 develops a life-cycle model of corporate finance where a variety of ages of borrowers coexist to show that higher default rates in financial markets need not be associated with lower social welfare as measured by the level of consumption by the lenders and borrowers. The essay demonstrates that, when the brokerage fee charged by securities companies decreases, the default rate in the bond market as well as the one among the borrowers who raise funds through banks rises while the social welfare increases.

Chapter 1

Reputation, Negotiated-Debt Transactions, and the Transition of a Financial System

1.1 Introduction

It is often argued that the financial structures which emerged in the 1980's in some industrialized countries, such as the United States and Japan, are substantially different from the previous structures in that they became more responsive to market forces. In particular, using time series data from flow of funds accounts published by the Bank of Japan from 1954 to 1985, Cargill and Royama (1988), (1992) show that the history of loan transactions indicates an evolution of financial trading arrangements from bilateral trading, where terms of loan contracts are determined via bilateral negotiation, to market-based trading, where the terms of contracts are determined competitively and anonymously. In other words, the channel of fund raising by firms has been shifting from banks to open markets such as the equity and corporate bond markets, and, hence, banks are losing their role of financial intermediation

(See also Frankel (1992) and Hoshi et al. (1990) for evidence in Japanese financial markets, and Baer and Mote (1992) for the evidence in the U.S. financial markets). The question is: What caused this movement towards securitization?

The purpose of this chapter is to address this question. An information-based banking model is constructed to demonstrate that acquisition of credibility by borrowers/firms is essential in explaining the current movement towards securitization in financial markets.[1]

In the current analysis, a bank negotiates with the borrowers over the terms of loan contracts. Given that the type of each borrower, risky or safe, is private information possessed by the borrower, a consequence of the negotiation becomes nontrivial. There is an incentive for a risky borrower to imitate safe borrower's actions so as to obtain a better offer, i.e. cheaper credit, from the bank. The role of the bank is to alleviate this adverse selection problem. Namely, in the course of negotiation, the bank detects borrowers' type, and it offers different lending rates based on their type. It is assumed that the history of default can be publicly observed. The reputation of the borrowers generated by this public information enables us to derive the dynamics of the degree of adverse selection and the life cycle of borrowing by firms. The model shows that the borrowers raise funds from the bank when young (i.e. they engage in bank-loan relationships) and from the market when old. When a variety of ages of borrowers coexist, the model exhibits the movement towards securitization.

[1]According to Binhammer (1988) (p.672), *securitisation* is defined as "the trend whereby securities are replacing bank loans as a means of borrowing". He states that it is "also used to describe the conversion of loans by banks and other financial institutions into negotiable securities and the issue of negotiable financial instruments secured by outstanding loans". The securitisation discussed herein is interpreted in the former way.

In order to describe the negotiation process, a standard sequential bargaining model with incomplete information is used (see Fudenberg and Tirole (1992), Osborne and Rubinstein (1990)). In particular, we use a version of the Fudenberg and Tirole (1983) model where the bank makes a take-it-or-leave-it offer of the lending rate up to two times to each borrower. The borrowers are assumed to possess private information about their type that is relevant to the bank for the determination of the lending rate. The model captures the bilateral feature of financial transactions between the bank and borrowers. The model is developed in Section 1.2, and a family of equilibrium dynamics are studied in Section 1.3.

In Section 1.4, we consider how altering the specification of the information structure between the bank and the borrowers affects the consequence of the aforementioned analysis. In particular, it is assumed that the lending rates accepted in the last period by the borrowers as well as the default history is publicly observed with some probability. When the default history is the only signal which reveals the type of a borrower, no incentive effect for the borrower arises as the probability of defaulting is exogenously given. However, if the lending rates accepted in the last period are also observable, an incentive effect arises as the borrowers can choose whether to accept or reject offers made by the bank. With this alteration of the model, it is shown that the speed of the evolution of financial system becomes faster. It is also shown that lending rates offered to the borrowers are lower when the lending rates accepted in the last period are observable compared with the economy in which default history is the only public information. Furthermore, the model predicts that the lending rate offered to borrowers decreases over time as the degree of adverse selection becomes lower. We also study the effect on the dynamics of the financial system of varying the probability of observing the lending rates accepted in the last period.

The current analysis is related to Diamond (1991) which focuses on the choice between direct borrowing and indirect borrowing through a bank that monitors borrowers' choice of a project to alleviate information asymmetry between the lenders and borrowers. In his paper, the shift from indirect borrowing to direct borrowing is derived due to the monitoring by the bank and reputation of the borrowers in a way that is similar to the analysis in this chapter. However, the current analysis is distinguished from Diamond (1991) in at least two ways. First, the current model captures the bilateral feature of financial transactions where lending rates are determined based on information obtained in the course of bilateral negotiation. In Diamond (1991), lending rates are determined using only the aggregate degree of adverse selection in a financial market. Consequently, different lending rates are offered to borrowers based on their types in the current analysis, while a single lending rate is offered in Diamond (1991). Second, in Diamond, a bank monitors borrowers so as to detect a selection of the risky project by borrowers who have a choice between a risky and a safe project. Hence, the monitoring reduces the moral hazard problem. On the other hand, in the current analysis, the type of project available to each borrower is given prior to any financial transactions. Hence, a bank negotiates to reduce adverse selection. It is shown that a bank negotiates with each borrower sequentially to separate borrowers based on their types over the number of negotiation undertaken in each period.

The rest of the chapter is organized as follows. Section 1.2 presents the model and describes the bilateral negotiation process. Section 1.3 studies the equilibrium dynamics of the model; i.e. the life cycle of borrowing and the movement towards securitization. Section 1.4 extends the analysis by introducing lending rates accepted in the last period as additional public information, which enables us to examine how it affects the borrowers' behaviour and, consequently, the evolution of the financial system. Section 1.5 discusses tentative extensions of the model and concludes the chapter.

1.2 The Model

1.2.1 The Environment

The economy consists of risk neutral lenders and borrowers (*he* for a lender and *she* for a borrower hereafter). The lenders live one period while the borrowers live T periods, where $2 \leq T < \infty$. There are always N_L lenders residing in this economy; i.e. there is no population growth for lenders. As for the borrowers, however, the same number of potential borrowers, N_B, arrive in the economy every period. The borrowers are one year old when they arrive, and they advance one year in age every period. Hence, a variety of ages of borrowers coexist in the economy, the initial period being the only exception. It is assumed that N_L is large relative to N_B so that there is always an excess supply of funds in the economy. Each lender receives one unit of non-consumable input as an endowment at the beginning of period. A lender can either invest his endowment to a borrower or store it himself. The lender has access to a constant returns to scale technology for storing the endowment within a period, converting it to a perishable consumption good at the end of the period. The storage technology returns Q units of consumption good for q units of input.

The borrowers receive no endowment. However, there are two kinds of projects available to the borrowers. Hence, the borrowers must raise funds from the lenders in order to operate their projects. The kind of project available to each borrower is associated with her type, which is assumed to be private information. Every project requires exactly q units of input, where $q > 1$. Hence, each borrower must raise funds from more than one lenders.

There are two types of borrowers; S-type and R-type. Each borrower has access to a constant returns to scale technology whose kind is associated with her type. It is assumed that the production facility of each borrower has capacity just sufficient for a single project. An S-type has access to a safe project which returns H units of consumption good for q units of input, while an R-type has access to a risky project which returns L units of consumption good with probability $\lambda \in (0,1)$ and returns zero with probability $1-\lambda$ for q units of input. In other words, an R-type borrower goes bankrupt with probability $1-\lambda$ regardless of any decision made by her or anybody else. The proportion of S-type borrowers at the beginning of period t is given by $\pi_t \in [0,1]$, whereas the proportion of R-type borrowers is given by $1-\pi_t$.

In order to introduce a nontrivial adverse selection problem into the current analysis, the following assumption is essential:

Assumption 1.1 $\lambda L < Q < H < L$

Three implications follow Assumption 1.1. First, $H < L$ indicates that R-type borrowers may have an incentive to imitate S-type borrowers' action since S-types have a lower reservation value than R-types. In other words, an R-type borrower is willing to contract for a high lending rate, but she would be able to enjoy a low lending rate by imitating the action undertaken by S-type borrowers. Second, $\lambda L < H$ indicates that the lenders may have an incentive to detect R-type borrowers. Third, $\lambda L < Q$ assures that the lenders prefer storing their endowments to lending to R-type borrowers.

Borrower i is identified with her age and track record, h_t^i, consisting of her default history prior to period t. Default occurs when borrowers fail to repay their debt (i.e. when the lending rate agreed between the borrowers and the bank cannot be realized). The next assumption is made to introduce intertemporal linkages into the model:

Assumption 1.2 *π_1, the age of borrower i and h_t^i $\forall i$ are public information in period t. π_1 is the proportion of S-type borrowers at age 1.*

Assumption 1.2 says that the information available to the lenders are updated every period since proportion $1 - \lambda$ of R-type borrowers default in each period, and the default rate, λ, is common knowledge. Since lenders' strategies are selected conditional on the information available to them in each period, Assumption 1.2 enables one to describe the dynamics of adverse selection and, hence, the choice of investment mode by the lenders. In Section 1.4, we extend the current analysis by introducing lending rates previously accepted by the borrowers as additional information that constitutes h_t^i along with default history.

In this environment, the lenders select either one of two trading arrangements (unless they choose to invest in their storage technology); i.e. bilateral trading or open-market trading. It is assumed that the establishment of a bank is necessary to conduct the bilateral trading, while the establishment of a securities company is needed to conduct the open-market trading. The establishment of the two financial intermediaries is assumed to be costly. Hence, if a bank or a securities company arises in the economy, it arises as a coalition among the lenders since it economizes on the set up cost. Both the bank and the securities company make collective investment decision in the way the lenders' funds are optimally allocated among the borrowers. In the following, we approximate the set up cost by zero for the sake of simplicity, yet the argument in the rest of the paper should go through with explicit treatment of the set up cost.

If the lenders choose to invest via open markets, they delegate the task of investment to the securities company. The open market can be interpreted as a corporate bond market in the following. Being delegated by the lenders, the securities company makes once-and-for-all offers of lending rates to the borrowers, taking into consideration the distribution over types of borrowers.

When the bilateral trading is chosen, the bank offers deposit rates to the lenders and collect funds from them. Being delegated by the lenders, the bank negotiates over lending rates with the borrowers to sort them out based on their types and, in effect, to alleviate the degree of adverse selection in financial markets. It is assumed that the negotiation is costly, and that the lender must pay whatever costs that arise in the process of intermediation. The exact process of bilateral trading is rather complicated and will be described in the next subsection.

1.2.2 The Bilateral Trading Process

For the last fifteen years, starting from the seminal work by Leland and Pyle (1977), the literature in the field of financial economics has attempted to rationalize the existence of banks. In particular, the literature has developed various kinds of information-based banking theories where banks are treated as a device to resolve incentive problems between ultimate lenders and ultimate borrowers.[2]

However, few works have attempted to capture the bilateral feature of financial transactions between banks and borrowers. It is well known that banks collect and process information about borrowers or projects chosen by the borrowers, and with this information they negotiate (or bargain) with the borrowers over terms of loan contracts (lending rate, collateral, compensating deposit, etc.) in a bilateral manner. In this spirit, Section 3.2 describes the negotiation between a bank and borrowers using a version of Fudenberg and Tirole (1983)'s sequential bargaining model.[3]

The bank and borrowers meet at the beginning of the period, and they negotiate over a lending rate. It is assumed that an outcome of production by the borrower cannot be observed by the bank. Hence, the lending rate cannot be determined contingent upon the outcome.[4] Under incomplete information, the bank's knowledge

[2]For example, Diamond (1984) studies the role of banks as a delegated monitor, viewing that delegated monitoring minimises the cost of information production. Williamson (1986) shows that intermediation is the dominant mode of financial transaction in a credit market with asymmetrically informed agents and costly monitoring. Diamond (1991) constructs a dynamic model of loan contracting, and studies reputation acquisition in a debt market where the reputation is affected by monitoring by a bank. He discusses how the degree of adverse selection affects the choice of an investment mode.

[3]In the remainder of this chapter, the time period and the age of borrowers are used interchangeably without causing any confusion. When the distinction between them is necessary, it will be notified (The distinction is necessary only in Section 3.3).

[4]It is not necessary to assume the unobservability of the outcome. The contingent contract is not

about the type of the borrower may change over the course of the negotiation process, which can be interpreted as the information produced by the bank in the context of the current analysis. The negotiation is allowed to last for up to two stages, within which the borrower's type may be detected.[5]

If a lending rate $r \in \Re_+$ (i.e. nonnegative real) is accepted in stage $j \in J = \{1, 2\}$, the outcome of the negotiation is (r, j) if the project succeeds. If the borrower defaults, $r = 0$. The preference of the bank, u_L, is defined over the set of outcome, $(\Re_+ \times J) \cup D$, where D represents a disagreement. If they reach a disagreement, the lenders' deposits in the bank will be disposed of and neither the bank nor the borrower obtains any return. Since the bank/the lenders is incompletely informed of the type of the borrower, the preference of the bank/the lenders needs to be defined over a probability distribution of the outcomes from the bank's point of view. Namely, the preference of the bank is defined over lotteries over $(\Re_+ \times J) \cup D$ space. In particular, it is assumed that the bank, or equivalently the lenders, maximises its expected utility.[6]

The preference of the borrower, u_B, is defined over a sequence of the set of outcomes since they live more than one period. It is assumed that both the lenders' and the borrowers' preferences are strictly decreasing in j, u_L is strictly increasing in r, and u_B is strictly decreasing in r. The former indicates that both agents attain higher utility if they reach an agreement in the first stage of their negotiation rather than in

possible even when the outcome is observable by both borrowers and the banks if it is impossible to validate the observation in court, or if it is too complex to write the contingent contract due to a large number of states of the economy.

[5]Hence, each *period* consists of two *stages*.

[6]The lenders are assumed to be risk neutral in order to abstract from risk-sharing issues. Also, it is implicit that the preference of the lenders who sucessfully made deposits in the bank is the same as that of the bank.

the second stage, whereas the latter specification indicates that the lender prefers to contract for a higher lending rate while the borrower prefers to contract for a lower lending rate. In particular, the preferences of the banks and the borrower at $t = t'$ are represented by

$$u_L = E_{t'}\{\delta_L^j \cdot r_{t'}\}$$

and

$$u_B = E_{t'} \sum_{t=t'}^{T} \beta^{t-t'} \{\delta_B^j \cdot I(x) \cdot (x - r_t)\}$$

respectively, where $E_{t'}$ is an expectation operator conditional on information available at the beginning of period t', and where $\beta \in (0,\ 1)$ is the borrower's subjective discount factor.[7]

The value of x is associated with the type of the borrower; i.e. $x = H$ (respectively, $x = L$) if a borrower is an S-type (respectively, R-type). $I(x)$ is an index function which equals 1 if $x = H$ and equals λ if $x = L$. It is assumed that the payoff to the lenders is discounted by $\delta_L^j \in (0, 1)$, while the payoff to the borrowers is discounted by $\delta_L^j \in (0, 1)$, where j represents the stage at which the bank and a borrower reach an agreement in their negotiation. An alternative interpretation is that the lenders (borrowers) must spend $1 - \delta_L^j$ $(1 - \delta_B^j)$ as a negotiation cost when an agreement is reached in stage j.

Furthermore, the following assumption is made:

[7]Note that the expression for u_L represents an expected return from a single borrower, and it does not represent a return to each lender who invested one unit of input. We use the expression as the bank's preference since it is a linear transformation of the expected return to each lender and it would not affect the lenders decision with regard to their choice of investment mode.

Assumption 1.3 $(Q/H)^{1/2} < \delta_L < (1/H)[\lambda H + \{(1-\delta_B)L + \delta_B H\} - H]$

Assumption 1.3 states that the negotiation cost for the lenders is neither very cheap nor very costly. The first inequality of Assumption 1.3 assures that the corporate bond market arises endogenously when the fraction of S-type borrowers is sufficiently large. The second inequality assures that the bank arises endogenously when the degree of adverse selection is sufficiently high.

We now describe the timing of the negotiation. Prior to the negotiation, the bank receives inputs from ultimate lenders, which it lends to the borrowers. Given h_t^i for all i and for all t, the bank screens out borrowers who have ever defaulted. A single default in the past means that she is an R-type since S-type borrowers never default. Then, the bank updates its belief that borrowers of a particular generation are S-type by calculating the distribution over the two types of borrowers at the beginning of each period. Note that the subjective belief of the bank should coincide with the real proportion of the S-types. Hence, the prior of the bank (and that of the lenders) and the real proportion of S-types, π_t, are interchangeably used in the following.

Knowing π_t, the bank makes take-it-or-leave-it offers in both stage 1 and stage 2. Namely, the bank makes the first offer, r_{t1}, to each borrower who has not yet been screened out of the loan market. Subsequently, a borrower either accepts or rejects the offer. If it is accepted, and if the project succeeds, the negotiation ends with outcome $(r_{t1}, 1)$. If the project fails, then, the outcome is $(0, 1)$. However, if rejected, the bank makes the second offer, r_{t2}, to each borrower who has rejected r_{t1} in the previous stage. In the second stage, the offer depends on the previously rejected proposal; namely, the bank updates its belief about the type of the borrower.

The revision of the belief must be consistent with Bayesian inference. Given the offer in stage 2, each borrower either accepts or rejects it. If accepted, and if the project succeeds, the outcome is $(r_{t2}, 2)$. If the project fails, then, the outcome is $(0, 2)$. If rejected, however, the bank and the borrower reach a disagreement, and no loan is made.

Finally, it is assumed that the loan contract that specifies a lending rate between the bank and the borrower is enforceable as long as the borrower does not fall into default. That is, it is not possible that a borrower claims she fell in default when she really did not and keep all the proceeds to herself. Alternatively, the contract can be interpreted as an enforceable debt contract that consists of a lending rate offer, r_j, and the corresponding repayment schedule; r_j if the project succeeds, and 0 if the project fails.

1.3 Equilibrium

1.3.1 The Equilibrium Financial Transactions between the Bank and the Borrowers

Section 4.1 characterises the equilibrium financial transactions. The equilibrium describes under what parameter restrictions the bank will arise endogenously in the economy, as well as how the bank resolves the information problem.

Perfect Bayesian equilibrium is used as the equilibrium criterion, which is defined as follows:

Definition 1.1 *A perfect Bayesian equilibrium (PBE) is a pair consisting of a triple of strategies and beliefs such that:*

(1) The strategy of each player (i.e. the bank, S-type borrowers and R-type borrowers) is optimal in the sense that the strategy is most preferred given the system of belief and other players' strategies.

(2) Beliefs are obtained from strategies and observed actions using Bayes' inference.

We focus on pure strategy perfect Bayesian equilibria for the sake of simplicity. The following argument should go through even if the agents were allowed to take mixed strategies, though it would complicate the analysis.

For the moment, let us consider the negotiation between a bank and the borrowers, and leave the question of under what parameter restrictions the lenders choose to invest via the banks. This decision problem is discussed in Section 3.2.

Let V_t be the value to R-types of borrowing when making optimal acceptance/rejection decision for lending rates offered by the bank from period t onward (till she dies at the age of T). In what follows, the suffix t for r_{t1}, r_{t2}, π_t and V_t is omitted for notational simplicity. Also, a prime represents next period values. For example, in period t, V is used for V_t, and V' is used for V_{t+1}.

Suppose that the negotiation takes place only once; i.e. the negotiation lasts only one stage. Then, R-type borrowers accept a lending rate r offered by the bank if and only if

$$\lambda\{\delta_B(L-r)+\beta V'\} \geq \beta V'$$

holds, or, equivalently,

$$r \leq L - \frac{1-\lambda}{\lambda}\frac{\beta}{\delta_B}V' \tag{1.1}$$

Define $L - \frac{1-\lambda}{\lambda}\frac{\beta}{\delta_B}V' \equiv \hat{r}$. Then, the next theorem follows:

Theorem 1.1 *The value of borrowing to R-type borrowers making optimal acceptance (or rejection) decision, V_t, is nondecreasing over time.*

The proof of Theorem 1.1 is given in Appendix 1.1.

First, let us consider the case where

$$\pi H + (1-\pi)\lambda H > (1-\pi)\lambda\hat{r} \tag{1.2}$$

or, alternatively,

$$\pi > \frac{\lambda(\hat{r}-H)}{H+\lambda(\hat{r}-H)}$$

Let us define $\frac{\lambda(\hat{r}-H)}{H+\lambda(\hat{r}-H)} \equiv \pi^c$. (1.2) indicates that the bank would choose to make loans to the borrowers with lending rate H if it were allowed to make only one offer. Since π and V' are nondecreasing overtime[8], the bank would choose to offer H if it were allowed to make only one offer in any period after t.[9]

For the region where the inequality (1.2) holds, let us consider the two-stage negotiation between the bank and the borrowers described in Section 2.2. In stage 2, both S-type and R-type borrowers accept an offer by the bank if and only if the offer is less than or equal to their reservation value. Namely,

$$r_2 \leq H$$

[8]Recall that Theorem 1.1 shows V' is nondecreasing

[9]Recall that the fraction $1-\lambda$ of R-types default, and that the default history is public information. Then, the bank screens out those with default history when it makes loans. Since λ is positive through time, the fraction of S-type borrowers, π, should increase over time.

and

$$r_2 \leq \hat{r}$$

must be satisfied for S-types and R-types respectively. We assume that $H < \hat{r}$ holds; i.e. β is sufficiently small. Hence, if an offer accepted by S-types, it is also accepted by R-types.

In stage 1, S-types accept an offer r_1 if and only if

$$\delta_B(H - r_1) \geq \delta_B^2(H - r_2)$$

forecasting that r_2 will be offered in stage 2. As for R-types, they accept an offer r_1 if and only if

$$\delta_B\lambda(L - r_1) \geq \delta_B^2\lambda(L - r_2) \tag{1.3}$$

again, forecasting that r_2 will be offered.

If r_1 is accepted, the game ends, and there will be no more negotiation in stage 2. Hence, suppose, without loss of generality, that r_1 was rejected by the borrower. Then, regardless of the offer in stage 1, the bank offers H in stage 2. Rationally anticipating that the bank will offer H in stage 2 if she refuses the first offer, S-types accept r_1 if and only if

$$r_1 \leq H$$

while R-types accept r_1 if and only if

$$\delta_B\lambda(L - r_1) \geq \delta_B^2\lambda(L - H) \tag{1.4}$$

or equivalently,

$$r_1 \leq (1-\delta_B)L + \delta_B H \tag{1.5}$$

Let us define the critical value for the first offer $r_1^* \equiv (1-\delta_B)L + \delta_B H$.

It is clear by now that the lender chooses r_1 between H and r_1^* depending on whether $\delta_B\{\pi H + \lambda(1-\pi)H\}$ is greater or less than

$$\delta_B(1-\pi)\lambda r_1^* + \delta_B^2 \pi H \tag{1.6}$$

(1.6) represents the expected return from offering r_1^* in stage 1 and H in stage 2. Note that R-type borrowers are indifferent between accepting and rejecting the offer r_1^*. Yet, the bank is better off if R-types accept r_1^* in stage 1 as the negotiation cost for the bank in stage 2 will be reduced. Hence, the bank makes an offer slightly less than r_1^*, say $r_1^* - \epsilon$, in stage 1, which is accepted by all the R-type borrowers. In the following, we will approximate this value with r_1^* without loss of generality.

Let us define

$$\Psi(\pi) \equiv \{\delta_B(1-\pi)\lambda r_1^* + \delta_B^2 \pi H\} - \delta_B\{\pi H + \lambda(1-\pi)H\}$$

Inside the first bracket is the expected return for the bank from offering r_1^* in stage 1 and H in stage 2, while inside the second bracket is the expected return from offering H in stage 1. Hence, $\Psi(\pi)$ represents the difference between the two expected returns. Taking a derivative of $\Psi(\pi)$ with respect to π, we have

$$\frac{\partial \Psi(\pi)}{\partial \pi} = \delta_B(\delta_B - 1)[(1-\lambda)H + \lambda L] < 0 \tag{1.7}$$

Also, we have

$$\Psi(1) = \delta_B(\delta_B - 1)H < 0 \tag{1.8}$$

and

$$\Psi(0) = \delta_B \lambda r_1^* - \delta_B \lambda H$$
$$= \delta_B \lambda \{(1-\delta_B)L + \delta_B H - H\} > 0 \quad (1.9)$$

Since $\Psi(\pi)$ is continuous in π, (1.7), (1.8) and (1.9) assure the existence of a unique $\pi^* \in (0,1)$ such that $\Psi(\pi^*) = 0$. Setting $\Psi(\pi^*) = 0$, π^* can be solved as:

$$\pi^* = \frac{\lambda(1-\delta_B)(L-H)}{\lambda(1-\delta_B)L + (1-\lambda)(1-\delta_B)H} \quad (1.10)$$

Note that the value of π^* is independent of time. Therefore, the outcome of the negotiation described herein can be applied to any period.

Now, consider the case where $\pi < \pi^c$. Then, the next theorem can be shown:

Theorem 1.2 *The bank would not offer $r_1 \in (r_1^*,\ L - \hat{r}]$ in the equilibrium when $\pi < \pi^c$.*

The proof of Theorem 1.2 is given in Appendix B.

Given Theorem 1.2, the bank chooses the first stage offer between H and r_1^*. Hence, the bank's strategy becomes the same as the previous case where $\pi \geq \pi^c$; i.e. the bank chooses r_1^* if $\pi < \pi^*$ and H if $\pi > \pi^*$.

Given the argument above, the following set of strategies and beliefs constitutes a *PBE* for all t:

Case 1 $\pi \geq \pi^*$: Stage 1: The bank offers H; S-types accept an offer if and only if $r_1 \leq \delta_B r_2$; R-types accept an offer if and only if $r_1 \leq (1-\delta_B)L + \delta_B H$.

Stage 2: The bank offers H; S-types accept an offer if and only if $r_2 \leq H$;

R-types accept an offer if and only if $r_2 \leq \hat{r}$; The posterior is given by the intial distribution of the types, π. I.e. there is no updating of the belief.

Case 2 $\pi^* > \pi$: Stage 1: The bank offers r_1^*; S-types accept an offer if and only if $r_1 \leq \delta_B r_2$; R-types accept an offer if and only if $r_1 \leq (1-\delta_B)L + \delta_B H$
Stage 2: The bank offers H; S-types accept an offer if and only if $r_2 \leq H$; R-types accept an offer if and only if $r_2 \leq \hat{r}$; The posterior is given by the true distribution of the types.

The outcomes of the negotiation associated with the equilibria are given as follows:

Case 1 $\pi \geq \pi^*$ (Pooling Equilibrium) : The bank offers H in stage 1, and both S-type and R-type borrowers accept the offer. The negotiation ends in stage 1.

Case 2 $\pi^* > \pi$ (Separating Equilibrium) : The bank offers r_1^* in stage 1, which is accepted by all the R-type borrowers. S-types do not accept the offer. In stage 2, the bank offers H, which is accepted by all the S-type borrowers.

1.3.2 The Choice of an Investment Mode by the Lenders

In Section 3.1, we examined the negotiation between the bank and the borrowers. However, the bank may not arise in the economy as the negotiation can be too costly for the lenders relative to the gain from detecting R-type borrowers and collecting higher lending rates from them. We now examine under what condition the lenders choose to invest via the bank. It is clear from the discussion above that the bank fails to exist for $\pi > \pi^*$. There is no point in wasting negotiation costs in stage 1 of the negotiation since the lenders can obtain the same return anyway by lending via the corporate bond market. In other words, the bank fails to arise in the economy when the financial trading equilibrium is pooling. It is also likely that the lenders prefer to invest via the corporate bond market for π which is a little less than π^* since we now need to take into account the bank's negotiation cost in stage 1 of the negotiation. Furthermore, it is likely that the bank fails to exist if π is very small. This is because the expected return from lending will become closer to λL. Since the return from the storage technology, Q, is greater than λL net of the negotiation cost, the lenders are likely to choose to store their endowments for sufficiently small π. These predictions are proved to be correct below.

First, the lenders choose to invest via the corporate bond market and obtain H as a return when the production is successful if and only if the return from lending via the corporate bond market outweighs the return from lending via the bank. Namely, the following inequality must hold:

$$\{\delta_L(1-\pi)\lambda r_1^* + \delta_L^2 \pi H\} \leq \{\pi H + \lambda(1-\pi)H\} \tag{1.11}$$

Solving (1.11) for π, we have

$$\pi \geq \frac{\delta_B \lambda r_1^* - \lambda H}{H - \lambda H + \delta_B \lambda r_1^* - \delta_B^2 H} \tag{1.12}$$

Define $\frac{\delta_B \lambda r_1^* - \lambda H}{H - \lambda H + \delta_B \lambda r_1^* - \delta_B^2 H} \equiv \Pi^*$. Π^* is the value of π above which the lenders choose to invest through the bond market. Clearly, $\Pi^* < \pi^*$.[10]

Second, the lenders choose to invest in the storage technology and obtain a certain return, Q, if and only if the following inequality holds:

$$Q \geq \{\delta_L(1-\pi)\lambda r_1^* + \delta_L^2 \pi H\} \tag{1.13}$$

[10] Assumption 1.3 assures that $0 < \Pi^* < 1$ holds.

or, equivalently,[11]

$$\pi \leq \frac{Q - \delta_L \lambda r_1^*}{\delta_L(\delta_L H - \lambda r_1^*)} \tag{1.14}$$

Define $\frac{D - \delta_L \lambda r_1^*}{\delta_L(\delta_L H - \lambda r_1^*)} \equiv \Pi^{**}$, where Π^{**} is the value of π below which the lenders choose to invest in their storage technology. Note that Assumption 1.2 and 1.3 assure that the numerator and the denominator of Π^{**} are positive. Assumption 1.3 also assures that $\Pi^* > \Pi^{**}$.

From (1.11) and (1.13), the result can be summarized as follows:

Theorem 1.3 *A bank arises for $\pi \in (\Pi^{**}, \Pi^*)$. A corporate bond market opens for $\pi \geq \Pi^*$, while there is no financial transaction between the borrowers and the lenders for $\pi \leq \Pi^{**}$.*

Theorem 1.3 states that the bank arises in the economy if the fraction of R-type borrowers is neither too large nor too small; i.e. $\Pi^* > \pi > \Pi^{**}$. An alternative interpretation of this result is that the bank arises in the economy where the degree of adverse selection is sufficiently high.[12] When the degree of adverse selection is sufficiently high, it is likely that the return from lending via the bank exceeds the return from investment via the bond market.

Theorem 1.3, (1.11) and (1.13) lead us to the following propositions.

Proposition 1.1 *A borrower with a perfect track record obtains loans from the bank while young, and she obtains loans from the corporate bond market when she becomes sufficiently old.*

[11] Assumption 1.3 assures that $0 < \Pi^{**} < 1$ holds.

[12] Note that the degree of adverse selection is not proportional to the level of π. The absolute distance between the fraction of S-type (equivalently, R-type) borrowers and 1/2 represents the measurement for the degree of adverse selection.

This proposition interprets Theorem 1.1 in the context of life cycle of borrowing by a single borrower. Suppose that $\pi \in (\Pi^{**}, \Pi^{*})$. Then, the lenders and borrowers engage in financial transactions, and a borrower obtains loans from the bank. As time passes, the proportion of S-type borrowers of the same age increases due to the observability of the default histories by the lenders. If the borrower continues to have a perfect track record, namely, no past default, she keeps on receiving loans from the bank. Eventually, the fraction of S-type borrowers reaches Π^{*}. Then, lenders start making loans to the borrower directly through the bond market. Lenders consider that the borrower is credible enough, i.e. the borrower is S-type with sufficiently high probability, and they make loans to her without negotiation since the return from direct lending through the bond market exceeds the return from lending via the bank net of the negotiation cost. From that period on, the borrower continues to receive loans via the bond market as long as she does not default.

Proposition 1.2 ***The bank is more likely to arise in the economy when the negotiation cost is cheaper.***

This proposition can be verified by examining an effect of varying the negotiation cost of the bank on Π^{*} and Π^{**}. From (1.11) and (1.13), we obtain

$$\frac{\partial \Pi^{*}}{\partial \delta_L} > 0 \tag{1.15}$$

and

$$\frac{\partial \Pi^{**}}{\partial \delta_L} < 0 \tag{1.16}$$

respectively. (1.14) and (1.15) indicate that the parameter space for π in which the bank arises endogenously shrinks both from above and below. An alternative interpretation is that the bank becomes less likely to emerge endogenously as it loses its bargaining power against the borrowers.

Proposition 1.3 ***The bank is more likely to arise in the economy when the negotiation cost for borrowers is higher.***

This proposition can be verified by taking derivatives of Π^* and Π^{**} with respect to δ_B. From (1.11) and (1.13), we have

$$\frac{\partial \Pi^*}{\partial \delta_B} < 0 \tag{1.17}$$

$$\frac{\partial \Pi^{**}}{\partial \delta_B} > 0 \tag{1.18}$$

(1.16) and (1.17) indicate that the parameter space for π in which the bank arises endogenously expands both from above and below. The intuition underlying this proposition is as follows: The higher negotiation cost for the borrowers implies the weaker position of the borrowers at the negotiation table against the bank. Hence, if the negotiation cost is higher for the borrowers, they must contract for higher lending rates. Therefore, as the borrowers' negotiation cost becomes higher, the lenders' expected return from lending becomes higher given their own negotiation cost, and, hence, the lenders are more likely to invest via the bank.

The next proposition completes the comparative static exercises:

Proposition 1.4 ***The bank is more likely to arise in the economy when (a) the rate of return from the safe project is higher, (b) the success probability of the risky project is lower, and (c) the return from the storage technology is lower.***

In order to verify (a), (b) and (c), take the derivatives of Π^{**} with respect to H, λ and Q. From (1.13),

$$\frac{\partial \Pi^{**}}{\partial H} < 0 \tag{1.19}$$

$$\frac{\partial \Pi^{**}}{\partial \lambda} < 0 \tag{1.20}$$

$$\frac{\partial \Pi^{**}}{\partial Q} > 0 \tag{1.21}$$

Hence, Proposition 1.4 has been proved. The intuition for (a) to (c) are given respectively as follows:

(a) If the return from the safe project is higher, the lenders will be willing to engage in the negotiation with the borrowers for some interval of π below Π^{**}. This is because the expected return from negotiation will outweigh the negotiation cost plus an opportunity cost (the return from storage technology), the negotiation cost being fixed.

(b) A greater value of λ implies that the risky project is safer, i.e. the expected return from an R-type borrower is higher. Then, the lenders are more willing to engage in negotiation with borrowers rather than to invest in the storage technology for the same reason as in (a).

(c) A greater value of Q means a higher opportunity cost for investing via the bank. Hence, the higher the return from the storage technology, the more unlikely the bank arises in the economy.

1.3.3 Equilibrium Dynamics

So far, the evolution of financial trading arrangements within the life cycle of a single borrower has been explored. Section 3.3 analyses the evolution of a financial system in which a variety of ages of borrowers are coexisting. In this subsection, the subscript t denotes the period of time and not the age of borrowers.

Let t^* be the time period such that

$$\pi_{t^*-1} < \Pi^* < \pi_{t^*} \tag{1.22}$$

(1.22) indicates that no borrower has access to the corporate bond market before period t^*; namely, no borrower has a sufficiently long perfect track record to borrow via the corporate bond market before period t^*.

Note that, in each period, borrowers with a perfect track record receive loans. Also, since the supply of funds exceeds the demand for funds throughout, there always exist funds leftover to the lenders. Those funds are invested in the storage technology. The following summarizes the evolution of the financial system (See Figure 1):

Period 1 to t^* : No borrower has yet established sufficiently good credibility to get access to financial transactions via a corporate bond market.

Period $t^* + 1$ to T: Some proportion of borrowers with perfect track records get access to the corporate bond market. The proportion of loans financed via the corporate bond market increases from $t^* + 1$ to T. The evolution of a financial system in this phase can be interpreted as the movement towards securitization.

Period $T+1$ onward: The economy reaches a stationary phase at period $T+1$. The age distribution of borrowers who engage in alternative mode of financial transactions remain constant from period $T+1$ on. The banks lend to borrowers who do not have access to the corporate bond market due to their insufficient, although perfect, track records.

Recall that t^* and T are the duration of the bank-loan relationship (i.e. how long a borrower must raise funds via the bank) and the life span of the borrowers respectively. Since T is given exogenously, t^* alone specifies the dynamics of a financial system. In particular, the slower transition of a financial system results from the longer duration of the bank-loan relationship. Hence, the remainder of this paper focuses mostly on the duration of bank-loan relationships rather than the transition of a financial system itself.

As indicated in the introduction, the equilibrium dynamics demonstrate the movement towards securitization. Specifically, the fraction of funds financed via the banks diminishes from period $t^* + 1$ to T. In fact, the securitization movements in financial markets are commonly observed in some industrialized countries such as the U.S. and Japan. For example, Cargill and Royama (1992) argues that "the transition of Japanese finance can best be thought of as a process of securitization in the sense that a shift is occurring from bilateral, negotiated, or customer-based ways of obtaining liquidity to methods that rely on the exchange of assets for liquidity in open, less regulated, and wide-participation markets." (p.367) In order to illustrate this phenomenon, they modify time series data from flow of funds accounts published by Bank of Japan from 1954 to 1985, and demonstrate how the role of negotiated transactions have declined for that period. (See Cargill and Royama (1988), chapter 2 for details.)

As for the U.S. financial markets, Baer and Mote (1992) found that commercial banks' share of total business financing has fallen from about 60 % in 1900 to roughly 20 % in 1989. They argue that "since the turn of the century, commercial banks have lost market share in commercial lending to a variety of other types of financial institutions" (p.476), and that "throughout the 1970s and 1980s, the role of banks in the financial system has been subject to continuous change as the funding of consumer and commercial credit has shifted from the banking industry to the capital markets." (p.530)

Note that, although the model predicts that the proportion of funds financed via banks decreases over time, it does not necessarily imply that banks will eventually lose all their market share in commercial lending in the future for two reasons. First, as the model predicts, there is always substantial information asymmetry between lenders and borrowers with short track records. In fact, the proportion of bank lending to middle size and small companies as well as consumer loans are increasing lately. Second, the banks would not lose their customers as long as the lending rates are tied to market interest rates. Loans tied to market rates are especially attractive to smaller firms which do not have access to money markets as they are an alternative to commercial paper.

In fact, in Japan, it is shown by Cargill and Royama (1988), (1992) that the proportion of bank loans did not decrease for the period 1954 to 1985 regardless of the current movement towards securitization. Cargill and Royama (1992) argue that "it may be too early to predict further declines in the indirect finance ratio and, in any event, the securitization process does not necessarily mean the demise of financial institutions–only a change in their nature of the relationship to borrowers." (p.367) Also, according to Baer and Mote (1992), in the U.S., "although commercial banks have lost their dominant position in lending to the largest corporations, they retain much of their advantage as unsecured lenders to small and medium-sized businesses. Moreover, they have long been the leading suppliers of consumer credit and recently overtook the savings and loans associations as the leading source of new residential mortgage loans." (p.481) Furthermore, they predict that "in conjunction with their growing off-balance-sheet activities and their expansion, through nonbank subsidiaries of their holding companies, into new activities, these facts suggest that banks are likely to remain the most important financial institutions in the United States for some time to come." (p.481)

1.4 The Evolution of a Financial System with an Incentive Effect

So far, the default history is the only public information which reveals the type of borrowers. In this section, we examine the evolution of a financial system when lending rates accepted by the borrowers in the last period are also publicly observed with probability $1-\rho \in (0, 1)$; i.e. the bank can catch some fraction of R-type borrowers as a result of financial transactions in the previous period. This modification is intended to capture the fact that banks obtain information about their customers from previous financial transactions and utilize it to alleviate information problem for the sake of current and future transactions. Namely, the banks can capitalize the information obtained from the previous financial transactions. Also, the partial unobservability of previously accepted lending rates proxies for the reality that banks obtain a set of observations from financial transactions, yet, they are not capable of telling the exact type of the borrowers due to some missing information or their limited ability.

In this case, credits are rationed away from fraction $1-\rho$ of borrowers who have accepted an offer by the banks in stage 1 of the negotiation along with those who have defaulted before.

Should the negotiation take place only once, R-type borrowers would accept an offer if and only if

$$\lambda\{\delta_B(L-r)+\rho\beta V'\}\geq\beta V'$$

should hold, or, equivalently,

$$r\leq L-\frac{\beta}{\delta_B}(\frac{1}{\lambda}-\rho)V'$$

Let us define $L-\frac{\beta}{\delta_B}(\frac{1}{\lambda}-\rho)V'\equiv\bar{r}$. Now, suppose that the bank were allowed to make an offer only once at period t. Then, the bank would choose to offer H if

$$\pi H+(1-\pi)\lambda H>(1-\pi)\lambda\bar{r}$$

Let π^{***} be a fraction of S-type borrowers such that

$$\pi^{***}H+(1-\pi^{***})\lambda H=(1-\pi^{***})\lambda\bar{r}$$

As in Section 3.1, the following theorem needs to be verified:

Theorem 1.4 ***When the lending rates accepted by the borrowers in the last period are partially publicly observable, V_t is nondecreasing over time.***

The proof of Theorem 1.4 is given in Appendix D. Theorem 1.4 assures that the bank would choose to offer H if it were allowed to make only one offer in any period after π reached π^{***} (See Section 3.1 for the detailed argument).

Now, suppose, in current period, $\pi > \pi^{***}$; i.e. suppose that the bank would offer H if it were allowed to make an offer only once. Furthermore, suppose, without loss of generality, that the offer in stage 1, r_1, was rejected by a borrower. Then, the bank offers H in stage 2. Anticipating that the bank offers H in stage 2, R-type borrowers accept the offer in stage 1 if and only if the following incentive constraint is satisfied:

$$\lambda\{\delta_B(L - r_1) + \rho\beta V'\} \geq \lambda\{\delta_B^2(L - H) + \beta V'\} \tag{1.23}$$

The right hand side of (1.22) has additional term $\lambda\beta V'$ because the borrower can reach the next period with probability λ without losing her credibility. On the other hand, the left hand side of (1.22) has additional term $\lambda\rho\beta V'$ because, if the borrower accepts r_1, she can reach the next period with probability $\lambda\rho$ without losing her credibility; i.e. she reaches the next period if her project succeeds *and* if her type is not revealed by the outcome of financial transactions in the last period. The perfect track record in this section is defined as no default history and no observation of accepting an offer greater than H in the last period.

(1.22) can be solved for r_1 as follows:

$$r_1 \leq (1 - \delta_B)L + \delta_B H - (1 - \rho)\frac{\beta}{\delta_B}V'$$

Let us define

$$r_1^{**} \equiv (1-\delta_B)L + \delta_B H - (1-\rho)\frac{\beta}{\delta_B}V' \tag{1.24}$$

Following the argument in section 3.1, if the lenders choose to invest via the bank, the equilibrium outcome of the negotiation between the bank and the borrowers turns out to be *separating*. Namely, R-types accept r_1^{**} in stage 1, and S-types accept H in stage 2.

The following propositions are now ready to be verified.

Proposition 1.5 *When lenders choose to make loans via the bank, the equilibrium lending rate offered in stage 1 of the negotiation is lower in the case where both the default history and some fraction of lending rates accepted by the borrowers in the last period are publicly observable than in the case only default history is observable.*

From (1.4) and (1.23), obviously, the stage 1 offer without the incentive effect, r_1^*, is greater than the stage 1 offer with the incentive effect, r_1^{**}, by $(1-\rho)\frac{\beta}{\delta_B}V'$. Hence, the proposition holds.

The statement in Proposition 1.5 is quite intuitive. If the lending rate accepted by an R-type borrower is observable with some positive probability, the borrower becomes more reluctant to accept an offer in stage 1. This is because the acceptance may reveal her type, which results in the cut off of loans to her thereafter. Hence, the bank must set the offer in stage 1 sufficiently low so that it induces R-type borrowers to accept it. In other words, the gain from accepting the offer in stage 1, $\lambda\{\delta_B(L-r_1)+\rho\beta V'\}$, must balance with the benefit from accepting the offer in stage

2 plus keeping the future profit opportunity with probability one net of negotiation cost; i.e. $\lambda\{\delta_B^2(L-H)+\beta V'\}$.

Note that r_1^{**} is decreasing in β. This is because β represents patience of the borrowers. The more patient an R-type is, the less he is willing to accept a high lending rate in stage 1 of the negotiation. In other words, the high β strengthens the bargaining power of the R-type at the negotiation. Also, r_1^{**} is increasing in ρ. In particular, $\lim_{\rho\to 1} r_1^{**} = (1-\delta_B)L + \delta_B H$. Namely, in the limit, the optimal offer converges to the offer made when default history is the only public information. This is because, the more likely the bank can detect R-type borrowers as a consequence of financial transactions in the last period, the more reluctant R-type becomes to accept the offer in stage 1.

Proposition 1.6 *Given sufficiently large T, a lending rate offered in stage 1 of the negotiation between the bank and the borrowers decreases through time if some fraction of lending rates accepted by the borrowers in the last period are public information.*

Equation (1.23) says that r_1^{**} is a function of V'. Since it is shown in Theorem 1.4 that V_t is nondecreasing over time, clearly, r_1^{**} is nonincreasing over time. In particular, r_1^{**} strictly decreases over time when the lenders make loans through the bank. Hence, Proposition 1.6 holds.[13]

The result in Proposition 1.6 differs from the one in Section 1.3 where the incentive effect was not considered. When lending rates accepted by the borrowers in the last period are not publicly observed, the lending rate offered in stage 1 of the negotiation

[13]This is because V_t is strictly increasing in the region where the negotiation takes place between the bank and the borrowers. It is shown in the proof of Theorem 1.4.

between the bank and borrowers remains constant through time, namely, $r_1^* = (1 - \delta_B)L + \delta_B H$ for all t. The result herein is more consistent with the observation in financial markets that older firms have access to cheaper credit.

Note that the following expression for V_t, $t < \tau$, is obtained by solving the defference equation given in Appendix 1.3:

$$V_t = [\lambda\beta\{1 + \delta_B(1 - \rho)\}]^{\tau - t} V_\tau + \frac{1 - [1 + \lambda\beta\{1 + \delta_B(1 - \rho)\}]^{\tau - t}}{\lambda\beta\{1 + \delta_B(1 - \rho)\}} K \qquad (1.25)$$

where

$$V_\tau = \frac{\lambda\beta(L - H)}{1 - \lambda\beta}$$

$$K = L - \{(1 - \delta_B)L + \delta_B H\}$$

(1.24) indicates that V_t is increasing in L, λ and δ_B while it is decreasing in H.[14] Since an increase in V_t means decrease in r_t^{**}, the results indicate that R-type borrowers become more conservative, or patient, in response to the increase in L, λ and δ_B and the decrease in H. In other words, with those changes in the variables, the incentive effect works more strongly; i.e. R-type borrowers become more reluctant to accept higher lending rates offered by the bank. In fact, these comparative static results are quite intuitive. First, either the increase in L or λ, or the decrease in H, or any combination of the three, should results in increase in R-types' conservativeness. This is because those changes increase the expected gross payoff to R-types, i.e. $\lambda(L - H)$. Second, reduction of the negotiation cost to R-types, i.e. the increase in δ_B, makes

[14]The comparative static results can be verified by taking derivatives of V_t with respect to those variables. The derivation can be provided by the author on request.

current value of future profits stream greater, and, hence, makes the R-type borrowers more conservative.

Proposition 1.7 *The duration of bank-loan relationships between the bank and the borrowers is shorter in the case both default history and some fraction of lending rates accepted by the borrowers in the last period are publicly observable than in the case only default history is observable.*

Since the proportion of S-type borrowers increases not only because the fraction λ of R-types default, but also because the fraction $1-\rho$ of R-type borrowers accept an offer in stage 1 and will never obtain any funds in the future, π increases faster if the lending rates accepted in the last period become components of the track record along with default history. In fact, if default history is the only public information, speed of the change is given by

$$(\pi_{t+1}/\pi_t)^* = \frac{\pi_t}{\pi_t+\lambda(1-\pi_t)}\cdot\frac{1}{\pi_t} = \frac{1}{\pi_t+\lambda(1-\pi_t)} \tag{1.26}$$

On the other hand, if both default history and some fraction of lending rates accepted in the last period are public information, it is given by

$$(\pi_{t+1}/\pi_t)^{**} = \frac{\pi_t}{\pi_t+\rho\lambda(1-\pi_t)}\cdot\frac{1}{\pi_t} = \frac{1}{\pi_t+\rho\lambda(1-\pi_t)} \tag{1.27}$$

Since $\pi_t+\lambda(1-\pi_t) > \pi_t+\rho\lambda(1-\pi_t)$, (1.25) and (1.26) indicate that $(\pi_{t+1}/\pi_t)^{**} > (\pi_{t+1}/\pi_t)^*$. Thus, the proposition has been proved.

Note that the right hand side of (1.26) is decreasing in ρ. This means that the duration of a bank-loan relationship lasts longer when the information revealed by the outcome of previous financial transactions is less indicative of the types of borrowers. Since the speed of the transition of financial system is positively associated with the duration of bank-loan relationships, this indicates that the movement of a financial system towards securitisation can be accelerated by strengthening disclosure requirement of companies' information about their financial transactions.

In particular, suppose $\rho = 0$. In this case, the bank-loan relationship lasts only for one period. Recall that the outcome of the negotiation is completely separating when financial transactions take place; i.e. different type of borrowers accept a different lending rate. Therefore, after the first negotiation took place, there is no information asymmetry between the bank and the borrowers, and, hence, there is no demand for the existence of the bank as a devise to resolve the information problem that prevails between the lenders and the borrowers. Hence, the banks would engage in negotiation only with age one borrowers if $\rho = 0$.

1.5 Conclusions

A model has been built to explain the evolution of a financial system from a bilateral trading oriented system to a market-based trading oriented one which is interpreted as the current movement towards securitization. In the analysis, the bank arose endogenously to resolve an information problem between the lenders and the borrowers, which derived the evolution of adverse selection in financial markets, which, in turn, resulted in the evolution of a financial system.

We also examined the evolution of a financial system when lending rates accepted by the borrowers in the last period as well as default history were publicly observed. A nontrivial incentive effect on the risky borrowers emerged in this case. It was shown that lending rates offered by the bank in stage 1 of the negotiation would be lower, and that the duration of bank-loan relationships between the bank and the borrowers would be shorter. The model also exhibited the dynamics of equilibrium lending rates. It was shown that the lending rates offered in stage 1 of the negotiation decreased through time as the borrowers became more credible and obtained more bargaining power against the lenders through time.

There are a few ways to extend the current analysis. First, the negotiation model of financial transactions can be used in highlighting the role of financial deepening, or the importance of well-functioning financial intermediation, in the context of a dynamic model. It is often said that credit markets in developed countries successfully mitigate information problems so that investments are efficiently allocated to more productive borrowers, and, hence, lenders receive a higher rate of return, which, in turn, results in higher saving, higher capital accumulation, and faster growth. The current model can be used to rationalize this conventional argument in the development economics literature. Chapter 2 of the thesis attempts to extend the analysis in this direction.

Second, recall that, in the current analysis, the movement towards securitization was described by the evolution of proportions of the borrowers financed via the bank and those financed via bond markets. However, in reality, it is common that firms raise funds both via banks and via markets. A dynamic model of capital structure with reputation and an incentive effect may be constructed to describe the securitization in financial markets. These topics are left for future research.

Appendix 1.1

We focus on the limiting case where $T \to \infty$ because the life expectancy of an R-type would have to be taken into account if T were too short. For example, if T is finite and if β is sufficiently close to 1, then the value of borrowing to the R-type is greater when she is younger just because her life expectancy is longer when young. The assumption does not lose generality because the following argument should go through for β sufficiently close to 1 and finite T.

Let τ be the age of a borrower when they get access to the bond market for the first time in her life. Then, for any $t \geq \tau$,

$$\begin{aligned} V_t &= \lambda\beta(L-H) + (\lambda\beta)^2(L-H) + (\lambda\beta)^3(L-H) + \ldots.. \\ &= \frac{\lambda\beta(L-H)}{1-\lambda\beta} \end{aligned} \tag{1.28}$$

Namely, $V_t = V_{t+1}$ for all $t \geq \tau$.

With this result in mind, suppose that, at any $t \geq \hat{t}$, $V_{t+1} \geq V_t$ holds. To prove Theorem 1.1, we need to show $V_{\hat{t}} \geq V_{\hat{t}-1}$ holds as well. From the result obtained above, $V_{t+1} \geq V_t$ holds for any $t \geq \tau$. Hence, assume, without loss of generality, $\hat{t} < \tau$. Namely, the bank and the borrowers engage in negotiation in period τ.

From the result obtained in the remainder of Section 1.3, we have

$$V_{\tau-1} = \lambda\beta V_\tau + \lambda\delta_B^2(L - r_1^*) \tag{1.29}$$

$$= \lambda\beta V_\tau + \lambda[L - \{(1-\delta_B)L + \delta_B H\}] \tag{1.30}$$

where $\lambda\beta V_\tau$ is the current value of expected future profits, and $\lambda[L-\{(1-\delta_B)L+\delta_B H\}]$

is the expected profit from borrowing in this period. Define $\lambda[L-\{(1-\delta_B)L+\delta_B H\}] \equiv K$. Then,

$$\begin{aligned} V_{\tau-2} &= \lambda\beta V_{\tau-1} + K \\ &= \lambda\beta\{\lambda\beta V_\tau + K\} + K \\ &= (\lambda\beta)^2 V_\tau + (1+\lambda\beta)K \end{aligned}$$

Similarly, we obtain

$$\begin{aligned} V_{\hat{t}} &= V_{t-(\tau-\hat{t})} \\ &= (\lambda\beta)^{\tau-\hat{t}} V_\tau + \{1 + \lambda\beta + (\lambda\beta)^2 + \ldots + (\lambda\beta)^{\tau-\hat{t}-1}\}K \\ &= (\lambda\beta)^{\tau-\hat{t}} V_\tau + \frac{1-(\lambda\beta)^{\tau-\hat{t}}}{1-\lambda\beta}K \end{aligned} \tag{1.31}$$

and

$$\begin{aligned} V_{\hat{t}-1} &= \lambda\beta V_{\hat{t}} + K \\ &= \lambda\beta\{(\lambda\beta)^{\tau-\hat{t}} V_\tau + \frac{1-(\lambda\beta)^{\tau-\hat{t}}}{1-\lambda\beta}\cdot K\} + K \end{aligned} \tag{1.32}$$

Substituting (1.33) into (1.35) and (1.36),

$$\begin{aligned} V_{\hat{t}} - V_{\hat{t}-1} &= (1-\lambda\beta)\cdot(\lambda\beta)^{\tau-\hat{t}} V_\tau + (1-\lambda\beta)\cdot\frac{1-(\lambda\beta)^{\tau-\hat{t}}}{1-\lambda\beta}\cdot K - K \quad (1.33) \\ &= (\lambda\beta)^{\tau-\hat{t}}\lambda\{(L-H) - \lambda\delta_B^2(L-r_1^*)\} > 0 \end{aligned}$$

Q.E.D.

Appendix 1.2

The proof partially follows Fudenberg and Tirole (1983).

Let π_2 denote the posterior belief that the borrower is an S-type conditional on the rejection of an offer in stage 1. Suppose $r_1 \in (r_1^*,\ L - \frac{1-\lambda}{\lambda}\frac{\beta}{\delta_B}V']$ is offered. Then, we want to show that an R-type cannot reject or accept this offer with probability one.

Suppose, by way of contradiction, that the R-type rejected $r_1 \in (r_1^*,\ L - \frac{1-\lambda}{\lambda}\frac{\beta}{\delta_B}V']$ with probability one. Then, the posterior of the bank, π_2, would remain the same as its prior, π. Since $\pi < \pi^{**}$ holds by assumption, the bank would offer $L - \frac{1-\lambda}{\lambda}\frac{\beta}{\delta_B}V'$ in stage 2. However, if it were the case, the R-type would be strictly better off if he accepted the offer in stage 1, contradiction.

Next, suppose that the R-type accepted $r_1 \in (r_1^*,\ L - \frac{1-\lambda}{\lambda}\frac{\beta}{\delta_B}V']$ with probability one. Then, the posterior of the bank, π_2, would become 1, and, hence, the bank would offer H in stage 2. However, if the R-type should anticipate that the second stage offer will be H, then, he would be better off by not accepting the offer in stage 1 because he is indifferent between accepting H in stage 2 and accepting r_1^* in stage 1, contradiction.

Therefore, $r_1 \in (r_1^*,\ L - \frac{1-\lambda}{\lambda}\frac{\beta}{\delta_B}V']$ cannot be an equilibrium offer in stage 1 when $\pi < \pi^{**}$.

Q.E.D.

Appendix 1.3

The proof of Theorem 1.5 essentially follows the proof of Theorem 1.1 given in Appendix 1.1. We only need to replace r^* in (1.34) with r^{**}. Then, we have

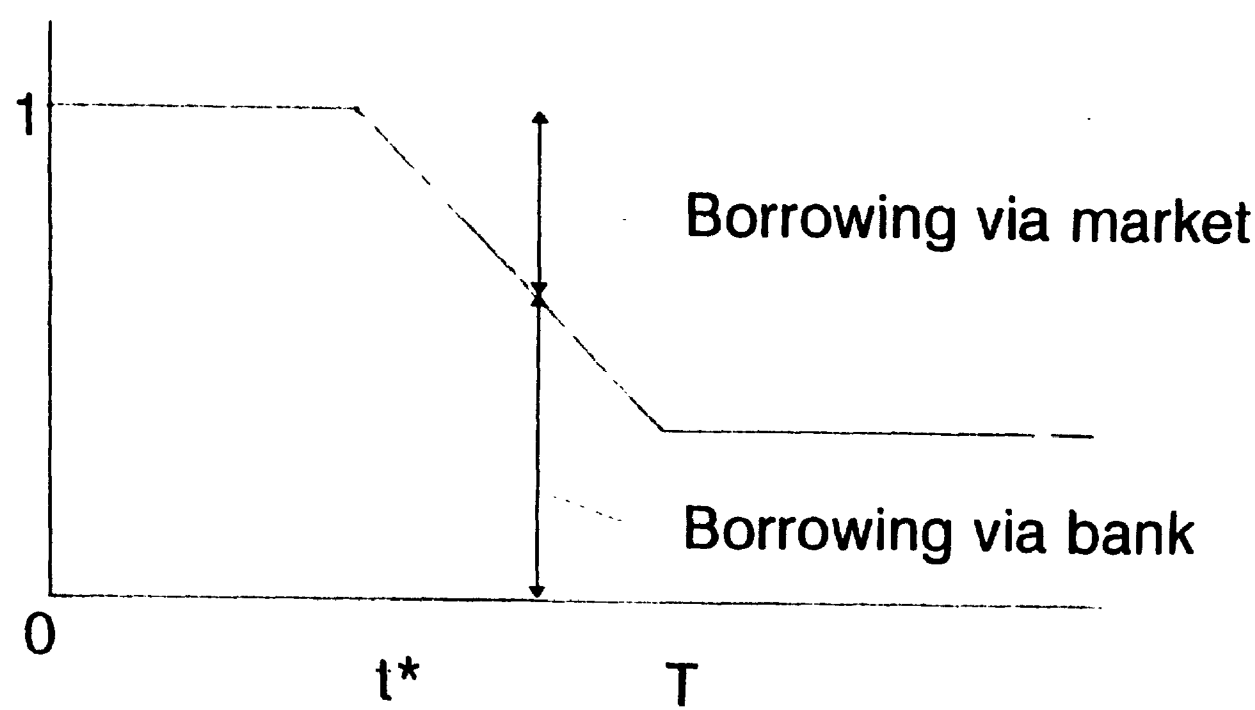
$$\begin{aligned} V_{\tau-1} &= \lambda\beta V_\tau + \lambda(L - r_1^{**}) \\ &= \lambda\beta V_\tau + \lambda[L - r_1^* + (1-\rho)\frac{\beta}{\delta_B}V' \\ &= \lambda\beta\{1 + \delta_B(1-\rho)\}V_\tau + \lambda\delta_B^2(L - r_1^*) \end{aligned}$$

Hence, we have obtained the same expression for $V_{\tau-1}$ as the one obtained in Appendix 1.1 except $\lambda\beta$ is now replaced by $\lambda\beta\{1+\delta_B(1-\rho)\}$. The rest of the argument follows Appendix 1.1, and, hence, omitted.

Q.E.D.

Figure 1.1

The movement towards securitization



Chapter 2

Financial Deepening and Economic Growth

2.1 Introduction

It has long been recognized that financial deepening, or well-functioning financial intermediation, plays an important role in promoting economic growth (see Gurley and Shaw (1967), Shaw (1973), McKinnon (1973) for example). In particular, it is argued that, in developed countries, the credit markets successfully mitigate information problems so that investments are efficiently allocated to more productive borrowers. By successfully resolving information problems, lenders receive a higher rate of return, which, in turn, results in higher saving, a higher capital accumulation, and hence, faster economic growth. Little work has been done, however, in explaining how the degree of information asymmetry and intermediation technology affect the rate of economic growth.

The purpose of this chapter is to study the role of financial deepening in the context of a dynamic model. Although the degree of financial deepening can be measured in various ways, we interpret it as two ways; (1) resources spent on intermediation services, or (2) the evolution of credit markets from those with substantial degree of adverse selection to those with no adverse selection, i.e. credit markets with complete information.[1] In particular, the model economy consists of two types of borrowers, risky and safe, whose types are unknown to lenders. The degree of adverse selection is measured by the distribution of the types among the borrowers.

In the model, the type of financial trading arrangement is determined endogenously. The financial trading arrangement can be open market (corporate bond market) trading, bilateral trading via a bank, or no trading at all, depending on the degree of financial deepening defined as above. The bank, if it arises in the economy, engages in a negotiation with borrowers over lending rates. In the course of the negotiation, the bank sorts out the borrowers based on their types, and, the resulting outcome exhibits a separating equilibrium where the risky borrowers accept a high lending rate offer while the safe borrowers accept a low lending rate offer. In order to describe the negotiation process, a sequential bargaining model with incomplete information is used (see Fudenberg and Tirole (1992) and Osborne and Rubinstein (1990) for example).

There are two major predictions derived from the current analysis. First, the bank arises in the economy if the degree of adverse selection is sufficiently high and if the negotiation cost is not too high. If the proportion of the safe borrowers is sufficiently high, a corporate bond market emerges as a way of conducting financial transactions, whereas, if the proportion of the safe borrowers is sufficiently low and the negotiation

[1]Other measurements are the gap between the yield on low-risk bank loans and bank deposits, the incidence of credit rationing, the existence of financial intermediaries, the ratio of a country's financial assets to its GDP, etc..

cost is sufficiently high, there is no direct financial transaction between borrowers and lenders.[2]

Second, it is shown that financial intermediation fosters the rate of economic growth since it resolves the information problem between the lenders and borrowers, and allocates more capital to safe borrowers, whereas, without intermediation, each lender invests his/her capital randomly to the borrowers via the corporate bond market. In fact, it is shown that the existence of the bank initiates perpetual growth which would not be attained without a bank.

There are a few papers related to the current analysis. Bencivenga and Smith (1991) constructs an endogenous growth model and examines the conditions under which the advent of a bank promotes the rate of economic growth. The bank in their paper reduces investment in liquid assets relative to the one in the economy without a bank where each lender must insure against unpredictable liquidity needs by himself/herself. Cooley and Smith (1991) constructs an endogenous growth model in which banks promote economic growth by encouraging specialization in the sense that some fraction of agents invest in education to obtain higher skills, borrow to put capital in place, and operate firms after completing the education, while the other

[2]These facts have been pointed out by many authors. For example, Bencivenga and Smith (1988) indicates that it is often discussed in the context of preindustrial nations prior to the development of intermediaries that "a good deal of investment is in the form of inventories or other highly liquid (but not very productive) assets " [p.10]. Furthermore, they indicate that, "under shallow finance, self-financed investments (unintermediated finance) are the predominant form of investment" [p.11]. On the other hand, it is well-known that financial structure of developed countries have been characterised by the movement toward securitisation for the last 10 to 20 years. That is, "financial structures appear to be converging into structures that permit competitive and market forces a greater role in the financial system than previously" [Cargill and Royama (1988), p.1]. That is, in the developed countries, securities have been replacing bank loans as a way of conducting financial transactions.

agents concentrate on working for firms. The current analysis differs from those papers in that the model herein explores the role of banks as a device to resolve the information problem in the context of economic growth. Also, this chapter develops an information-based banking model that captures the bilateral feature of financial transactions which in itself is interesting.

The rest of the chapter is organized as follows. Section 2.2 describes the environment of the model and the bilateral negotiation between the bank and the borrowers. Section 2.3 studies the equilibrium of the model. First, the equilibrium outcome of the negotiation is analyzed, and, then, equilibrium dynamics are examined. Section 2.4 examines economic policy interventions which initiate economic growth. Section 2.5 concludes the paper.

2.2 The Environment

2.2.1 The Borrowers

There exist a finite number, n, of borrowers in an economy. (*he* is used for a lender, and *she* is used for a borrower hereafter.) A proportion π of the borrowers are *safe* ($S-$type) and the remaining proportion $1-\pi$ are *risky* ($R-$type) through time. The proportion of S-types is assumed to be public information.

Each borrower has access to the following production technology which converts capital good, k_t, into output, y_t:

$$y_t = I^i \cdot f^i(k_t)$$

where $f : R_+ \rightarrow R_+$ is continuous and homogeneous of degree one, and I^i is an index function which takes one of two values: 0 or 1. The superscript i of the production function denotes the type of the borrower; that is, $i = S$ ($i = R$) for safe borrowers (risky borrowers). It is assumed that $I^S = 1$ and that $I^R = 1$ with probability λ ($0 < \lambda < 1$) and $I^R = 0$ with probability $1 - \lambda$. λ represents the probability of defaulting. In this sense, an S-type (an R-type) has access to a *safe* (*risky*) production technology.

It is assumed that $f^R(k) > f^S(k)$ and $f^S(k) > \lambda f^R(k)$ hold for all k. The first inequality says that the level of output by R-types exceeds that by S-types if the production turns out to be successful. The second inequality says that the expected output by S-types is greater than that by R-types. Also assumed is that $f^i(0) = 0$ and $\lim_{k\to\infty} f^{i\prime}(k) \geq F$ for any i where F is a positive finite number.[3] The prime denotes the derivative with respect to k. The restriction used herein is a necessary condition to derive perpetual growth in the current analysis.[4]

Note that all the capital used by the borrowers are owned by the lenders; that is, the borrowers own nothing. Hence, if the type of a borrower is completely known to the lenders, all the output is returned to the lenders and the borrowers obtain no benefit. However, we assume that the type of each borrower is private information held by the borrower. In other words, the lenders cannot observe the exact type of a borrower. The only information available to the lenders is the degree of aggregate

[3]These restrictions on the production function are different from the assumptions that are usually used in the standard neoclassical growth model. Contrary to the current assumption, the standard neoclassical growth model assumes that the Inada conditions are satisfied; i.e., $f(0) = 0$, $\lim_{k\to\infty} f'(k) = 0$, and $\lim_{k\to 0} f'(k) = \infty$. These conditions along with the standard properties of technology and preference result in the well-known steady state property of neoclassical growth model.

[4]The model used herein is a simple version of Jones and Manuelli (1990).

uncertainty, i.e. the distribution of the types of the borrowers. Assuming that the borrowers attain utility by consuming the output, an adverse selection problem may arise in the economy due to the information asymmetry between the lenders and borrowers; namely, in an equilibrium, an R-type borrower may report that she is an S-type so that she is able to keep $f^R(k) - f^S(k)$ to herself. As we vary the exogenous parameter π and the cost required for the negotiation, we obtain a family of dynamical economies that differ from each other in their rate of growth.

The Lenders

There exist a continuum of identical infinite-period-lived lenders of measure 1 in the economy. Each lender has access to a constant returns to scale storage technology that converts k units of capital good into $D(k)$ units of consumption good at the end of period. Hence, the lender chooses whether to invest his capital to the borrowers or store it himself at the beginning of each period. The following assumption is made for the storage technology:

Assumption 2.1 $f^S(k) > D(k) > \lambda f^R(k)$

The first inequality of the assumption states that the return from lending to an S-type exceeds the return from investing in the storage technology, while the second inequality states that the return from lending to an R-type is strictly less than the return from investing in the storage technology in expected terms.

If a lender decides to lend to a borrower, then, the timing of production, consumption and investment can be described as follows. In each period, a representative lender lends his entire capital stock, k_t, to the borrowers, receives return, r_t, from them, consumes some, c_t, and accumulates the rest as capital, k_{t+1}, for the next period. The lender has preference over intertemporal consumption sequences, $\{c_t\}_{t=0}^{\infty}$, which is represented by the following additively separable utility function:

$$U(c_0, c_1, \ldots) = E \sum_{t=0}^{\infty} \beta^t u(c_t)$$

where β is a discount factor and $0 < \beta < 1$, and $u : R_+ \to R$ is twice differentiable, strictly increasing, strictly concave, and $\lim_{c \to 0} u'(c) = \infty$. With this preference, the representative lender decides how to allocate the return from investment between current period consumption and the next period investment in each period. There is no depreciation of the capital.

The lenders choose whether to make investment through a bank or a security company (i.e. corporate bonds market). It is assumed that the establishment of the two businesses requires a cost. Hence, the lenders choose to collude and establish a single intermediary, a bank or a securities company, to economise on the set up cost. In the following, however, we approximate the set up cost by zero for the sake of simplicity. The rest of the arguments should go through with a positive set up cost.

If the investment through bank is chosen by the lenders, the bank negotiates over lending rates with the borrowers in order to detect the type of the borrowers and, in effect, alleviate the degree of adverse selection in the credit market. The lender must pay all the costs that arise in the process of negotiation. It is assumed that the lenders are sufficiently risk averse so that the bank as a delegated agent of the lenders prefers to negotiate with all the borrowers regardless of the cost that incurs over the course of negotiation. The detailed description of the negotiation is provided in Section 2.1.2.

When investment is made via the corporate bond market, the investment can be fully diversified. Further, it is assumed that there is no restriction on the minimum purchase of bonds. Hence, even though there is uncertainty in the financial market, the lenders obtain a certain return whichever investment mode is chosen.

In summary, the lender's problem is expressed as follows:

$$\max \sum_{t=0}^{\infty} \beta^t u(c_t) \tag{2.1}$$

subject to

$$c_t + k_{t+1} \leq e_t$$

where $e_0 = k_0$ is given. e_t represents the return from investment net of the negotiation cost. The exact expression for e_t is given in Section 3.2.

Financial Intermediation

This subsection describes the negotiation between the banks and the borrowers. A version of Fudenberg and Tirole (1983)'s sequential bargaining model is used to describe the bilateral negotiation.

If the lender chooses investment via the bank, the negotiation between the bank and the borrowers takes place in the following way. The bank and the borrowers meet at the beginning of each period, and they negotiate over lending rates. Under the incomplete information, the bank's knowledge about the type of the borrower may change over the course of the negotiation process, which is interpreted as information production in the context of the current analysis. The negotiation is allowed to last for up to two stages, within which the borrower's type may be detected.

It is assumed that neither the lenders nor the bank can observe the history of financial transactions of each borrower; i.e. history of default, history of lending rate accepted by the borrowers, etc.. Therefore, the negotiation between the bank and the borrowers remains the same through time. Due to the unobservability of the past financial transactions, the borrowers do not take into consideration reputation effects on their future bargaining position against the bank when they choose their current strategy.

It is assumed that the payoff to the lenders is discounted by δ_L^j while the payoff to the borrowers is discounted by δ_B^j, where the superscript j denotes the stage of the negotiation at which the bank and the borrower reach an agreement. In other words, the lenders (respectively, borrowers) must spend $1 - \delta_L^j$ (respectively, $1 - \delta_B^j$) as a negotiation cost when an agreement is reached in stage j.

Furthermore, we make the following assumption:

Assumption 2.2 $(D/H)^{1/2} < \delta_L < 1/H[\lambda H + \{(1 - \delta_B)L + \delta_B H\} - H]$

where $H \equiv f^S(k)$ and $L \equiv f^R(k)$. Assumption 2.2 states that the negotiation cost for the lenders is neither very cheap nor especially costly. The first inequality assures that the corporate bond market arises endogenously if the proportion of S-types are sufficiently large. The latter inequality, on the other hand, assures that the bank arises endogenously if the degree of adverse selection is sufficiently high.

The timing of the negotiation between a bank and borrowers in period t is described as follows. After receiving deposits, i.e. capital, from the lenders, the bank makes the first offer, r_{t1}, to each borrower, knowing the distribution of the types of the borrowers at the beginning of the period. Subsequently, each borrower either accepts or rejects the offer. If it is accepted, the negotiation ends in stage 1. If rejected, however, the bank makes the second offer, r_{t2}, to each borrower who has rejected r_{t1} in the previous period. In the second period, the offer depends on the previously rejected proposal; namely, the bank updates its belief about the type of the borrower. The revision of the belief must be consistent with Bayesian inference, and the updated belief is denoted by π_2. Given the second offer, each borrower either accepts or rejects it. If accepted, a financial transaction takes place. If rejected, the bank and the borrowers reach disagreement, and no loan is made.

It is assumed that the outcome of the production by each borrower cannot be observed by the bank. Hence, the lending rates cannot be determined contingent upon outcomes.[5] Also, it is assumed that the loan contract which specifies a lending rate is enforceable as long as the borrower does not default. Namely, it is not possible that a borrower untruthfully report she defaulted so as to keep all the outcomes for herself.

[5]It is not necessary to assume the unobservability of the outcome. The contingent contract is not possible even when the outcome is observable by both the banks and the borrowers if it is impossible to validate the observation in court, or if it is too complex to write the contingent contract due to a large number of states of the economy.

2.3 Equilibrium

2.3.1 Negotiation between the Bank and the Borrowers

In Section 3.1, we examine the equilibrium outcome of the negotiation between a bank and the borrowers. The lenders' choice of an investment mode among the three (i.e. the investment via the banks, the investment via the market, and the investment in the storage technology) is discussed in Section 3.2.

The equilibrium criterion we use is perfect Bayesian equilibrium which is defined as follows:

Definition 2.1 *A perfect Bayesian equilibrium (PBE) is a pair consisting of a triple of strategies and beliefs such that:*

(1) The strategy of each player (i.e. the bank, S-type borrowers and R-type borrowers) is optimal in the sense that the strategy is most preferred given the system of belief and other players' strategies.

(2) Beliefs are obtained from strategies and observed actions using Bayes' inference.

We focus on pure strategy perfect Bayesian equilibria for the sake of simplicity. The following argument should go through even if the agents were allowed to take mixed strategies.

In the following, the suffix t for H, L, r_1 and r_2 are omitted for the sake of notational simplicity.

First, consider the case where

$$\pi H + \lambda(1-\pi)H > (1-\pi)\lambda L \tag{2.2}$$

or, equivalently,

$$\pi > \frac{\lambda(L-H)}{H+\lambda(L-H)}$$

and define $\pi^c \equiv \frac{\lambda(L-H)}{H+\lambda(L-H)}$. (2.2) indicates that the bank would choose to make loans to the borrowers with an interest rate H if it were allowed to make only one offer.

In stage 2, both R-type and S-type borrowers accept an offer made by the bank if and only if the offer is less than or equal to their reservation value. Namely,

$$r_2 \leq H$$

and

$$r_2 \leq L$$

must be satisfied for S-types and R-types respectively. Since $L > H$, any offer accepted by S-types is also accepted by R-types.

In stage 1, S-types accept an offer r_1 if and only if

$$\delta_B(H - r_1) \geq \delta_B^2(H - r_2)$$

forecasting that r_2 will be offered in stage 2. As for R-types, they accept an offer r_1 if and only if

$$\delta_B\lambda(L - r_1) \geq \delta_B^2\lambda(L - r_2) \tag{2.3}$$

again, forecasting that r_2 will be offered.

If r_1 is accepted, the negotiation ends, and there is no further negotiation in stage 2. Hence, suppose, without loss of generality, that r_1 was rejected by a borrower.

Then, regardless of the offer in stage 1, the bank offers H in stage 2. Rationally anticipating that the bank will offer H in stage 2 if she refuses the first offer, an S-type accepts r_1 if and only if

$$r_1 \leq H$$

while an R-type accepts r_1 if and only if

$$\delta_B \lambda(L - r_1) \geq \delta_B^2 \lambda(L - H) \tag{2.4}$$

or equivalently,

$$r_1 \leq (1 - \delta_B)L + \delta_B H \tag{2.5}$$

and define the critical value for the first offer $r_1^* \equiv (1 - \delta_B)L + \delta_B H$.

It is clear by now that the lender chooses to be either r_1 or H and r_1^* depending on whether $\delta_B\{\pi H + \lambda(1 - \pi)H\}$ is greater or less than

$$\delta_B(1 - \pi)\lambda r_1^* + \delta_B^2 \pi H \tag{2.6}$$

(2.6) represents expected return from offering r_1^* in stage 1. Note that the R-type borrowers are indifferent between accepting and rejecting the offer r_1^*. However, the bank is better off if R-types accept r_1^* in stage 1 as it would save the negotiation cost in stage 2. Hence, the bank offers $r_1^* - \epsilon$, where ϵ is an infinitesimally small, positive number. In the following, we approximate this value with r_1^* without loss of generality.

Let us define

$$\Psi(\pi) \equiv \{\delta_B(1 - \pi)\lambda r_1^* + \delta_B^2 \pi H\} - \delta_B\{\pi H + \lambda(1 - \pi)H\}$$

The expression in the first bracket is the expected return for the bank from offering r_1^* in stage 1 and H in stage 2, while the expression in the second bracket is the expected return from offering H in stage 1. Hence, $\Psi(\pi)$ represents the gap between the two expected returns. Taking the derivative of $\Psi(\pi)$ with respect to π, we have

$$\frac{\partial\Psi(\pi)}{\partial\pi} = \delta_B[(1-\pi)\lambda\{(1-\delta_B)L+\delta_B H\}+\delta_B\pi H-\lambda(1-\pi)H] < 0 \tag{2.7}$$

Also, we have

$$\Psi(1) = \delta_B(\delta_L - 1)H < 0 \tag{2.8}$$

and

$$\begin{aligned}\Psi(0) &= \{\delta_B\lambda r_1^* - \lambda H\}\\ &= \delta_B\lambda\{(1-\delta_B)L+\delta_B H - H\} > 0\end{aligned} \tag{2.9}$$

Since $\Psi(\pi)$ is continuous in π, (2.7), (2.8) and (2.9) imply that there exists a unique $\pi^* \in (0,1)$ such that $\Psi(\pi^*) = 0$. Setting $\Psi(\pi^*) = 0$, we get

$$\pi^* = \frac{\lambda(r_1^* - H)}{(1-\lambda-\delta_L)H+\lambda\{(1-\delta_B)L+\delta_B H\}} \tag{2.10}$$

Note that π^* is independent of time. Therefore, the outcome of the negotiation described herein can be applied to any period.

Second, consider the case where $\pi < \pi^c$. In this case, the bank would not offer $r_1 \in (r_1^*, L]$. The proof is the same as the proof of Theorem 1.1 in Chapter 1 except that L is used instead of $L - \frac{1-\lambda}{\lambda}\frac{\beta}{\delta_B}V'$. Hence, the proof is omitted. Therefore, the bank chooses the first offer between H and r_1^*. However, according to the previous argument, the bank chooses to offer r_1^* in stage 1.

Hence, the following set of strategies and beliefs constitutes PBE for all t:

Case 1 $\pi \geq \pi^*$: Stage 1: The bank offers H; S-types accept an offer iff $r_1 \leq \delta_B r_2$; R-types accept an offer iff $r_1 \leq (1-\delta_B)L + \delta_B H$.

Stage 2: The bank offers H; S-types accept an offer iff $r_2 \leq H$; R-types accept an offer iff $r_2 \leq L$; The posterior is given by the intial distribution of the types, π. I.e. there is no updating of the belief.

Case 2 $\pi^* > \pi$: Stage 1: The bank offers r_1^*; S-types accept an offer iff $r_1 \leq \delta_B r_2$; R-types accept an offer iff $r_1 \leq (1-\delta_B)L + \delta_B H$.

Stage 2: The bank offers H; S-types accept an offer iff $r_2 \leq H$; R-types accept an offer iff $r_2 \leq L$; The posterior is given by the true distribution of types.

The outcomes of the negotiation associated with the equilibria are given as follows:

Case 1 $\pi \geq \pi^*$: The bank offers H in stage 1, and both S-types and R-types accept the offer. The negotiation ends in stage 1.

Case 2 $\pi^* > \pi$: The bank offers r_1^* in stage 1, which is accepted by all the R-type borrowers. S-types do not accept the offer. In stage 2, the bank offers H, which is accepted by all the S-type borrowers.

2.3.2 The Choice of an Investment Mode by the Lenders

In Section 3.1, we examined the negotiation between the bank and the borrowers. However, a bank may not arise in the economy as the negotiation can be too costly for the lenders relative to the gain from detecting the type of the borrowers and collecting higher lending rates from them. We now examine under what condition the lenders choose to invest via the bank. It is clear from the discussion above that the bank fails to exist for $\pi > \pi^*$. There is no point in wasting the negotiation costs in stage 1 of the negotiation since the lenders can obtain the same return by investing via the corporate bond market and, in addition, they can save the negotiation costs for $\pi > \pi^*$. It is also evident that the lenders prefer to invest via the corporate bond market for π that is a little smaller than π^* since the negotiation cost is likely to exceed the benefit from negotiation in that parameter space. These predictions are proved to be correct in the following sense.

First, the lenders choose to invest via the corporate bond market and obtain H as a return when the production is successful if and only if the following inequality holds:

$$\delta_B(1-\pi)\lambda r_1^* + \delta_B^2 \pi H \leq \pi H + \lambda(1-\pi)H \tag{2.11}$$

Solving (2.11) for π we have[6]

$$\Pi^* = \frac{\lambda(\delta_L r_1^* - H)}{(1-\lambda-\delta_L^2)H + \delta_L\lambda\{(1-\delta_B)L + \delta_B H\}} \tag{2.12}$$

where Π^* represents the proportion of π above which the lenders choose to invest through the bonds market. Clearly, $\Pi^* < \pi^*$ holds.

Second, the lenders choose to invest in the storage technology and obtain a certain return $D(k_t)$ if and only if the following inequality holds:

$$D \geq \delta_L(1-\pi)\lambda r_1^* + \delta_L^2 \pi H \tag{2.13}$$

or equivalently,[7]

$$\pi \;\leq\; \frac{D - \delta_L \lambda r_1^*}{\delta_L(\delta_L H - \lambda r_1^*)} \equiv \Pi^{**} \tag{2.14}$$

[6]Assumption 2.2 assures that $0 < \Pi^* < 1$ holds.

[7]Assumption 2.2 assures that $0 < \Pi^{**} < \Pi^* < 1$ holds.

From (2.12) and (2.14), the result can be summarized as follows:

Theorem 2.1 *The banks arise for $\pi \in (\Pi^{**}, \Pi^{*})$. The corporate bond market opens for $\pi \geq \Pi^{*}$, while there is no financial transaction between the borrowers and the lenders for $\pi \leq \Pi^{**}$.*

The theorem states that the bank does arise in the economy if the proportion of R-type borrowers is sufficiently high *and* sufficiently low, i.e. $\Pi^{*} > \pi > \Pi^{**}$. An alternative interpretation of this result is that the bank arises in an economy if the degree of adverse selection is substantially high. When the degree of adverse selection is substantially high, it is likely that the return from investment via the bank exceeds the return from investment via the corporate bond market since the benefit from resolving the information problem outweighs the cost of negotiation.

The next theorem can also be obtained as a ~ult of the previous argument:

Th~orem 2.2 *The expected return from lending to the borrowers is nondecreasing in the proportion of S-type borrowers, π.*

Clearly from the previous argument, the return from investment, e, is given for respective parameterization of π as follows:

$$e = \begin{cases} \pi H + \lambda(1-\pi)H & \text{if } \pi \geq \Pi^{*} \\ \delta_L(1-\pi)\lambda r_1^{*} + \delta_L^2 \pi H & \text{if } \Pi^{*} > \pi > \Pi^{**} \\ D & \text{if } \Pi^{**} \geq \pi \end{cases} \tag{2.15}$$

Hence, given k, for $\pi \leq \Pi^{**}$, the rate of return remains constant for all k, while, for $\pi > \Pi^{*}$, the rate of return is strictly increasing in π; i.e., the return from investment increases as the proportion of S-type borrowers increases (see Appendix 2.1 for the proof).

2.3.3 Balanced Growth Equilibrium

Having examined the family of equilibria in financial transactions, we now study the equilibrium dynamics. Namely, we solve the representative lender's problem (2.1) stated in Section 2.2. By the principle of optimality, the lender's problem postulated by (2.1) can be attained as the solution to the following alternative formulation:

$$V(k_t) = \max\{u(c_t) + \beta V(k_{t+1})\}$$

subject to

$$c_t + k_{t+1} \leq e_t$$

or equivalently,

$$V(k_t) = \max\{u(e_t - k_{t+1}) + \beta V(k_{t+1})\} \tag{2.16}$$

where r_t is given by (2.15), and where the function $V : R_+ \to R$ represents the value of the utility from period t on that is obtained from the optimal investment/consumption choice by the lender.[8] Now, the equilibrium of the dynamical economy is defined as follows:

Definition 2.2 *Given k_0, an equilibrium is a set of sequences $\{c_t, k_{t+1}\}_{t=1}^{\infty}$ that solve the functional equation (2.16) for all $t \geq 1$, where e_t in (2.16) is obtained as a consequence of equilibrium financial trading arrangement described in Section 3.1.*

[8]We need to verify the uniqueness of V to attain the alternative formulation. More precisely, define an operator T such that $(TV)(k_t) = \max\{u(c_t) + \beta V(k_{t+1})\}$. In order to verify that there exists a unique V that satisfies the functional equation, it is sufficient to show that T is a contraction mapping. This is not as straightforward as it looks since the proof must be done both for bounded and unbounded returns. As we see in the sequel, the economy may attain perpetual growth depending on the rate of return as well as the discount factor. It can be shown that the specification of technology and preference assures that T is a contraction mapping. See Stokey, Lucas and Prescott (1989) for detailed discussion.

For the sake of notational simplicity, define

$$\pi H + \lambda(1-\pi)H \equiv s_1 f^S(k)$$

$$\delta_L(1-\pi)\lambda r_1^* + \delta_L^2 \pi H \equiv s_2 f^S(k)$$

$$D \equiv s_3 f^S(k)$$

All three rates of return are expressed as linear functions of $f^S(k)$ since both the negotiation cost and the return from the storage technology are linear in $f^S(k)$.

Substituting $e_t = s_j f^S$ into (2.16), we obtain

$$V(k_t) = \max\{u(s_j f^S(k_t) - k_{t+1}) + \beta V(k_{t+1})\} \tag{2.17}$$

The first order condition and the envelope condition can be obtained from (2.17) as follows:

$$u'(s_j f^S(k_t) - k_{t+1}) = \beta V'(k_{t+1}) \tag{2.18}$$

$$V'(k_t) = s_j f^{S'}(k_t) u'(s_j f^S(k_t) - k_{t+1})$$

$$\rightarrow V'(k_{t+1}) = s_j f^{S'}(k_{t+1}) u'(s_j f^S(k_{t+1}) - k_{t+2}) \tag{2.19}$$

(2.18) is a standard optimality condition governing investment, which states that the marginal utility of current period consumption equals the marginal utility from the discounted future consumption obtained by allocating the consumption to the capital. On the other hand, (2.19) states that marginal value of capital to the future utility equals the marginal utility of using the capital in current period production and allocating its return to current consumption. By (2.18) and (2.19), we have

$$u'(c_t) = \beta s_j f^{S'}(k_t) u'(c_{t+1})$$
$$\rightarrow \frac{u'(c_t)}{u'(c_{t+1})} = \beta s_j f^{S'}(k_t) \qquad (2.20)$$

We now proceed to show the following propositions.

Proposition 2.1 *The rate of growth measured by per capita consumption of the lenders is higher for greater proportion of S-type borrowers.*

This proposition can be obtained by (2.20), Theorem 2.2 and strict concavity of the lender's preference. The proposition implies that the lenders in an economy with greater π enjoy a higher level of welfare. Alternative interpretation is that the saving rate is lower in an economy with smaller π. Hence, an economy with smaller π attains lower rate of capital accumulation.

Proposition 2.2 *Financial deepening measured by resources spent by the bank in the course of negotiation promotes economic growth.*

In order to verify this proposition, let us examine the effect of varying the negotiation cost for the bank on the family of equilibria stated in Section 3.1. From (2.12) and (2.14), we have

$$\frac{\partial \Pi^*}{\partial \delta_L} > 0 \qquad (2.21)$$

and

$$\frac{\partial \Pi^{**}}{\partial \delta_L} < 0 \qquad (2.22)$$

respectively. Theorem 2.1, (2.21) and (2.22) indicate that the interval of π in which the banks arise endogenously expands both from above and below as δ_L increases. Let Π_1^* (respectively, Π_1^{**}) be the value of π after the reduction in the negotiation cost above (respectively, below) which the lenders and the borrowers do not make financial transactions. Then, for $\Pi_1^* > \pi > \Pi_1^{**}$, Theorem 2.2 and (2.20) imply that the rate of return increases as δ_L increases, and, hence, the growth rate is promoted in this interval.

Proposition 2.3 *Financial repression associated with lending rate ceilings hinders the advent of the banks, and, hence, hinders economic development.*

The proposition can be verified by replacing the equilibrium lending rate, r^*, with regulatory lending rate, r^{**}, such that $r^{**} < r^*$, where r^* is the offer made by the banks in stage 1 of the negotiation in the equilibrium. Let us define $r^{**} \equiv r^* - \epsilon$, where $\epsilon > 0$. Then, replace r^* with $r^{**} = r^* - \epsilon$ in (2.14). Solving for π, we obtain

$$\pi \leq \frac{D - \delta_L \lambda(r_1^* - \epsilon)}{\delta_L\{\delta_L H - \lambda(r_1^* - \epsilon)\}} \equiv \Pi^{***} \tag{2.23}$$

Clearly from (2.14) and (2.23), $\Pi^{***} > \Pi^{**}$ holds. This indicates that the interval of π in which the banks arise shrinks from below. Also, from Theorem 2.2, (2.15) and (2.20), the interest rate ceilings result in slower rate of economic growth.

Proposition 2.4 *If banking operations are prohibited by some legal restriction, economic development will deteriorate for some intervals of π.*

It is clear from the characterization of financial trading equilibrium in Section 3.1 that $s_2 > \max\{s_1,\ s_3\}$ for $\pi \in (\Pi^*,\ \Pi^{**})$, and, hence, the proposition holds. The statement can be interpreted as a consequence of severe financial repression.

2.3.4 Government Intervention

For the sake of concreteness, let $u(c_t) = \ln c_t$, and let $f^S(k_t) = a_S k_t$. Clearly, the technology and the preference satisfy the restriction described in Section 2.2.

Then, (2.20) can be expressed as follows:

$$\frac{c_{t+1}}{c_t} = \beta s_j a_S \tag{2.24}$$

(2.24) implies that the economy attains perpetual growth if $\beta s_j a_S > 1$ holds, whereas the economy falls into zero-growth equilibrium if $\beta s_j a_S = 1$. On the other hand, if $\beta s_j a_S < 1$ holds, the level of consumption decreases over time, and it reaches zero in the limit; i.e. the economy will be caught in a *poverty trap.*

Now, the question is: Are there any economic policies that initiate economic growth when the economy is caught in the poverty trap? To answer this question, suppose that there exists $\pi^0 \in (\Pi^*, \Pi^{**})$ such that $\beta s_2 a_S = 1$ when the proportion of S-types is π^0. Also, suppose that the current proportion of S-types, π, is in the interval of (Π^*, π^0). In this case, it can be shown that some government interventions may initiate economic growth by affecting the bargaining power of the borrowers at the negotiation, and, hence, affecting the rate of return from investment. In particular, if the bargaining power of the borrowers becomes weaker, the banks and the borrowers contract for a higher lending rate, and, hence, the rate of growth becomes faster. Since the bargaining power of the borrowers becomes weaker with an increase in the borrowers' negotiation cost or their willingness to pay to the banks, government policies must affect the borrowers through one of those channels in order to initiate economic growth.

First, consider a policy which deteriorates the borrowers' bargaining position. Suppose that the government provides a subsidy to borrowers. The subsidy of τH is given to each borrower at the beginning of each period. The subsidy can be used as a payment to the bank along with the production outcome. Then, repeating the argument in Section 3.1, (2.3) can be rewritten as follows:

$$\delta_B \lambda (L - r_1) \geq \delta_B^2 \lambda \{L - (1 + \tau) H\}$$

or, equivalently,

$$r_1 \leq (1 - \delta_B) L - \delta (H + \tau) \equiv r^{**} \tag{2.25}$$

(2.25) indicates that, with the subsidy, the bank offers higher rate of return r^{**} than the one offered in an economy without the subsidy (i.e. $r^* = (1 - \delta_B) L - \delta_B H$). Since s_2 is increasing in r, $\beta s_2 a_S$ increases when the subsidy is introduced. If the increase in s_2 is high enough to attain $\beta s_2 a_S > 1$, the economy reaches perpetual growth.

Second, suppose that the government passes a legislation that requires the borrowers to submit some documentations whenever they engage in negotiation with the bank. It can be interpreted as a tax on the borrowers. Assume that the effort required for this obligation is γ, where γ is assumed to be linear in $f^S(k)$. Then, (2.4) can be rewritten as follows:

$$\delta_B \lambda (L - r_1) \geq \delta_B^2 \lambda (L - H - \gamma)$$

This inequality replace (2.5) with the following:

$$r_1 \leq (1 - \delta_B) L - \delta_B (H + \gamma)$$

Hence, the offer in stage 1 will be increased by $\delta_B\gamma$, while the offer in stage 2 remains the same, therefore, the rate of return will be increased. A sufficiently high increase in the rate of return assures that the economy reaches perpetual growth.

The results in this subsection are summarised as follows:

Proposition 2.5 *A certain type of subsidy as well as taxation of the borrowers can improve the bargaining position of the banks against the borrowers, and, hence, initiate economic growth.*

Note that, in the current analysis, neither subsidies nor taxes to the lenders would affect the rate of growth. This is because the bank has all the bargaining power; i.e. only the bank is allowed to make offers. However, if the model is modified to allow the borrowers for making counter offers, subsidies and taxes to the lenders will also affect their bargaining position, and, hence, may initiate economic growth.

2.4 Conclusion

This chapter has explored the role of financial deepening in the context of financial trading arrangement and economic growth. A sequential bargaining model was used to capture the bilateral feature of financial transactions via the bank while a perpetual growth model was used to describe a family of dynamical economies. It was shown that the bank arose endogenously in an economy with a sufficiently high degree of adverse selection in the credit market. The bank negotiated with the borrowers in order to resolve the information problem between the lenders and borrowers. When the proportion of safe borrowers was sufficiently high, the corporate bond market emerged endogenously, while no financial transaction took place when the proportion was sufficiently low. It was also shown that financial deepening measured by resources spent on intermediation services would make it easier for the bank to arise in the economy.

Further, the model predicted that the higher rate of growth was associated with the greater proportion of safe borrowers and the lower negotiation cost. The consequence of financial repression as well as other government interventions were also discussed. It was shown that, with some parameter specifications, financial repression generally had negative effects on economic growth, and that certain tax and subsidy scheme would help to initiate economic growth when the economy was caught in the poverty trap.

Note that the negotiation model which described financial transactions between the bank and the borrowers can be combined with other endogenous growth models with various kinds of externalities (human capital accumulation, technological progress, research and development activity, etc.).[9] By so doing, we will get a variety of comparative static results, such as the effect of financial deepening on human capital accumulation, labour/leisure choice, investment in research and development, etc..

[9]See Sala-i-Martin (1991) and Rebelo (1992) for review of literature in this field.

Appendix 2.1

For $\pi \in [\Pi^*, 1]$,

$$\frac{\partial r}{\partial \pi} = (1-\lambda)H > 0$$

For $\pi \in (\Pi^{**}, \Pi^*)$,

$$\begin{aligned} \frac{\partial r}{\partial \pi} &= -\delta_L \lambda\{(1-\delta_B)L + \delta_B H\} + \delta_L H \\ &> 0 \end{aligned}$$

where the inequality holds by Assumption 2.

For $\pi \in [0, \Pi^{**}]$,

$$\frac{\partial r}{\partial \pi} = 0$$

Hence the claim that r is nondecreasing in π has been verified.

Chapter 3

Risk-Adjusted Deposit Insurance and the Loan Sales Market

3.1 Introduction

It is often argued that risk-adjusted deposit insurance is preferable to fixed rate deposit insurance on the grounds that the former is more efficient and equitable than the latter.[1] However, the current system in countries such as the U.S. and Japan adopts flat rate premiums mainly because the implementation of the risk-adjusted deposit insurance is infeasible when the banks' strategy choice is subject to adverse selection; i.e. the banks do not have an incentive to truthfully report their riskiness to the deposit insurance corporation (DIC).

This chapter attempts to show that the existence of a loan sales market can resolve this information problem if loans sold in the market are not treated as assets when calculating capital requirementS.[2]

[1] For example, 'Deposit Insurance in a Changing Environment', a report prepared by the Federal Deposit Insurance Corporation in 1983, proposed that fixed rate deposit insurance be replaced with risk-adjusted deposit insurance system.

[2] Loan sales is the sale by banks (chiefly by money-center banks) of newly originated loans to nonbank financial institutions and other banks. In most cases, loan sales take a form of participation

The model economy consists of two banks with different default characteristics; safe and risky. It is assumed that the distribution of the types of banks is known to the DIC, while the riskiness of each bank is private information held by the bank. The DIC attempts to assign a fair insurance rate to each bank, the attempt of which is hindered by the adverse selection. In this environment, we compare the following three economies; (1) an economy without a loan sales market, and with complete information, (2) an economy without a loan sales market, and with incomplete information (i.e. adverse selection), and (3) an economy with a loan sales market, and with incomplete information. It is shown that, in the economy without a loan sales market, the adverse selection problem hinders the assessment of the banks' riskiness by the deposit insurance corporation. Also, an underinvestment problem arises due to the misassessment by the deposit insurance corporation. If a loan sales market is allowed to exist in the economy, however, it is shown that the risky bank may become the borrower in the loan sales market while the safe bank may become the lender in the loan sales market in the Nash equilibrium; i.e. the advent of the loan sales market may induce the banks to separate themselves based on their riskiness. It is also shown that the advent of the loan sales market avoids the underinvestment problem.

There are two literatures that are directly related to the current analysis. The first is the literature on risk-adjusted deposit insurance. Since Merton (1977) first indicated the isomorphic relationships between equity and a call option, the litera-

so that the selling banks are responsible for serving loans, monitoring borrowers when they default, etc.. Loans sold are without recourse in the sense described above, they are not treated as assets when calculating capital requirement. For detailed description of current developments in loan sales, see James (1988) and Salem (1985).

ture in financial economics has attempted to arrive at empirical estimates of deposit insurance premiums, using the option-based methodology; for example, see Marcus and Shaked (1984), Ronn and Verma (1986) and Pennacchi (1987a), (1987b) among others. They use time series data on the market value of banks' equity and the book value of their debt in order to estimate the fair deposit insurance premiums. The current analysis, although it does not use the options model, is distinguished from the existing works in that it provides an alternative source of information relevant to estimate banks' riskiness and to calculate fair insurance premiums. Namely, this paper suggests that security prices in the loan sales market provide information necessary to assess the banks' riskiness.

The second literature related to the current analysis is the one on loan sales such as James (1988) and Pyle (1985), among others. They explore a cost of loan sales, namely, the effect of loan sales on the default risk of deposits.[3] They argue that, since loan sales without recourse are not subject to capital requirements, they provide a way for banks to increase leverage. By so doing, the banks can enhance subsidies arising from deposit insurance, which results in a higher probability of defaulting. The current paper also argues that loan sales may emerge as an off balance sheet activity of banks. However, the analysis here is distinguished from the existing literature since it focuses on a benefit of loan sales rather than costs. As noted before, the existence of a loan sales market helps the deposit insurance corporation implement a risk-adjusted risk premium system, and, hence, resolve both under- and overinvestment problems

[3] James (1988) also examines a benefit of loan sales. He argues that the use of loan sales avoid underinvestment problems that emerge when banks have risky debt outstanding.

by banks. The result is obtained because the paper examines an adverse selection problem in a bank loan market rather than the moral hazard problem discussed by James (1988) and Pyle (1985).

The remainder of this chapter is organized as follows. Section 3.2 describes the environment of the model. The equilibrium outcome of the economy without a loan sales market is discussed. Section 3.3 examines the equilibrium outcome of the economy with a loan sales market. Section 3.4 discuss the results of the model in the light of reality in financial markets, and Section 3.5 concludes the paper.

3.2 The Economy without a Loan Sales Market

3.2.1 The Model

The economy consists of four kinds of agents: lenders, borrowers, banks, and a deposit insurance corporation (DIC, hereafter). The lenders are endowed with one unit of investment good, whereas the borrowers are endowed with nothing. The borrowers, however, have access to a constant returns to scale production technology that converts one unit of investment good into Q units of consumption good. It is assumed that there exist two types of borrowers: *good* and *bad*. The good types' investment project succeeds with probability 1, while the bad types' investment project fails with probability 1. The other agents in the economy can distinguish a borrower in one group from the one in the other, yet the exact type of the borrower is unknown to them.

There are two banks in the economy; safe and risky. We identify the former with S-type and the latter with R-type. The R-type is riskier than the S-type because the former goes bankrupt with probability $1-\theta^R$ while the latter goes bankrupt with probability $1-\theta^S$, where $0 < \theta^R < \theta^S < 1$. In other words, the S-type has lower chance of defaulting than the R-type. It can be interpreted that the S-type invests to the good type borrowers with probability θ^S, while the R-type invests to the good type borrowers with probability θ^R. Namely, the S-type is superior in distinguishing the borrowers' types to the R-type.

The probability of default is generic to each bank, and it cannot be changed by strategies chosen by the bank. Hence, the moral hazard problem is not an issue in the current analysis. However, an adverse selection problem arises in the economy. It is assumed that the type of the banks is private information which is observed only by the banks. Namely, the rest of the agents cannot tell the exact type of each bank. It is assumed, however, that the distribution of the types of the banks is known to the DIC; i.e. the rest of the agents have a prior assessment that each bank is S-type with probability 1/2.[4] Note that the ultimate lenders do not know the distribution of the banks' types. Namely, the DIC has advantageous information to the lenders.

The lenders have access to a constant returns to scale storage technology which converts one units of endowment to q units of consumption good. Hence, the lenders choose between investment in their storage technology and loans to the borrowers. It is assumed that the lenders can make loans to the borrowers only through banks; i.e. direct investment opportunities are ignored in the current analysis.

It is assumed that the banks are subject to two kinds of bank regulations: capital

[4]It is implicit that no information that is relevant to detect the type of borrowers (stock prices, for example) is available to the rest of the agents in the current analysis.

regulation and deposit insurance. The capital regulation requires that equity capital held by the banks be equal to or greater than a fixed proportion of deposits. We assume that both banks have K units of investment good as equity capital, and that the capital-deposit ratio is ϕ. Let D be lenders' deposits. Then, the capital regulation herein requires $K \geq \phi D$ must hold. In the analysis, the capital-deposit ratio is given exogenously rather than controlled by a monetary authority. This is a plausible assumption since capital regulations in many industrialized countries follow the BIS (Bank of International Settlement) requirement.[5]

The DIC's problem is given by

$$\max_{\gamma^i}[-\sum_{i\in\{S,R\}}\{(1-\theta^i)D-\gamma^i\}^2]$$
$$s.t.\quad E[\sum_{i\in\{S,R\}}\{(1-\theta^i)D-\gamma^i\}]=0$$

where γ^i is a risk premium that type i bank is charged. The maximand says that the DIC wants to charge a fair insurance premium to each bank so as to maximize the aggregate production level. The constraint, on the other hand, indicates that the DIC wants to cover expected payments it must make to depositors by the insurance premiums it collects from the banks. Note that the existence of the DIC is justified by the informational advantage it has against the lenders. If the DIC did not exist, the lenders would have to spend tremendous costs for the assessment of the banks' riskiness, and the deposits to the banks as well as the investments to the borrowers might be passed up.

[5]It is said that the implementation of the BIS requirement on debt-equity ratio was initiated by American authorities to restrict the activities of Japanese banks in the U.S. financial markets in late 1980's. Japanese banks generally had higher debt-equity ratios than U.S. banks.

We now consider a single-period model of financial transaction among the four groups of agents. The timing of the game played by them is as follows. At the beginning of the period, the lenders go to the banks to deposit their investment good. Recall that the population of the lenders is very large, and that the amount of deposit accepted by the banks is limited due to the capital regulation. We assume that the population is so large that not all the lenders can make a deposit. Then, competition among the lenders competes away any excess revenues to them from making a deposit in the banks. Hence, the deposit interest rate equals $q + \epsilon$ in an equilibrium, where ϵ is an infinitesimally small, positive number. We approximate the equilibrium interest rate with q in the following. It is assumed that the capital requirement must be satisfied at this point. Namely, the maximum possible deposit that the banks can collect is ϕK.

After the deposits are made, and before investments are undertaken by the banks, the DIC collects insurance premiums from the banks based on the information it has about the type of the banks. Then, the banks invest to the borrowers all the equity capital and the investment good obtained from the lenders as deposits net of the insurance premium. It is assumed that there are so many borrowers that the demand for funds always exceeds the supply of funds. Hence, the competition among the borrowers competes away revenues to the borrowers; i.e. the banks collect all the production outcomes from the borrowers. When the production is completed, the banks collect loan interests from the borrowers, and it pays deposit interests to the lenders. In the current setup, the banks have all the bargaining power against the lenders and the borrowers so that they obtain all the production outcomes.

In sum, the preference of banks is given by the following:

$$U^i = \{(D + K - \gamma^{i*})Q - Dq\}\theta^i$$

where $i \in \{S, R\}$ denotes the type of the bank, and

$$\gamma^{i*} = \arg\max_{\gamma^i}[-\sum_{i\in\{S,R\}}\{(1-\theta^i)D - \gamma^i\}^2]$$

Finally, we make the following assumption:

Assumption 3.1 *$U^i > 0$ holds for all γ^{i*} chosen by the DIC.*

The assumption indicates that the banks are willing to collect deposits with interest rate q regardless of the decision made by the DIC. Hence, the banks always choose maximum leverage; i.e. $D = \phi K$.

3.2.2 Benchmark Equilibrium with Complete Information

First, consider the economy with complete information; i.e. the type of the banks is public information. In this case, the DIC chooses risk premiums as follows:

$$\gamma_1^S = (1 - \theta^S)Dq$$

for S-type bank, and

$$\gamma_1^R = (1 - \theta^R)Dq$$

for R-type bank.

With these risk premiums, the level of investment made by S-type bank, I_S, is

$$I_1^S = D + K - \gamma_1^S \tag{3.1}$$

whereas the level of investment made by R-type bank is

$$I_1^R = D + K - \gamma_1^R \tag{3.2}$$

Hence, the aggregate production outcome with complete information, Y_1, is given by

$$\begin{aligned} Y_1 &= (I_1^S Q - Dq)\theta^S + (I_1^R Q - Dq)\theta^R \\ &= \{(D+K)Q - Dq\}(\theta^S + \theta^R) - (\gamma_1^S\theta^S + \gamma_1^R\theta^R)Q \end{aligned} \tag{3.3}$$

3.2.3 Equilibrium With Adverse Selection

This subsection explores the consequence of information asymmetry between the banks and the DIC. As have been described in Section 3.2.1, the DIC knows the distribution of the banks' types, but it does not know the exact type of each bank. In this case, both banks claim that they aıe the S-type since the DIC would charge a higher insurance premium if they claimed otherwise, which would reduce the level of investment and, hence, the return to the banks.

Without knowing the exact type of the banks, the DIC charges the same premium given by the following:

$$\gamma_2^S = \gamma_2^R = \frac{1}{2}(2 - \theta^S - \theta^R)Dq$$

Let us define $\gamma \equiv \gamma_2^S = \gamma_2^R$.

Given the insurance premium above, the level of investment by the banks, I_2^S and I_2^R, is given by

$$I_2^S = I_2^R = D + K - \gamma_2 \tag{3.4}$$

Hence, the aggregate level of production with adverse selection, Y_2, is given by

$$Y_2 = (I_1^S Q - Dq)\theta^S + (I_1^R Q - Dq)\theta^R$$
$$= \{(D + K - \gamma_2)Q - Dq\}(\theta^S + \theta^R) \tag{3.5}$$

From the analysis in Section 3.2.2 and 3.2.3, the following proposition holds:

Proposition 3.1 *When there is the adverse selection between the banks and the DIC, the S-type bank underinvests while the R-type overinvests in the equilibrium relative to the equilibrium level of investments in the benchmark economy with complete information. In total, the aggregate level of production is lower in the economy with the adverse selection than the one in the economy with complete information.*

The results in the proposition are immediate from the previous analysis. The first half of the proposition can be verified by comparing (3.1) and (3.2) with (3.4). It is obvious that the level of investment in the equilibrium with complete information is less than the one in the equilibrium with adverse selection for the S-type whereas it is greater for the R-type. The second half of the proposition is a result of the misallocation of funds. It can be verified by comparing (3.3) with (3.5).

3.3 The Economy with a Loan Sales Market

This section verifies that the advent of a loan sales market resolves the underinvestment and overinvestment problem that arise due to the adverse selection.

Suppose that a loan sales market *can* arise in the economy. The participation in the loan sales market costs μ, where μ is an infinitesimally small positive number.

Then, the timing of the financial transaction can be described as follows. At the beginning of the period, the banks collect deposits from the lenders. Because of the competition among the lenders, the deposit interest rate is q for a unit of investment good. The maximum possible amount of deposit the banks can raise is limited by ϕK due to the capital regulation. Subsequently, each bank chooses whether to participate in the loan sales market or not. If it decides to participate, then, it chooses whether to become a *'seller'* or a *'buyer'* of loan-backed securities in the loan sales market. Hence, each bank has three strategies; i.e. the strategy set is given by $\{NP, seller, buyer\}$ where "NP" stands for "*not to participate*". We denote a combination of strategies by (s_1, s_2) where s_1 is the strategy chosen by S-type and s_2 by R-type. It is assumed that, if a strategy pair chosen by the banks does not generate proper matching, no transaction occurs in the loan sales market, and the banks invest directly to the borrowers. We say that the matching is *proper* if the loan sales market consists of a seller and a buyer, and if there is potential gain from trading loan-backed securities; i.e. the reservation value of the buyer exceeds that of the seller.

The DIC collects insurance premiums from the banks after observing transactions in the loan sales market. In particular, the DIC observes whether the loan sales market opened or not, and, if it opened, which bank became the seller and which became the buyer.

There are nine potential outcomes associated with strategy pairs chosen by the banks; $\{NP, seller, buyer\} \times \{NP, seller, buyer\}$. The payoff matrix is given in Figure 3.1. Since we are interested in Nash equilibria, all the dominated strategies can be eliminated.[6] In particular, unless a strategy pair generates proper matching in the loan sales market, the pair can be dominated by (NP, NP); i.e. both banks choose not to participate. This is due to the participation cost μ. Consequently, the payoff matrix is reduced to the one in Figure 3.2. Since (NP, NP) is always preferred to $(NP, buyer)$ and $(seller, NP)$, we only need to compare outcomes in two cases; (NP, NP) and $(seller, buyer)$.

If both banks choose not to participate, then, the game is the same as the one described in Section 3.2.1. Namely, both banks invest all the equity capital and deposits net of risk premium payment to the DIC. If the S-type decides to become the seller while the R-type decides to become the buyer, the timing of financial transaction becomes different from the previous one. In this case, the seller invests to the borrowers, and, then, he combines the loans for resale as a single security. The buyer obtains the loan-backed security from the seller in the loan sales market. We assume that the negotiation over the price of the security between the seller and the buyer follows the next rule: The buyer offers a fraction, α, of his funds (i.e. equity capital and the deposits net of insurance premium payed to the DIC) to the seller. If there is any funds left to the buyer, he invests the leftover directly to the borrowers. Given the offer of funds by the buyer, the seller and the buyer bargains over the price of the funds, namely, the rate of return, r. The rate of return, r, indicates that the return to the seller is r while the buyer obtains the remaining. The reservation value

[6]It is well-known that every Nash equilibrium survives iterated elimination of strictly dominated strategies. See Gibbons (1992) for example.

of the S-type is given by

$$r^S = \frac{\{(D+K-\gamma_1^S)Q - Dq\}\theta^S}{D+K}$$

whereas that of the R-type is given by

$$r^R = \frac{\{(D+K-\gamma_1^R)Q - Dq\}\theta^R}{D+K}$$

First, the seller offers r_1 to the buyer, where the subscript 1 represents the offer in stage 1 of the bargaining. Subsequently, the buyer chooses whether to accept or reject the offer. If accepted, the bargaining ends, and they trade the security in the loan sales market. If rejected, however, the buyer makes a counter offer, r_2, and the seller chooses whether to accept or reject it. Until they reach an agreement, the bargaining with alternating offer continues. It is assumed that the bargaining is costly unless an agreement is reached instantly, and, hence, the revenues to the banks are discounted. In particular, the discount factor is δ_S for the S-type, and δ_R for the R-type. Then, the payoff to the seller is given by

$$\delta'^{t-1}(1-\beta)\{(D+K-\gamma')Q - Dq\}\theta' + \alpha\{(D+K-\gamma')Q - Dq\}\theta'$$

whereas the payoff to the buyer is given by

$$\delta''^{t-1}\beta\{(D+K-\gamma')Q - Dq\}\theta' + (1-\alpha)\{(D+K-\gamma'')Q - Dq\}\theta''$$

where t denotes the stage they reach an agreement, and where superscripts $'$ and $''$ denote the seller and the buyer respectively. β denotes a sharing rule which is associated with an offer r. Let β^* be the equilibrium sharing rule which results from the bargaining. It is well-known that there exists a unique (subgame perfect) equilibrium sharing rule β^* in this sequential bargaining game (See Osborne and Rubinstein (1990) for example.).

Having described the timing of the financial transaction, we now analyze Nash equilibria of the game.

First, we show the following lemma:

Lemma 3.1 *The buyer of the loan-backed security offers all his funds to the seller in the loan sales market.*

Proof: Due to the nature of the bargaining game described above, the buyer obtains the rate of return higher than his reservation value. Since the reservation value of the buyer is given by the rate of return from investing directly to the borrowers, the buyer's utility can be improved by investing all his funds to the seller in the loan sales market.

Q.E.D.

With Lemma 1.1, the following propositions can be shown:

Proposition 3.2 *The advent of the loan sales market may resolve the underinvestment and the overinvestment problem that appeared in the economy without loan sales market and with adverse selection.*

Proof:

To prove this proposition, we calculate the payoffs to the banks when strategy pairs (NP, NP) and $(seller, buyer)$ are chosen. The payoffs associated with (NP, NP) are the same as those obtained in Section 3.2.3. Hence, we only need to calculate the payoffs associated with $(seller, buyer)$.

When $(seller, buyer)$ is chosen, the banks make investments, anticipating that the DIC will charge γ_1^S as an insurance premium. Then, observing the transaction in the loan sales market, the DIC collects the premium. The DIC charges γ_1^S to both banks since the investments to the borrowers are solely done by the S-type. The sharing rule, β, determines the payoffs to the two banks as follows:

$$U^S = (1-\beta^*)\{(D+K-\gamma_1^S)Q - Dq\}\theta^S + \{(D+K-\gamma_1^S)Q - Dq\}\theta^S$$

$$U^R = (1-\beta^*)\{(D+K-\gamma_1^S)Q - Dq\}\theta^S$$

Clearly, $(seller, buyer)$ constitutes an equilibrium for sufficiently high β^*, while (NP, NP) constitutes an equilibrium for sufficiently low β^*. In particular, the following condition must hold foı the advent of the loan sales market:

$$\beta^*\{(D+K-\gamma^S)Q - Dq\}\theta^S > \{(D+K-\gamma_2)Q - Dq\}\theta^R$$

or, alternatively,

$$\beta^* > \frac{\{(D+K-\gamma_2)Q - Dq\}\theta^R}{\{(D+K-\gamma^S)Q - Dq\}\theta^S} \tag{3.6}$$

Since $\gamma_2 > \gamma^S$, the right hand side of (3.6) is less than 1. Since any $\beta^* \in [0,1]$ can be supported by a proper choice of δ_S and δ_R, there exists β^* which satisfies (3.6).

Q.E.D.

Recall that the sufficiently high β^* is supported by a sufficiently low δ_S and a sufficiently high δ_R. In other words, $(seller, buyer)$ is supported as the Nash equilibrium if the bargaining power of the R-type is sufficiently stronger at the negotiation in the loan sales market than that of the S-type.

Proposition 3.3 *With the loan sales market, the aggregate level of production in expected terms is higher than the one attained in the economy without loan sales market.*

Proof:

Recall that, when the loan sales market arises in the economy, the level of investment by the S-type is

$$(2-\beta^*)(D+K-\gamma_1^S) \tag{3.7}$$

whereas the one by the R-type is

$$\beta^*(D+K-\gamma_1^S) \tag{3.8}$$

Then, the aggregate level of production is given by

$$Y_3 = 2\{(D+K-\gamma_1^S)Q - Dq\}\theta^S \tag{3.9}$$

The proposition can be verified by comparing (3.7), (3.8) and (3.9) with (3.4) and (3.5).

Q.E.D.

Note that the level of aggregate production with loan sales market exceeds the one with complete information and without loan sales market. This is because all the investments to the borrowers are done virtually by the S-type alone in the economy with loan sales market, while the investments are done by each banks in the latter.

3.4 Discussion

The model has predicted that the adverse selection problem can be resolved with the advent of a loan sales market. Then, the question is: Should the prices in the loan sales market be used by the Federal Deposit Insurance Corporation as information to implement the risk-adjusted insurance premiums, will the adverse selection problem be resolved? Our answer to this question is negative based on several aspects of reality that are not captured by the model.

First, recall that there were only two banks with different risk characteristics in the previous sections. In reality, however, there exist many banks with more than two risk characteristics. For example, suppose that there exist a safe bank with a default rate θ^S and a continuum of risky banks with default rate θ^R on the real line $[\underline{\theta}^R, \bar{\theta}^R]$, where $\theta^S < \underline{\theta}^R$. The safe bank is large relative to the risky banks so that the safe bank is capable of absorbing all the demand for loan-backed securities by the risky banks. Also, assume that the safe bank has all the bargaining power against the risky banks so that only the safe bank offers security prices sequentially to the risky banks knowing that the distribution of the default rates (i.e. the distribution of the reservation values of the risky banks). Suppose that all the risky banks choose to become a buyer in the loan sales market. Then, in this more realistic environment, it can be shown that the safe bank makes discrete offers over the interval $[\underline{\theta}^R, \bar{\theta}^R]$ (See Sobel and Takahashi (1983) for the skimming property of the sequential bargaining with one-sided information.). Since no bank has an incentive to deviate from this action, this is a Nash equilibrium. As can be seen by now, the DIC cannot tell the exact type of the risky banks in this case.

Second, in the previous sections, the only reason the banks trade loan-backed securities was that the two banks can share the additional benefits which arises due to the resolution of the adverse selection between the banks and the DIC (which, in turn, makes it possible to implement fair insurance premiums.). In reality, however, there are other reasons to trade loan-backed securities. For instance, institutions which lack relationships or contact with existing borrowers may become buyers of the loan-backed securities to enter commercial lending business (See Salem (1986) for detailed discussion on incentives to buy and sell loans.). In this case, being a buyer of the loan-backed security does not necessarily imply that the bank is riskier than the seller.

Third, prices of loan-backed securities are not always observable by a third party. For example, Salem (1986) says "No bank we interviewed would tell us the exact or average spread it earns."(p.11)

Therefore, we conclude that the results in the previous sections do not necessarily indicate that observations from loan-sales markets are necessary and sufficient information to assess riskiness of banks. But, rather, they indicate that the price of loan-backed securities is one of the relevant pieces of information for the assessment of the banks' riskiness.

3.5 Conclusion

It was shown that the existence of loan sales market might resolve the adverse selection problem between the deposit insurance corporation and the banks. With the loan sales market, the deposit insurance corporation could charge fair insurance premiums to the banks based on their risk characteristics. It was also shown that the overinvestment and the underinvestment problem might be resolved due to the advent of loan sales market.

In sum, the major prediction of the current analysis is that the banks of different risk characteristics may voluntarily (at least partially) reveal their types when the loan sales market exists, which not only realize the (more) efficient allocation of funds but also makes it possible for the deposit insurance corporation to collect fair insurance premiums from the banks.

An interesting extension may be to incorporate a moral hazard problem which arises by the existence of deposit insurance corporation into the current analysis since the moral hazard problem is as important as the adverse selection problem discussed here.

Figure 3.1

		R-type NP	R-type buyer	R-type seller
S-type	NP	a, b	a, $\underline{b}$	a, $\underline{b}$
	buyer	$\underline{a}$, b	a, $\underline{b}$	$\underline{a}$, $\underline{b}$
	seller	$\underline{a}$, b	$\bar{a}$, $\bar{b}$	$\underline{a}$, $\underline{b}$

a: payoff to the S-type from direct investment
b: payoff to the R-type from direct investment
a: a minus the participation fee
b: b minus the participation fee
a: Payoff to the S-type with the loan sales market
b: payoff to the R-type with the loan sales market

Figure 3.2

		R-type: NP	R-type: buyer
S-type	NP	a, b	$a, \underline{b}$
S-type	seller	$\underline{a}, b$	$\bar{a}, \bar{b}$

Chapter 4

A Note on Default Rates

4.1 Introduction

It is often argued that low default rates in financial markets are preferable for a society. th When financial markets are subject to an information problem, however, the argument is not so obvious as it looks.

The purpose of this chapter is to show that social welfare, measured by the level of consumption by lenders and borrowers, need not be associated with default rates in financial markets. To verify this, we develop an overlapping generation model of corporate finance. In the model, there exist two groups of borrowers with different default rates, safe and risky. All the borrowers attempt to raise funds for their projects, yet, loans are cut off by the lenders for those without sufficiently good credibility; i.e. too many defaults in the past. Borrowers with good credibility, on the other hand, can raise funds in one of the two ways; through markets and through a bank. Whether a borrower raise funds via a bond market or via a bank depends on his/her default history. That is, if the number of past defaults of a particular borrower is sufficiently small, lenders choose to lend to him via the bond market.

If the number of past defaults is not sufficiently small, the lenders cannot obtain a sufficiently high prior that the borrower is safe, and, hence, they choose to invest to him via a bank. In the case of bank lending, banks undertake a costly monitoring effort to detect the type of the borrowers. Because of this information production, it is assumed that investment through the banks requires a higher fee for the lenders than that through the market.

The model demonstrates that the default rate in the market as well as the default rate among the borrowers who raise funds through banks increases when the fee required to invest through the market decreases. Since the ultimate lenders benefit from the reduction of the fee, the result indicates that higher output available for consumption is associated with higher default rates in financial markets.

The rest of this chapter is organized as follows. Section 4.2 describes the environment of the model. Section 4.3 explores how the default rate in a bond market changes as we vary the brokerage fee. Section 4.4 concludes the paper.

4.2 Model

The economy consists of lenders, borrowers, securities companies and banks. The lenders live for one period, while the borrowers live for finitely many periods, n. The same number of lenders and borrowers are born in each period. Hence, there exist a variety of ages of borrowers except in the initial period. The lenders are endowed with one unit of an investment good, whereas the borrowers are endowed with nothing. The lenders invest their investment goods to the borrowers, and obtain consumption goods as a return. The lenders also have access to a constant returns to scale storage technology which returns Q units of consumption good for a unit of investment good.

There are two groups of borrowers; S-type and R-type. The number of S-type borrowers and R-type borrowers are assumed to be the same without loss of generality. An S-type has access to a relatively safe project which yields H units of consumption good for a unit of investment good, while an R-type has access to a risky project which yields L units of consumption good for a unit of investment good. The success rate of the S-type's project is λ while that of the R-type's project is ϕ. Unsuccessful investments yield no payoffs. The borrower's type is assumed to be private information held by the borrowers. The lenders know the aggregate distribution of the types, but cannot tell the exact type of each borrower without cost.

The following assumptions are made:

Assumption 4.1 $\lambda H > Q > \phi L$

Assumption 4.2 $L > H$

Assumption 4.1 says that, in expected terms, the return from investing to an S-type exceeds the return from investing in the storage technology, and that the return from investing in the storage technology exceeds the return from investing to an R-type. Assumption 4.2 says that the return from investing to an R-type is greater than the return from investing to an S-type if the projects are both successful. Note that Assumption 4.2 is necessary to introduce an adverse selection problem into the current model. Since the exact type of the borrowers is unknown to the lenders, R-type borrowers always claim that they are S-type borrowers as their willingness to pay for a lending rate is lower than R-types'.

It is also assumed that the default history of each borrower is public information. With this information, the lenders, as well as the bank, update their beliefs that a borrower is or is not an S-type. Hence, the heterogeneity of the borrowers stems not only from the type and the age of the borrowers but also from the reputation obtained by the track record from the lenders' point of view. The revision of beliefs is assumed to be consistent with the Bayes' rule.

In this environment, the lenders choose how to supply their funds. There are two possible modes; investment through a bond market, and investment through banks. If the lenders choose to invest through a bank, it monitors the borrowers to detect their types. The monitoring by the bank is assumed to be perfect; i.e. the bank finds the exact type of the borrowers with probability one. A fraction p of the return from investments is collected by the bank as a monitoring cost.

If the lenders decide to invest through the bond market, they invest via securities companies, which, in turn, invest directly, and randomly (i.e. without any monitoring) through the market on behalf of the lenders. It is assumed that lenders must pay fraction q of the return from investment as a brokerage fee.

It is also assumed that the population of the lenders is large relative to that of the borrowers, and that both the banking and the securities industry are competitive. Hence, any excess revenues to the lenders and to the intermediaries (both banks and securities companies) are competed away. That is, borrowers obtain all the return from projects net of transaction fees collected by the banks and securities companies plus the minimum payments necessary to the lenders, i.e. the rate of return from the storage technology.

4.3 Result

Under this environment, the average return obtained by borrowers from raising funds via banks is given by

$$\{\xi\lambda H + (1-\xi)\phi L\}(1-p) - Q \equiv B(\xi)$$

where ξ is the prior belief of the lenders and the banks that borrowers with a particular default history are S-types. As for the average return to a borrower from raising funds through the market, it is given by

$$\{\xi\lambda H + (1-\xi)\phi H\}(1-q) - Q \equiv M(\xi)$$

if the lenders (or securities companies) choose to offer H as a lending rate, whereas it is given by

$$(1-\xi)\phi L(1-q) - Q \equiv M'(\xi)$$

if the lenders (or securities companies) choose to offer L as a lending rate. Since $M'(\xi)$ is negative regardless of the value of ξ, the borrowers compare $B(\xi)$, $M(\xi)$ and Q (the return from investing in the storage technology) to choose how to raise funds.

We now verify the following proposition.

Proposition 4.1 *The default rate in the bond market as well as the default rate among borrowers who raise funds through banks may increase when the brokerage fee in the bond market is reduced. That is, social welfare as measured by the consumption level of borrowers and lenders increases when the default rates increase.*

The proposition is proved by constructing an example. To do it, choose the parameters in the way they satisfy the assumptions, $B(1/2) > M(1/2)$, $B(1) < M(1)$ and $\partial B(\xi)/\partial\xi > \partial M(\xi)/\partial\xi$ hold.[1] Let ξ^* be the critical value of ξ $B(\xi^*) = M(\xi^*)$.

Now, ξ^* must satisfy the following:

$$\{\xi^*\lambda H + (1-\xi^*)\phi L\}(1-p) = \{\xi^*\lambda H + (1-\xi^*)\phi H\}(1-q)$$

Solving for ξ^*, we have

$$\xi^* = \frac{\phi L(1-p) - \phi H(1-q)}{(\lambda H - \phi H)(1-q) - (\lambda H - \phi L)(1-p)}$$

As is clearly seen, ξ^* is increasing in q (Note that the value of ξ is independent of q.). Therefore, as q increases, more borrowers obtain funds through banks, which, in turn, results in a decrease in the default rates both in the bond market and among those who raise funds via banks. Hence, the proposition has been verified.

The intuition behind this result is as follows: If the brokerage fee is reduced, some of the borrowers who currently raise funds through banks get access to the borrowing through the bond market since the monitoring cost required for the bank lending becomes relatively costly compared with the lending via markets. That is, the banks lose some of their less risky borrowers to the markets. Since the borrowers who raise funds through the banks are riskier on average than those who raise funds through the markets, it implies that there will be more risky borrowers raising funds through the markets, and, hence, the default rate in the market increases. Also, the default rate among the borrowers who raise funds via banks increases since the fraction of more risky borrowers increases after the less risky borrowers move to the markets.

[1] For instance, $p = .4$, $q = .35$, $\lambda = 2/3$, $\phi = 1/4$, $H = 3$, $L = 4$, $Q = .8$ satisfy these conditions.

4.4 Conclusion

The current analysis has shown that default rates in financial markets cannot be associated with social welfare as measured by aggregate consumption. In particular, it was shown that a reduction in the consumption level was associated with a reduction in the default rates. Hence, the result contradicts with the common argument that a lower default rate in financial market is necessarily preferable.

Note that the market default rate also increases when the fee charged by the banks, p, decreases. Since the increase in the fee results in the reduction of the return to the borrowers, the market default rate is positively correlated with aggregate consumption level in this case. Hence, it can be concluded that the default rate cannot be used as an indicator of social welfare.

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