Essays in Banking

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Abstract

The theme of this thesis is Banking, concentrating on banking crises. The first chapter looks at banking crises which occur because of problems of asymmetric information about borrowers. The asymmetric information means that the loan securities that the bank sells can become illiquid and there are sudden drops in securities prices. The second chapter looks at a crisis resolution policy and shows how the actions of the Lender of Last Resort in a crisis can affect the incidence of future banking crises, in particular that a more generous Lender of Last Resort can lead less frequent crises as banks choose safer projects. The final paper returns to the theme of loan sales. We derive conditions for when the market is sustainable in the face of moral hazard by the bank which makes the loan. In an empirical section we show that there is a negative relationship between the fraction of a loan retained and the probability of default.

Resumen

El tema de esta tesis es Banca, concentrándose específicamente en el tema de Crisis Bancarias. El Capitulo 1 estudia las crisis bancarias que ocurren debido a problemas de asimetría de información entre los tomadores de préstamos. Dentro del marco propuesto, asimetría de información significa que los títulos sobre préstamos que el banco vende pueden tornarse ilíquidos y[/o] que pueden ocurrir caídas súbitas en el precio de los títulos. El Capitulo 2 analiza la política de resolución de crisis y muestra como las acciones de un Prestamista de Última Instancia durante una crisis pueden afectar la incidencia/probabilidad de sufrir futuras crisis bancarias. En particular, un Prestamista de Última Instancia más generoso puede contribuir a reducir la frecuencia de las crisis dado que los bancos eligiran proyectos más seguros. El ultimo capitulo de esta tesis vuelve a considerar el tema de la venta de préstamos, a través de títulos emitidos por el banco. En este capítulo se derivan aquellas condiciones para las cuales

el mercado es sostenible, en el caso de que exista daño moral por parte de los bancos que realizan los préstamos. En una sección empírica mostramos que hay una relación negativa entre la fracción de préstamos retenida y la probabilidad de default.

Introduction

I have divided the thesis into three separate papers, which attempt to explore the issue as to how banking crises come about. The first chapter looks at banking crises which occur because of problems of asymmetric information about borrowers. This paper builds a simple model to look at the effect of securitisation on the banking system. In this paper we build a model of asymmetric information in the secondary market for loans and a 'lemons' problem faced by uninformed agents who buy these loans. I show how certain conditions can sustain a secondary loan market even when banks have inside information about their borrowers, but only when other investment opportunities are good. In this case the bank obtains information as to the expected default of borrowers who have purchased a house. The asymmetric information means that the loans sell at a discount in the secondary market. High expected house prices help to support the secondary loan market as it makes the 'lemon's problem' less severe. The loan securities that the bank sells can become illiquid and there are sudden drops in securities prices. Although the secondary loan market delivers welfare increases it is also unstable. I show how the emergence of secondary markets can lead not only to a fundamental increase in asset prices but also to a change in return correlations from negative to positive across asset classes.

The second chapter looks at a crisis resolution policy and shows how the actions of the Lender of Last Resort in a crisis can affect the incidence of future banking crises. When considering the issue of bank rescues there is a tradeoff between crisis prevention and moral hazard. This chapter considers an intermediate case of the Lender of Last Resort, where the limited access to resources to recapitalise banks leads to a ‘partial LOLR’.

I introduce a Lender of Last Resort which minimises a social loss function related to the cost resolving the failures of insolvent banks but which is subject to the resources it has available. I show that this can help to alleviate the moral hazard problem induced by lenient rescue policies. However, a new source of moral hazard arises. Once the LOLR takes into account the social cost of failure banks have an incentive to increase this cost at the expense of monitoring. In addition when the resources are limited banks have a further incentive to be the ones to receive a rescue when other banks are in distress at the same time. I show that it may possible to achieve a Pareto improvement by giving Lender of Last Resort more resources to deal with a crisis, both in terms of less costly resolution of systemic banking crises when they occur but also in a lower frequency of bank failures. This is because a more generous Lender of Last Resort can lead less frequent crises as banks choose safer projects.

The final paper returns to the theme of loan sales. Banks have a reduced incentive to monitor when credit is dispersed because they do not ultimately bear all the credit risk, and this arises in settings such as multiple-bank lending syndicates or when there is a secondary loan market. Monitoring incentives are diluted not only by the fact that each bank is not exposed to the full credit risk, but also by the fact that there are other banks who may potentially monitor. We present novel evidence on long run borrower performance in favour of the view that the lead bank’s monitoring effort, as reflected in its syndicate lending stake, matters. Greater retained interest materially lowers the probability that the borrower defaults and improves profitability and investment-grade status three years after syndication. We illustrate how credit dispersion and transfer exacerbate agency problems in a simple theoretical framework. We also show that a situation where banks stop monitoring due to the ability to sell their credit risk in a secondary market is ultimately unstable, although it may be possible for banks to shirk in the short-run. We derive conditions for when the market is sustainable in the face of moral hazard.

Contents

Chapter 1

Sweetening the Lemon. House prices and adverse selection in secondary loan markets

This paper builds a simple model to look at the effect of securitisation on the banking system. In this paper we build a model of asymmetric information in the secondary market for loans and a 'lemons' problem faced by uninformed agents who buy these loans.

We show how certain conditions can sustain a secondary loan market even when banks have inside information about their borrowers, but only when other investment opportunities are good. Although the secondary loan market delivers welfare increases it is also unstable. We show how the emergence of secondary markets can lead not only to a fundamental increase in asset prices but also to a change in return correlations from negative to positive across asset classes.

JEL Code: G21, D53, D82
Keywords: banks, asymmetric information, loan markets, mortgages, credit risk transfer

Recent developments in the U.S. housing market and the market for mortgage backed securities have been a source of considerable debate. In the 10 years preceding the subprime crisis there had been a massive expansion in lending to borrowers who would be considered too risky or to have too little documentation to qualify for mortgage loans. The dotted line in figure 1.1[1] shows the considerable increase in the number of mortgage loans being made to these borrowers. We refer to subprime borrowers as those with low credit scores, typically with a FICO[2] score below 620, poor income documentation and a lack of credit history. These borrowers are characterised not only by their significant credit risk but also by their opaque finances, which are difficult for a bank to communicate to outsiders. The high probability of default, and investor awareness of it, is probably best encapsulated by the introduction of NINJA loans as an asset class, where NINJA stands for *no income, no job, no assets.*

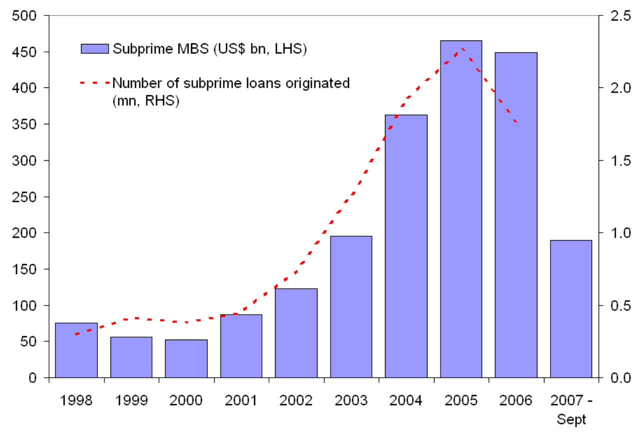


Figure 1.1: Subprime Mortgage Backed Securities (LHS) and number of subprime loans made (RHS)

However, these loans were not retained on the bank's balance sheet but packaged and sold to investors. Before the subprime crisis there had been a massive

[1]Source: Loanperformance database

[2]One of the most universally used credit scoring agencies in the USA.

expansion of issuance of residential mortgage backed securities (RMBS) in several countries, notably the USA and the UK. The bars in figure 1.1 shows the contemporaneous increase in the value of subprime MBS.
Before securitisation credit quality was an important concern for banks because mortgage lenders retained the loans they originated. It remained important and asymmetric information was limited due to the expertise of bond insurers and the initial MBS buyers. It was also easier for banks to communicate the borrower information to these experts. However, in 2004 CDO (collateralised debt obligations) investors[3], who were not experts, became the dominant investors in the asset class.
At the same time as the market for subprime MBS developed there was a substantial increase in house prices as shown in figure 1.2.

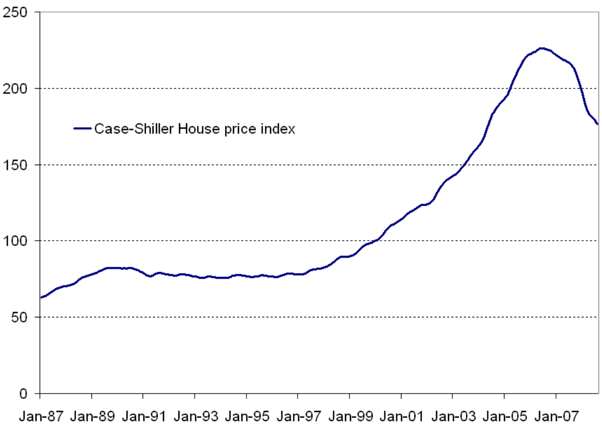


Figure 1.2: House prices in the USA, Jan 00=100

This paper builds a simple model to look at the effect of securitisation on the banking system. The focus of the model is the funding of banks, *credit* risk and recovery values in the case of default. This allows us to analyse the asset class of main interest: subprime loans, where default has a high probability; and the small loan size, which means that pre-payment is less of an issue.[4]

[3] described by Adelson and Jacob (2008) as less discriminating

[4] Pre-payment often involves a fixed cost so is less likely to be undertaken by borrowers holding small loans, in addition about 80% of subprime loans had prepayment penalties.

There is a substantial RMBS literature focusing on prepayment risk. However I focus on default risk due to the interest in subprime loans.

Banks have also traditionally made use of 'soft information' about their clients which, by definition, is difficult to communicate. The result of this is they have inside information relative to secondary markets and outsiders, which means that there is potential for an Akerlof (1970) style lemons problem which limits the effectiveness of financial innovation. There are many informational frictions along the process of securitisation, which are well documented and discussed in Ashcraft and Schuermann (2008). The informational friction of focus in the model in this paper is between the bank, which originates the loan, and the third-party, to whom the loan is sold.

In the model securitisation of mortgages is ex-ante welfare improving because it provides liquidity to the bank, but the banking system can sometimes go into crises. Secondary markets for these securities can exist even when the bank has inside information. The source of the private information is the default of the mortgage borrower, because it is difficult to communicate information about subprime borrowers. The bank needs liquidity to make more profitable investments elsewhere. In the model investors are prepared to buy the securities as long as the adverse selection risk is sufficiently low; either because the loans have a high recovery value in the case of default or because there is a high probability that the bank has profitable investment opportunities. In the model a secondary market for housing loans allows the bank to extend more housing loans, leading to an appreciation in housing prices. The model shows that, following financial innovation such as a secondary market for loans, the relationship between house prices and other markets breaks down or even reverses. We demonstrate in the model that adverse selection and inside information play an important role and the 'financial innovation' delivers welfare increases ex-ante. However, the asymmetric information problem delivers unstable markets, and if a 'crisis' occurs the bank is worse off than if secondary markets had never existed in the first place.

The remainder of the paper continues as follows. A review of the related literature in section 1.1. Then we move to the model. First we outline a benchmark model of 'traditional banking' in section 1.2, where banks make *and* hold loans until maturity; then section 1.3 introduces non-bank investors and a market for mortgage backed securities into the original benchmark model. Section 2.3 concludes.

1.1 Literature review

In the model in this paper the bank has to make a decision on how to allocate its funds between periods. Secondary markets for loans are valuable in this model because they provide the bank with liquidity allowing the bank to make profitable investments elsewhere. This is consistent with Altunbas, Gambacorta, and Marqués (2007). The role of banks as liquidity managers has been extensively covered in the banking literature. This is covered in depth in Freixas and Rochet (1997) and Allen and Gale (2007).
Since the subprime crisis broke in August 2007 several papers have tried to examine how lending behaviour of banks was affected during the lending boom,[5] see Dell'Ariccia, Igan, and Laeven (2008), Bhardwaj and Sengupta (2008), Vig (2008). Although the change in credit extension has been widely criticised it should be taken into account that this was only possible inasmuch as investors were prepared to buy the securities the banks were selling. Gorton (2008) provides evidence that the incentives of banks and buyers of mortgage backed securities are not entirely misaligned. As pointed out by Adelson and Jacob (2008) the original buyers of subprime securities and associated derivatives were originally experts in mortgage credit risk (e.g. bond insurers and buyers from mainstream mortgage backed securities). The notion that the price and performance of the securities sold in the secondary market are heavily dependent on house prices is in line with the views of Gorton (2008) (see also Frank

[5]The term lending standards has been deliberately avoided here as it is a multi-dimensional issue.

J. Fabozzi (2008) and Demyanyk and Van Hemert (2008)).

The boom in house prices, both due to its size and duration, and lack of relation to underlying costs (see Shiller (2007))has sparked considerable interest. There have been claims that this is due to a bubble in the housing market (for example Shiller (2005)) and some pricing irrationality Julliard (2008) and considerable counterargument, (e.g. see Himmelberg, Mayer, and Sinai (2005)). Both Mian and Sufi (2008) and Mayer and Pence (2008) provide empirical evidence that the expansion of mortgage credit in areas with a high underlying demand is associated with house price appreciation.

In the seminal papers of Gorton and Pennacchi (1995a) and Holmstrom and Tirole (1997a) show that a bank must retain a stake in a loan to maintain monitoring incentives.Parlour and Plantin (2008a) show that credit risk transfer markets can be inefficient for safer borrowers as banks must commit a higher investment of capital to credibly signal that they are monitoring.[6] Duffee and Zhou (2001) and Morrison (2001) also find that credit risk transfer markets can lead to welfare reductions. One of the limitations of these models is that it is not clear why either banks or borrowers cannot commit *not* to use the credit risk transfer market. A solution for such an entrepreneur could be to insist on the inclusion of a 'no-sale' clause in its original loan contract, given that the use of loan sales reduces welfare.[7] In the model we demonstrate that *liquid* secondary loan markets are unambiguously welfare-improving for both banks and borrowers. However, due to their instability, if secondary markets unexpectedly break down welfare is *worse* for banks than if liquid secondary loan markets had never existed in the first place.

[6]The condition in Holmstrom and Tirole (1997a) paper that the bank invests some of its capital is only a market clearing condition. Incentives to monitor are given by the different expected payoff if the bank monitors the project.

[7]As an aside this is reasonably common in other loan contracts; for example in syndicated loans the lead arranger is frequently contracted *not* to sell their stake in the loan

1.2 The traditional market for mortgages

This model sets up a stylised version partial equilibrium model of 'traditional banking' where the bank makes mortgage loans to risky borrowers and retains the loan until maturity; i.e. before the advent of securitisation and loan sales. The bank also faces the problem of how to allocate its funds between the two periods. I consider the case of a bank in a local market, with some degree of monopolistic power in the lending market, particularly for mortgages. The bank has to choose between long term and short term lending. The model of the bank is a partial equilibrium setting in that the problem of depositors is not considered, nor is the problem of the original house-owners/house builders. This section acts as the benchmark case to show how the simple introduction of loan sales, done in section 1.3, changes the bank's problem.

1.2.1 The bank's problem

There is one bank and three periods: $0, 1, 2$. The bank receives deposits D at date 0 and faces a demand for mortgages $M = M(r_m)$ where r_m is the interest rate The bank has limited funds (deposits) available for the purpose of long term or short term lending, which it loans to borrowers. The long term borrowers use the funds to purchase an asset: a house from which they derive utility. The bank keeps the loan to maturity and receives the payoff only when the loan matures in the final period. Alternatively the bank may store funds into period 1, the middle period, and make short term loans then. As these are short term loans they are not mortgage loans.

A1 Returns from short-term non-mortgage lending are, by assumption, not pledgable throughout the model; nor is it possible to credibly signal the expected returns.

This assumption has several natural interpretations. In a common corporate finance case this may be because to credibly signal the expected return the bank would have to reveal so much information about the short term projects that competitors would be able to appropriate the project. It is not necessary that *all* short term lending opportunities are not pledgable, only that *some* are not. Alternatively, we could envisage Holmstrom and Tirole (1997a) style cases where the bank must retain some of the expected returns on projects to maintain monitoring incentives. If the middle period shock is interpreted as a 'liquidity shock' such as a possible need to service withdrawals, the bank run literature from Diamond and Dybvig (1983) onwards has provides many reasons why a bank may not wish to communicate this fact to outsiders.

Short term opportunities

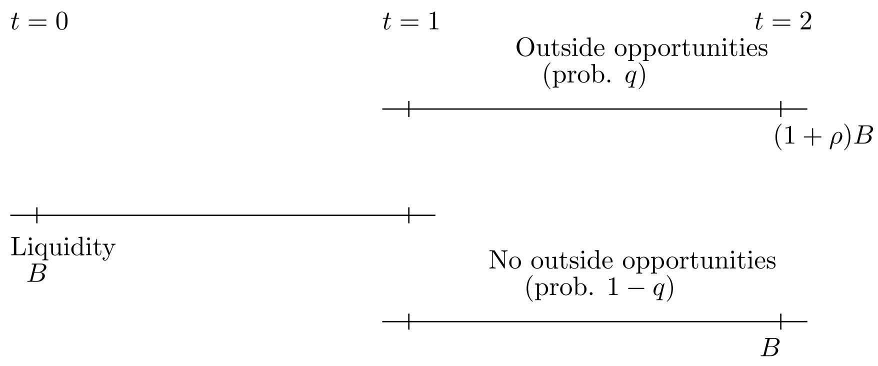
In the middle period the bank realises outside opportunities with probability q which yield with constant returns to scale $1+\widetilde{\rho}$ on each unit invested. Adding outside opportunities in the first period simply adds notation but does not significantly add to the analysis, as then expected return on housing loans must equal $(1+\rho_0)(1+\rho_1)$. Giving an expected discount rate of $E(\delta) = E\left(\frac{1}{1+\widetilde{\rho}}\right)$. These outside opportunities could also be considered liquidity needs, which is a reason why I also work with the discount factor δ.

The timing is as shown in figure 1.3.

The mortgage market

As the main focus of interest in this paper is the interaction between banks and secondary markets the mortgage market is deliberately kept as simple as possible. When a bank makes a mortgage loan it is for the *specific* purpose of buying a house, and the borrower cannot spend the funds elsewhere. To simplify the model I assume all payments from mortgages occur in the final period, and to emphasise that lending is being made long term. The timeline

Figure 1.3: Short-term lending opportunities



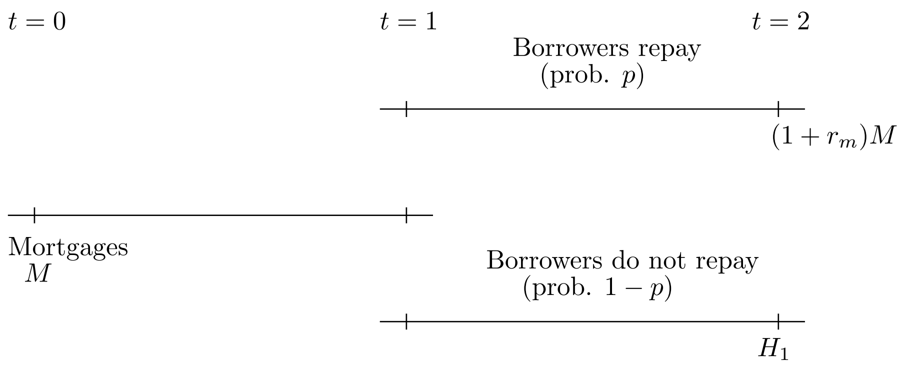
in the mortgage market is as shown in figure 1.4 below.

Mortgage lending is risky, as borrowers may default. Loans are successful with probability p in which case the bank gets the contracted repayment. If the borrower defaults the bank sells the house and recovers the proceeds. This comes from the borrower's limited liability/need for non-negative consumption.[8] By assumption the bank has a local monopoly and mortgage lending is subject to a downward-sloping demand. An in depth micro-foundation of the borrower problem is found in the appendix in section .0.4 The bank effectively either chooses the interest rate or the quantity.

A2 All borrowers either succeed with probability p, or fail with probability $1 - p$. To keep the focus on aggregate shocks borrowers are perfectly correlated: either all repay, or all default

[8] In the context of the housing market this reflects the fact that residential mortgages are generally 'no recourse' loans, meaning that if the homeowner stops making payments, the creditor can take the property but cannot take other assets or attach income.

Figure 1.4: The mortgage market



The housing market

By assumption borrowers need to borrow funds from banks to purchase housing.[9] Borrowers make a down-payment of fraction α of the housing they buy.[10]

A3 The loan from the bank for mortgage purposes can *only* be used to purchase housing.

In the context of the housing market this assumption is reasonable as mortgage loans are usually contracted on the purchase of a specific house.[11] The loan cannot be used for any other purpose. The price H_0 of the housing stock X, which is in fixed supply,[12] is determined by the mortgage funds available to

[9] For simplicity this is not explicitly microfounded but in the context of houses it is clear that a certain amount of housing has to be purchased before any meaningful utility can be derived from the ownership. Equivalently housing is not sold in arbitrarily small amounts.

[10] In the context of housing this can perhaps be interpreted as the deposit, and come from the cash that borrowers have in hand in the first period. α is not exogenous

[11] In the context of housing finance this assumption seems reasonable, the mortgage is attached to a particular house. This also avoids the Allen and Gale (????) problem of borrowing to purchase a risky asset because the bank does not observe which asset is purchased

[12] This is not a crucial assumption, and the results are robust to relaxing the assumption as long as the price of the average unit of housing is increasing in the demand, (i.e. it is not

purchase it.

Equilibrium in the asset market is determined when supply of funds to purchase housing equals the cost of purchasing the housing stock HX and occurs through the price mechanism. $M = (1 - \alpha)H_0$

$$H_0 = \frac{M}{1 - \alpha} \tag{1.2.1}$$

Clearly this is increasing in α the down-payment borrowers make, and also in M the funds from the banks, and decreasing in X the level of housing supply. For simplicity X is fixed at 1 throughout.

Housing in the final period is exogenous, although I posit that in an extended framework of overlapping generations of banks it could be fully endogenised:

$$H = H_2 = (1 + E(g))H_0 = \frac{1 + E(g)}{1 - \alpha}M \tag{1.2.2}$$

The bank's intertemporal problem

The bank's problem is to maximise expected profits on the loans it makes, given the funds it has available, and subject to the downward sloping demand for repaying mortgages. It also chooses the allocation of its funds between long term lending in the first period: M and storing funds to take advantage of expected opportunities to lend in the second period B.[13]

infinitely inelastic). However, it is crucial that the housing stock is durable to have some value in the final period

[13]This problem can be reduced to a problem in r_m but it is easier to see the portfolio allocation this way.

$$\max_{M,B} \left(p(1 + r_m(M)) + (1 - p)\frac{1 + E(g)}{(1 - \alpha)} \right) M + BE(1 + \rho) \tag{1.2.3}$$

$$D \geq B + M \tag{1.2.4}$$

$$M = M(r_m) \tag{1.2.5}$$

$$B \geq 0 \tag{1.2.6}$$

$$M \geq 0 \tag{1.2.7}$$

Constraint (1.4.14) is the constraint that the bank's deposits must be greater or equal to the funds it lends long term in the first period, and the funds it lends in the second period. Constraint 1.4.15 is that the bank takes into account the demand function for mortgages. A profitablilty/storage constraint is not necessary, as the bank can make profits (in expectation) from simply storing its deposits into the middle period so that $B = D$ and lending only in the second period.

1.2.2 Equilibrium

Equilibrium is defined as a set $\{M, B, H_0, r_m\}$ such that (i) the bank's profit is maximised, (ii) the market for the housing good clears, (iii) the expected marginal return on a loan for housing finance equals the expected return on outside opportunities in the middle period. A fuller discussion of the optimisation problem looking at the interpretation of the constraints, proof that they are binding or otherwise is left to the appendix in section .0.2

For an interior solution for B and M:

$$\begin{aligned}\frac{\partial \Pi}{\partial M}\Big|_{M*} &= \left(p(1 + r_m(M)) + (1 - p)\frac{1 + E(g)}{(1 - \alpha)} \right) + Mp\frac{\partial r_m(M)}{\partial M} \\ &= E\left(\frac{\partial \Pi}{\partial B}\Big|_{B*} \right) = E(1 + \widetilde{\rho})\end{aligned} \tag{1.2.8}$$

In other words, the marginal return on increasing M and lending more in the first period must equal the marginal value of storing an extra unit of B in the first period and lending in the second period. The bank makes mortgage loans until this point is reached and then stores the rest of its funds into the next period. It may be that there is an exterior solution, which would be the case if (1.2.9) or (1.2.10) held.

$$\left.\frac{\partial \Pi}{\partial M}\right|_{M=0} < E(1+\widetilde{\rho}) \tag{1.2.9}$$

In other words mortgage lending is so unprofitable that the bank does none of it. This could be the case if potential borrowers are extremely risky, or derive so little utility from housing that they are unwilling to enter a mortgage contract.

$$\left.\frac{\partial \Pi}{\partial M}\right|_{M=D} > E(1+\widetilde{\rho}) \tag{1.2.10}$$

This has an interpretation in that the bank has so few deposits (or diminishing returns in mortgage making are small) that it makes all of its loans in the form of mortgages. To make the problem interesting and to compare to the solution in the subsequent model we assume that the solution is an interior solution and that there is both mortgage lending and also lending in the second period.

Features of equilibrium and comparative statics All borrowers who desire a loan at interest rate $1+r_m$ receive it and there is no credit rationing. If returns in other markets are expected to be high in the middle period then the bank reduces the funds it lends long term: M and expands its short term lending: B. An expectation of attractive opportunities in other markets has the effect of decreasing the volume of funds lent by the bank, a higher interest rate on housing loans, and a lower price of the good bought with the loan, i.e. houses.

Proposition 1.2.1 *With an interior solution the effect of an increase in deposits in period* 0 *is to increase short term lending in the middle period*

Proof Follows immediately from (1.2.8). In this benchmark case making a long term mortgage loan comes with an *opportunity cost* of lending opportunities in the future. If condition (1.2.8) holds then the effect of an increase in deposits will be for the bank to store any increase and make loans in the second period.

Proposition 1.2.2 *In this setup r_m^* and $E(\rho)$ are positively correlated: $\frac{\partial r_m^*}{\partial E(\rho)} > 0$ I.e. when expected opportunities in the middle period are high the optimal repayment charged on loans to consumers is also high.*

Proof For an interior solution: The optimal interest rate charged by the bank r_m^* must be such that marginal expected returns are equalised across asset classes. From (1.2.8) $\frac{\partial \Pi}{\partial M}\Big|_{M*} = E(1+\rho)$, with $\frac{\partial \Pi}{\partial M} > 0$ and $\frac{\partial^2 \Pi}{\partial M^2}$, so an increase in ρ implies a decrease in M^*; the intuition behind this is because as the opportunity cost of making mortgage loans increases the optimal solution is to make fewer of them. As the bank faces a downward sloping demand curve in r_m for mortgages $\frac{\partial r_m^*}{\partial M} < 0$, which implies $\frac{\partial R^*}{\partial E(\rho)} > 0$.

For a corner solution either (i)$M = D$ i.e. outside opportunities are so low/mortgages are so profitable that the bank invests all its funds in mortgages and r_m^* solves the bank's unconstrained maximisation problem in the first period, or (ii) $M = 0$ r_m is effectively infinite and no loans to consumers are made.

Proposition 1.2.3 *In the benchmark banking model in this section if expected opportunities in other markets are expected to be good, house prices are low in the first period corr$(H_0, E(\rho)) < 0$*

Proof

$$\frac{\partial M^*}{\partial E(\rho)} < 0 \tag{1.2.11}$$

as above and as shown above in subsection 1.2.1

$$\frac{\partial H_0}{\partial M} > 0 \tag{1.2.12}$$

which implies good opportunities for the bank in other markets are associated with low house prices in the first period.

In this model it is clear that there are two important issues for the bank. A bank which arrives in the middle period with $\rho > E(\rho)$ will *ex-post* prefer to have made fewer mortgages and saved more (and vice versa if $\rho \leq (E(\rho))$. In addition a bank which made mortgages but got unlucky and the borrowers defaulted will also prefer to have made fewer mortgages. The bank would like to have some kind of mechanism to insure against both these possibilities.

1.3 Loan sales and the market for mortgages

Now we introduce financial innovation in the form of secondary loan markets to the original benchmark model, where the bank is able to sell claims on the mortgages to outside investors. Alternative options for raising finance are not discussed in depth here, but a discussion is included in section (.0.1) in the appendix. Part of the original popularity of selling mortgage loans in the form of securitised loans to non-bank investors was a response to regulatory arbitrage and the simple act of selling to a 'non-bank' creates value in the form of capital relief. In addition by tranching the mortgage book it because possible to increase the value to different types of investors. 'Non-bank' investors also valued securitisation because it allowed them to improve the diversification of their investment portfolios. These are not explicitly modeled here to keep the model as simple as possible. However, it provides motivation of why securitisation may be preferred to other methods of funding. A simple securitisation structure and a short discussion of the regulatory arbitrage is included in the appendix in section .0.3.

The functioning of the secondary market Secondary market agents can be thought of as investors such as hedge funds, mutual funds. I assume that there are lots of them, although each one may be atomistic. This ensures that the volume of loans for sale is not relevant to solving the investor's problem. Investors are risk neutral and require an expected gross return normalised to 1. To simplify the model all investors are assumed to be identical. This implies that only the expected return on the entire pool of loans sold is of importance.The later observed developments in securitisation, where loans were packaged and sold into tranches to suit investor tastes is outside the scope of this model. Secondary market agents do not have access to mortgage lending technology. This stresses the comparative advantage between banks and secondary market agents. Banks have lending technology but have an opportunity cost of making these loans. Secondary market agents have no opportunity cost of holding loans to maturity but are unable to originate loans.

First I examine the case when there is no informational asymmetry between banks and loan buyers. This is the model in section 1.3.1. Then I introduce a source of information asymmetry in section 1.4.

1.3.1 Securitisation without private information

The case of no asymmetric information would probably most naturally reflect securitisation of 'prime' mortgages where borrower information easily interpretable, or borrowers with substantial mortgages where pre-payment risk is an issue. Pre-payment is a function of interest rates and so it seems reasonable to assume that both investors and banks are equally aware. If there is no asymmetric information between the bank and investors, as the bank learns nothing about its borrowers, then the bank can sell its mortgage book at the price $p(1 + r_m)M + (1 - p)H$. This will be the bank's choice whenever it has a profitable outside opportunity, i.e. for all values of $\widetilde{\rho} > 0$. By increasing the volume of loans in the first period the bank also receives increased revenue in the middle period, in the event of an outside opportunity to invest occurring. The bank is not just making a housing loan *but* also making a sellable product that can be converted into investment funds in the middle period. There is no downward facing demand curve in terms of quantity as non-bank investors are risk neutral and deep-pocketed. The change in the bank's problem is that now returns on mortgage lending are multiplied by $E(1+\rho)$. The bank's problem becomes:

$$\max_{M,B} \left(p(1 + r_m(M)) + (1-p)\frac{1+E(g)}{(1-\alpha)} \right) ME(1+\rho) + BE(1+\rho) \quad (1.3.1)$$

$$D \geq B + M \quad (1.3.2)$$

$$M = M(r_m) \quad (1.3.3)$$

$$B \geq 0 \quad (1.3.4)$$

$$M \geq 0 \quad (1.3.5)$$

Equilibrium

So long as making an extra unit of mortgages increases profits at the margin, i.e. $\left.\frac{\partial \Pi(M)}{\partial M}\right|_{M<D} > 0$, the bank will lend all of its deposits in the form of mortgages in the first period. The bank does not store liquidity into the middle period *for any* expectation of $\widetilde{\rho}$ as storage makes an expected return of 0 compared to a positive expected return on making mortgages. This follows immediately from taking the first order conditions. This immediately implies $M = D$. The interest rate that mortgage borrowers $r_{m,noasym} = \left. r_m^{-1} M(r_m)\right|_{M=D}$. Bank's mortgage lending, and therefore consumers *are completely isolated* from other asset markets/the business cycle.

Comparing the traditional banking market for mortgages with the model with loan sales

With symmetric secondary markets the bank's profits are unambiguously higher (as it can still replicate the no-securitisation solution). The bank makes an increased volume of mortgage loans as $M = D$. Compared to the solution with no secondary markets the optimal $r^*_{m,sm} < r^*_{m,nosm}$ i.e. borrowers repay a smaller amount on their loans. In the data this would be observed as borrowers with a given risk profile (e.g. FICO) credit score receiving an interest rate at a lower rate than in the model where loan sales do not exist. Mortgage borrowers are better off as $r^*_{m,sm} < r^*_{m,nosm}$; which implies that: $U(borrowers)_{sm} = \widetilde{U}_{sm} > \widetilde{U}_{nosm} = U(borrowers)_{nosm}$. All consumers are at least as well off with securitisation, as the consumers who chose not to enter the contract are unaffected. A proof is in the appendix in section .0.4.

The price of housing at time 0 is higher than H_{nosm} for two reasons: (1) the increased bank funds used to make mortgages, as the bank no longer holds a reserve for the middle period; (2) the increased cash balances from the borrowers who now enter the contract, but did not under the previous, higher interest rate.

Proposition 1.3.1 *With no asymmetry and with securitisation and if* $\left.\frac{\partial \Pi(M)}{\partial M}\right|_{M<D} > 0$ *then the effect of an increase in deposits is to increase mortgage lending*

Proof If $\left.\frac{\partial \Pi(M)}{\partial M}\right|_{M<D} > 0$ then mortgage lending dominates storage (which has and expected return of 0).

This compares to proposition 1.2.1in section 1.2.1 where an increase in deposits was used only to make loans in the middle period but did not affect mortgage lending.

Proposition 1.3.2 *In this setup* r^*_m *and* $E(\rho)$ *are independent.*

Proof M is independent of $E(\rho)$ and so $r_{m,noasym} = \left. r_m^{-1} M(r_m)\right|_{M=D}$ also independently of $E(\rho)$

This compares to proposition 1.2.2 where an increase in $E(\rho)$ was associated with a decrease in M.

Proposition 1.3.3 *House prices are unrelated to expected opportunities in the middle period* $corr(H_0, E(\rho)) = 0$

Proof House prices are entirely defined by M and r_m which are independent of $E(\rho)$ as shown in 1.3.2

This compares to proposition 1.3.3 where high expected opportunities in the middle period were associated with a decrease in house prices.

The market is also (constrained)[14] efficient as for all values of $\rho > 0$ the bank is able to undertake profitable investment opportunities.

1.4 Securitisation with private information

We now introduce a source of informational asymmetry between the banks and the secondary market.

A4 By assumption the bank has private information in the middle period as to whether the loans have succeeded or failed, success happens with probability p.

The bank also has private information as to whether it has an outside non-pledgable opportunity to invest, which happens with probability q, resulting in a discount factor of δ. Whether the loans are likely to payoff is the bank's private information (and 'soft' information because it is difficult to communicate information about borrowers). This makes sense in the context of subprime loans, as potential borrowers can fail to qualify for 'prime' loans in a multitude of different ways which can be difficult and costly for non-experts to interpret.

[14]Constrained efficient as the efficient solution would be to borrow as much as possible and credibly pledge returns on outside investments, but this option has been assumed away

A5 In contrast both the face value of the loan: $(1+r_m)M$ and house prices in the final period: H are public information (and 'hard' information as they are easier to verify).

This assumption seems reasonable as the contractual interest rate on the loans is observable, and house price indexes are public information. What we shall see is that the bank's acquisition of private information becomes less important if $(1+r_m)M$ and H are close to each other.

Equilibrium prices in the secondary market

First we discuss with the problem of pricing in the middle period and then work backwards to the bank's problem. The price paid by investors on the secondary market for the loans with face value $(1+r_m)M$ is no longer the unconditional expected return for a set of loans: $p(1+r_m)M+(1-p)H$, but the *conditional* expected return *given* that the loans are sold.

Probability that the pool of loans is a success, given that the loan is sold:

$$\frac{pq}{1-p+pq} \tag{1.4.1}$$

Probability that the housing loans are defaulted loans, given that the loans are for sale:

$$\frac{1-p}{1-p+pq} \tag{1.4.2}$$

The price π of the mortgage loans in the secondary market with face value $(1+r_m)M$ *given* that it is sold:

$$\pi = \frac{pq(1+r_m)M}{1-p+pq} + \frac{1-p}{1-p+pq}H \tag{1.4.3}$$

The adverse selection discount that secondary market demands is the difference between the unconditional and conditional price, or equivalently the difference between the no asymmetric information and symmetric information price.

$$p(1+r_m)M + (1-p)H - \frac{pq}{1-p+pq}(1+r_m)M + \frac{1-p}{1-p+pq}H \quad (1.4.4)$$

$$= p(1+r_m)M\left(1 - \frac{q}{1-p+pq}\right) + (1-p)H\left(\frac{-p(1-q)}{1-p+pq}\right) \quad (1.4.5)$$

$$= (1+r_m)M\frac{p(1-p)(1-q)}{1-p+pq} + (1-p)H\left(\frac{-p(1-q)}{1-p+pq}\right) \quad (1.4.6)$$

The adverse selection discount is concave in p: the unconditional probability of success. The intuition behind this is fairly simple. If a loan has a high unconditional probability of success, then it is likely that the loan is being sold because the bank has better opportunities. If a loan has a low unconditional probability of success then when it is seen for sale, it is likely to be because it has defaulted. The adverse selection discount is decreasing in H: the value of housing in the case of default.[15] This is because with high recovery values in the case of default credit risk is less meaningful. Inside information is reduced as 'good' loans and 'bad' loans are more similar. Expected house prices are therefore an important determinant of the price of loans in the secondary market. The combination of the difficulty in communicating information about borrowers and medium repayment probability in the subprime market go someway towards explaining the importance of the maintenance of high house prices in sustaining the existence of subprime loan sales.

[15] This has its parallel in the lemons market of Akerlof (1970) of increasing the value of a 'lemon' car

When does a pooling equilibrium exist...?

A bank holding a portfolio of non-performing loans will be prepared to sell at any price greater than H. Markets are pooling if banks holding *good* i.e. performing loans are prepared to sell them. This occurs when the discounted value of retaining the loan is smaller than selling it at the pooling price on the secondary market. For a bank holding a set of performing loans the discounted value of retaining the loan is $\delta(1+r_m)M = \frac{(1+r_m)M}{1+\rho}$.

$$\frac{(1+r_m)M}{1+\rho} \leq \pi = \frac{pq(1+r_m)M}{1-p+pq} + \frac{1-p}{1-p+pq}H \tag{1.4.7}$$

with the cut-off ρ^* when this holds with equality. As the value to be extracted from a defaulted loan is increased this raises the pooling price on the secondary market. This in turn implies that secondary markets are liquid for a larger range of discount factors, and high H can lead to the emergence of pooling secondary markets.

This is not the efficient solution as for $\rho \in [0, \rho^*)$ there are still profitable investment opportunities that could be realised if the bank could either credibly signal that its loans are performing, or that is has no information as to their performance, but the discount due to the pooling price means that the bank prefers to hold on to them.

The linkages between banks, consumers, the market for housing, other asset markets and non-bank investors, and the assumptions needed to *sustain* liquid secondary markets is illustrated in figure 1.5. If outside investment opportunities ρ are interpreted as the economic cycle, a natural interpretation as it represents new opportunities for the bank to use its funds, then this means that the collapse in liquidity in secondary markets will occur *later* in the cycle the higher the recovery value in default. In the absence of complete information pooling equilibrium secondary markets are only sustainable as long as *both* recovery values are high enough, and outside opportunities are good enough

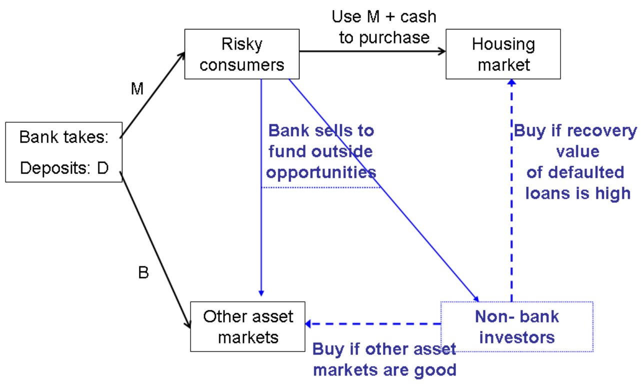


Figure 1.5: The flow of funds in the economy and links between markets

to induce holders of performing loans to sell. A decline in housing prices *by itself* will not necessarily be enough to move the equilibrium from a pooling equilibrium to a separating one. As the threshold $\frac{\partial\left(\frac{1}{1+\rho}\right)^*}{\partial H} < 1$ then secondary market liquidity can be sustained *even if* default values increase slower than the outside opportunities deteriorate. However, liquid secondary markets are inherently unsustainable unless $H = R$ i.e. the recovery value in the case of default is equal to the repayment on the loan.[16] House prices affect the price of loans in the secondary market (π) in a *non-linear* fashion. Although the *pooling* price is linear in H, if H (exogenously) falls to a level such that the price of loan on the secondary market is not high enough to sustain the pooling equilibrium, then π falls discontinuously to H, the separating price. House prices also have two effects on the bank's profits. On the *intensive margin* the bank receives a higher price for the loans it sells as expected house prices increase, on the *extensive* margin a higher house price expands the range of ρ for which the bank sells the loans. When the recovery value of the housing good in the case of default is low, we would expect to see multiple switching of regimes between 'pooling' and 'separating' markets for loans. But with a

[16]But this will not be part of the bank's optimal contract.

higher level of recovery value in the case of default then we would expect to see less frequent regime switching. As an aside it should be noted that although correctly priced at the time of sale, any downward shock to expected house prices H will cause the entire *existing* pool of sold loans to decrease in price, although by less than $\triangle H$: $\frac{\partial \pi}{\partial H} = \frac{1-p}{1-p+pq}$ as there is still the possibility that the sold loans were performing loans.

1.4.1 Bank's problem with an asymmetric market for mortgages

We now turn to the bank's problem when an asymmetric market for loans exists in the middle period. The bank's problem is different depending on whether it anticipates pooling or separating markets in the middle period. If the bank anticipates pooling secondary markets i.e. if $E[\rho \in (\rho^*, \infty)$ in the middle period then the contract offered at time 0 changes. The bank originates loans with 'the potential to distribute' in the middle period. The price on the secondary market and $E(\rho)$ are now taken into account. Note that the bank explicitly originates loans expecting that house prices will remain high or that outside opportunities are good enough to sustain the pooling equilibrium.

Without full information but taking into account secondary market prices (π) and $E[\rho \in (\rho^*, \infty)$ then the problem becomes:

$$\max_{r_m,B,M} M\left(1+r_m(M)\right)p(1-q) + (pq)\,\pi(1+\widetilde{\rho}) + (1-p)q\pi(1+\widetilde{\rho})$$
$$+(1-p)(1-q)\pi + B\left(1-q+q(1+\widetilde{\rho})\right) \quad (1.4.8)$$
$$D \geq B + M \quad (1.4.9)$$
$$M = M(r_m) \quad (1.4.10)$$
$$B \geq 0 \quad (1.4.11)$$
$$F \geq 0 \quad (1.4.12)$$

Where the term $M\left(1 + r_m(M)\right)p(1-q)$ reflects the expected probability that the loans will pay-off and the bank has no outside opportunities and gets payoff $(1+r_m)M$; the term $(pq)\,\pi(1+\widetilde{\rho})$ reflects the probability that the bank has good loans and good opportunities, it sells the loans for π in the secondary market and makes a return of $1+\widetilde{\rho}$; the term $(1-p)q\pi(1+\widetilde{\rho})$ reflects the probability that the bank's loans fail but the bank has outside opportunities and invests the sale proceeds for a return of $\pi(1+\widetilde{\rho})$; and the term $(1-p)(1-q)\pi$ reflects the probability that the bank has failed loans and no outside opportunities.

Note that the bank is only *explicitly* concerned with credit risk in one state: when the loans perform and the bank has no outside opportunities. Otherwise, the bank is concerned only in as much as the price on the secondary market is affected. Holding a buffer stock for investment opportunities in the middle period still has two costs. The first, as before, because it reduces the mortgage loans available to be made in the first period; but also because it reduces the available sellable assets in the middle period, in the event of having an outside opportunity.

On the other hand if the bank anticipates the 'separating price' i.e. if $E[\rho \notin (\rho^*, \infty)$ then the problem is similar to that in section 1.2.1 *but* the bank will sell the loans in the case of default and experiencing a positive investment opportunity.

$$\max_{M,B} \left(p(1+r_m(M)) + (1-p)\frac{1+E(g)E(1+\rho)}{(1-\alpha)} \right) M + BE(1+\rho) \tag{1.4.13}$$

$$D \geq B + M \tag{1.4.14}$$

$$M = M(r_m) \tag{1.4.15}$$

$$B \geq 0 \tag{1.4.16}$$

$$M \geq 0 \tag{1.4.17}$$

The difference between (1.2.3) and (1.4.13) is the addition of the term $E(1+$

ρ) multiplying the bank's payoff in the case of mortgages defaulting, as the bank will sell claims on defaulted mortgages as price H to invest elsewhere. The solution is similar to that in 1.2.1 *but* mortgage lending is slightly more profitable in expectation; the bank makes more mortgages than with the same $E(\rho)$ but no secondary markets, and mortgage interest rates are lower. But the bank makes fewer mortgages and interest rates are higher than if pooling secondary markets are anticipated.

1.4.2 Equilibrium

Equilibrium is defined as as an interest rate r_m, a price in the secondary market π, storage for loans in the second period B, mortgage loans in the first period M and a price in the housing market H_0 such that: the bank's maximisation problem is solved, the price in the secondary market solves the non-bank investors problem, and H_0 clears the market for housing. The market for housing clears in the same way as in section 1.2.1 but with a few minor caveats, such as $H_0 < R$.

If pooling secondary markets are anticipated to exist in the middle period, i.e. $\rho > \rho^a st$ then there is again no need for the bank to withhold a 'buffer': B from its deposits. The bank frees up all of its deposits D to invest in mortgages in the first period as long as $\frac{\partial \Pi(M)}{\partial M}\Big|_{M<D} < 0$. If $\rho < \rho^*$ then the bank stores deposits into the next period and reduces mortgage lending. This is the opposite effect to an increase in bank deposits in section 1.2.1 but the same as in 1.3.1. With thre result that expected opportunities in other, seemingly unrelated, asset markets *expand* lending in the housing market. For mortgage borrowers the interest rate r_m is the same with both asymmetric secondary markets(when a pooling equilibrium is anticipated) and symmetric secondary markets. To some extent this also helps reduce the asymmetric information problem between banks and loan buyers due to the reduced payout on performing loans. However, if $E(\rho)$ falls such that the secondary market becomes the separating price, borrower welfare is decreased as the interest rates paid on their mortgages *increases.*

Proposition 1.4.1 *if $E(\rho) \in (\rho^*, \infty)$ & $\frac{\partial \Pi}{\partial M} > 0$ then $B^* = 0$. I.e. if the expectation of returns in the second period is such that the pooling equilibrium exists and the bank can increase its mortgage loan related profits by making more mortgage loans then the optimal B to retain into the second period is 0. If $E(\rho) \notin (\rho^*, \infty)$ & $\frac{\partial \Pi}{\partial M} > 0$ then $B^* \neq 0$.*

Proof If $E(\rho) \in (\rho^*, \infty)$ then the bank expects that outside opportunities will be good enough such that the 'pooling equilibrium' will prevail in secondary loan markets in the next period. Note that B is simply storage technology in the first period, i.e. it makes a net return of 0 from period 1 to 2. On the other hand, if the deposits are turned into mortgage loans then the marginal loan makes a positive expected return (as $\frac{\partial \Pi}{\partial M} > 0$). If this is true then turning deposits into mortgage loans dominates storage.[17] On the other hand if $E(\rho) \notin (\rho^*, \infty)$ then $B^* \neq 0$ as we are back to the interior case of section 1.2.1.

This can be compared with the equilibrium in section 1.2.2 where we assumed an interior solution, or if an exterior solution existed i.e. $B = 0$ it was because ρ was expected to be *low.* Here the exterior solution applies when ρ is expected to be *high.* In section 1.3.1 the exterior solution $B = 0$ applied for *all* values of $\rho \in (0, \infty)$.

Proposition 1.4.2 *In this setup r_m^* and $E(\rho)$ have a discontinuous relationship and to some extent $\frac{\partial r_m^*}{\partial E(\rho)} > 0$ I.e. when expected opportunities in the middle period are high the optimal repayment charged on loans to consumers is low.*

Proof If $E(\rho) \in (\rho^*, \infty)$ then $r_m = r_{m,noasym} = r_m^{-1} M(r_m)\Big|_{M=D}$ and are independent of $E(\rho)$ so long as $E(\rho > \rho^*)$. If $E(\rho) \notin (\rho^*, \infty)$, in other words

[17] Note that in section 1.4 the adverse selection discount exactly compensates for the ability to sell discounted loans , in terms of the value on the secondary market, so long as a pooling equilibrium is sustained.

outside opportunities are expected to be low, then the bank's problem is the 'separating problem' and $r_m = r_m^{-1}M(r_m)\Big|_{M<D} \geq r_{m,noasym}$

This can be compared to proposition 1.2.2 where high $E(\rho)$ was associated with high mortgage interest rates and proposition 1.3.2 where $E(\rho)$ and r_m were independent.

Proposition 1.4.3 *In this setup H_0 and $E(\rho)$ have a discontinuous relationship and to some extent $\frac{\partial H_0^*}{\partial E(\rho)} > 0$ I.e. when expected opportunities in the middle period are high the house price is high.*

Proof This follows directly from proposition 1.4.1.

If $E(\rho) \in (\rho^*, \infty)$ then $H_0 = H_{noasym}$ as $M = D$ is independent of $E(rho)$ so long as $E(rho > \rho^*)$. If $E(\rho) \notin (\rho^*, \infty)$ $M < leqD$ and from section 1.2.1 $\partial H/\partial M > 0$.

The market with no asymmetric information in section 1.3.1 and this section appear similar; but the market with asymmetric information is unstable and mortgage backed securities sell at a lower price in the secondary market. The probability of sale is weakly greater in the pooling market.[18] However, due to the timing of the model there is an important source of risk when there is asymmetric information, which is not present in the symmetric case, which is discussed below.

1.4.3 Warehousing risk

In the model with anticipated pooling secondary markets the bank originates mortgages expecting that there is a possibility to be able to distribute them

[18]as in the pooling market loans are sold with probability $pq + (1-p)$ which is greater than q: the probability of sale in the symmetric information case.

in the middle period and that house prices will be high. Due to the timing in the model, mortgage loans are originated in the first period and loan sales and opportunities occur in the subsequent period. In finance, this interim holding period for the loan before the loan is sold to non-bank investors sold is known as 'warehousing'; and has its parallel in the market for manufactured goods, which are stored in a warehouse in the time between being manufactured and sold. However, there is a possibility that the middle period arrives with a shock to house prices such that they are expected to be low and the pooling equilibrium collapses. The bank may have outside opportunities to invest and performing loans, *but* with a 'separating' secondary market.[19]In the context of this model this is most likely due to a supply shock to the housing stock or a realisation of ρ substantially below $E(\rho)$.[20]

It is clear that the outcome with low house prices and 'separating' secondary markets is worse than when the secondary market is a pooling market, and also worse than the market with no informational asymmetry. However, it is not immediately obvious that this situation is worse than if the bank had made its investment decision using the traditional model (i.e. anticipating that the credit risk transfer market would not exist). However, it is worse off than in *expectation* for a bank that does not have access to loan sale technology.

Proposition 1.4.4 *If the bank has $\rho \in (\rho^*_{\overline{H}}, \rho^*_{\underline{H}})$ i.e. it would have sold its loans at the secondary market price with high house prices: $\overline{H}$ but not at the secondary market price with low house prices: $\underline{H}$ it is worse off when secondary markets collapse to the separating equilibrium than it would be (in expectation) under the regime when secondary markets did not exist in the first place.*

[19]This could occur because of a 'gap' between non-bank investors perception of the opportunity cost of holding loans and the banks, but is more likely a result of a collapse in recovery values in the default state causing the market to 'dry up'.

[20]This would tie in with the fact that the areas that seem to be the most affected by the subprime crisis and subsequent drop in house prices are also the ones with the biggest recent increase in supply. An obvious explanation is that house builders add to the housing stock without taking into account the externality that their building has on the sustainability of the pooling equilibrium

Proof The bank, anticipating pooling/liquid secondary markets and high house prices, chooses $M = D$ in the first period. However, $D = M$ *is* in the choice set of a bank that does not have access to loan sale technology as it can always choose to lend all of its deposits as mortgage loans. As this is not the solution to the optimisation problem of the bank it must be that the bank is worse off in expectation than when the markets did not exist, as it allocated its funds in a way that would not be expected to be optimal.

Proposition 1.4.5 *For a bank holding defaulted loans the outcome is unambiguously worse than if the secondary market had not existed.*

Proof When anticipating liquid secondary markets the bank loans all of its funds in the first period. For a bank holding defaulted loans and with no investment opportunity: return is $\underline{H}$ (the bank effectively sells all the housing stock and recovers $\underline{H}$), compared to $\underline{H} + B$ otherwise. For a bank holding defaulted loans and with an investment opportunity: return is $\underline{H}(1 + \rho)$ (the bank effectively sells the defaulted loans at the separating price $\underline{H}$ and recovers $\underline{H}$ and invests to get $\underline{H}(1 + \rho)$), compared to $(\underline{H} + B)(1 + \rho)$ otherwise.

Proposition 1.4.6 *For a bank with performing loans and no outside opportunity the bank is actually* better *off than when loan sale markets did not exist.*

This is fairly intuitive as the bank did not want to access the loan market in the first place, and the opportunity to sell loans also acts as some kind of insurance about not getting investment opportunities in the middle period.

Proof $(1 + r^*_{m,sm})M_{sm} > (1 + r^*_{m,nosm})M_{nosm} + B$. If this were not true at some point $\partial\Pi/\partial M$ would be negative.

For a bank holding performing loans and with an outside opportunity the outcome is a bit more involved as the collapse of the pooling equilibrium is an outcome of the bank's investment opportunities. Although the optimal interest rate r_m charged to each borrower is lower when the bank anticipates high house prices and pooling secondary markets $(1+r^*_{m,sm})M_{sm} > (1+r^*_{m,nosm})M_{nosm}$[21]. The decision not to sell loans is a result of outside opportunities not being good enough to make it worth selling the loans.

If the bank has $\rho \in (\rho^*_{\overline{H}}, \rho^*_{\underline{H}})$ then it would have sold the claims on its mortgages under the high house price regime but does not under the low house price regime as the outside opportunities are not good enough. By retaining the mortgages it gets $(1 + r^*_{m,sm})M_{sm} > (1 + r^*_{m,nosm})M^*_{nosm}$ but the sign on $(1+r^*_{m,sm})M_{sm} \gtrless (1+r^*_{m,nosm})M^*_{nosm} + B^*(1+\rho)$ is ambiguous as it depends on the realisation of ρ: a random variable.

1.5 Conclusion

The effects of the imperfect 'financial innovation' model are fairly straightforward. Following a large positive shock and some innovation that allows loan sales the bank has very good outside opportunities to invest; to take advantage of this opportunity the bank sells its claim to the return on its mortgages even though they are expected to pay a high return. Due to the size of the opportunity the price in the secondary market is high, despite the low anticipated recovery in default. Following this financial innovation, i.e. the invention of a loan sale product, the bank has a mechanism to transform a long term illiquid asset into a short term asset. Due to this innovation the bank makes more mortgage loans in the first period, increasing the price of houses.

If the recovery value of the house in the default state increases then private information as to whether the loan is expected to perform is less of an issue, as the loss given default is small. Certainly this was the case in earlier subprime

[21]As a reminder of why: the bank would simply reduce M to make larger profits from mortgage loans. The lagrange multiplier on the lending constraint is positive so the bank can increase profits by making more mortgage loans

vintages. But *expected* liquid secondary markets by themselves create the potential for an appreciation house prices, by freeing up banks to extend more housing credit. I conjecture that in an extended overlapping generations model we would find that high house prices and secondary markets for housing loans would be mutually reinforcing. Loan sale markets also cause relationships between the housing market and other investment markets to reverse.

Although the adverse effects of credit dispersion and secondary markets have taken center stage recently this does not necessarily mean they are welfare-reducing. Credit risk transfer markets provide a form of valuable insurance for banks as it enables credit expansion. In this paper welfare is increased for mortgage borrowers, through a lower interest rate and increased access to credit. The bank is also better off as it can take advantage of opportunities in the second period, so its profits increase. However, this does not imply that the move to financial disintermediation is innocuous. The opportunity to sell loans on the secondary market causes a new adverse selection problem in the loan markets. Secondary loan markets allow banks to sell loans that they expect to underperform. This limits the effectiveness of the 'financial innovation', as there are potentially profitable investment opportunities that go unfunded. The private information problem also results in a 'crisis' when the pooling equilibrium collapses. However, the unstable market for mortgage backed securities may be preferred and more efficient than other stable forms of raising finance such as trying to raise deposits or equity.

In terms of policy implications forcing banks to acquire more information about its borrowers may be *welfare destroying*, even if it done costlessly. This is because the first best solution is to acquire no private information about risky borrowers. In terms of assisting mortgage borrowers, which has been a focus of attention recently, giving banks more funds in a 'recession' is not useful when the market for mortgage backed securities has broken down. A bank receiving more deposits will store its funds and use in the next period to lend outside the mortgage market. Maintaining 'regulatory arbitrage' whereby a bank gets capital relief by selling to a 'non-bank' may also be welfare improving as it increases the probability that the bank is selling loans to release value elsewhere, meaning that secondary markets are stable for longer in the cycle. High house prices relative to the interest rate are valuable in this model because they help to reduce the extent of the asymmetric information problem between banks and loan sellers and reduce the level of repayment borrowers have to make on their mortgages. In this context making foreclosure easier and less costly for banks is welfare improving, at least ex ante.

Chapter 2

Making it worse: banking crises, macroeconomic risk and the limitations to the Lender of Last Resort

When considering the issue of bank rescues there is a tradeoff between crisis prevention and moral hazard. This paper considers an intermediate case of the Lender of Last Resort, where the limited access to resources to recapitalise banks leads to a ‘partial LOLR’.

The LOLR minimises a social loss function related to the cost resolving the failures of insolvent banks but subject to the resources it has available. We show that although this can help to alleviate the moral hazard problem induced by lenient rescue policies a new source of moral hazard arises. Once the LOLR takes into account the social cost of failure banks have an incentive to increase this cost at the expense of monitoring. In addition when the resources are limited banks have a further incentive to be the ones to receive a rescue when other banks are in distress at the same time.

We also show that it may possible to achieve an improvement by giving Lender of Last Resort more resources to deal with a crisis, both in terms of less costly resolution of systemic banking crises when they occur but also in a lower frequency of bank failures.

Keywords: Lender of Last Resort; banking; macroeconomic-risk; bail-out

> "It's not based on any particular data point," a Treasury spokeswoman told Forbes.com Tuesday. "We just wanted to choose a really large number." Forbes (2008)

2.1 Introduction

In the last three decades there have been several banking crises, including the current financial crisis, around the world affecting low-income and high-income countries alike. The costs, both social and fiscal, in resolving bank failures has led to a substantial debate over this role of the Lender of Last Resort (LOLR). The LOLR was originally conceived as a means to rescue banks experiencing *liquidity problems* and to prevent bank runs occurring. However, the role of the LOLR has been extended to rescuing *insolvent* institutions. Recent bailouts have involved, amongst other resolution policies, governments guaranteeing bank loans, buying equity and injecting capital, purchasing illiquid securities and non-performing loans at favourable prices. In these cases the government has injected real resources or become exposed to potential real losses. The ability of a government to absorb these losses is not unlimited, both because a government generally has competing uses for its resources but also must keep debt at a sustainable level. Lenient rescue policies have long been criticised for inducing an ex-ante moral hazard problem and excessive risk taking by banks as far back as Bagehot (1873). On the other hand, not having a LOLR at all can cause unnecessary social losses resulting from bank failures. This has become the rational extending the role of the Lender of Last Resort from the original role of liquidity provider to a role where it may rescue insolvent institutions. There is a well known tradeoff between the ability to deal with a crisis with a generous Lender of Last Resort and exacerbating moral hazard. This suggests that the optimum may lie somewhere inbetween.

The literature has so far concentrated on the two extreme cases of no LOLR and the unconstrained LOLR. In contrast, this paper focuses on an intermediate case. In the model the LOLR is constrained by the level of resources at its disposal to be used for recapitalising the failed banks. This could also be considered as 'saving the banking *system*' but trying to reduce the cost of doing so. Part of the contribution of this paper is to examine a mechanism that could limit the LOLR so that it does not always rescue a failed bank. [1] We posit that limiting the resources, intentionally or otherwise, at the LOLR's disposal may be one way to achieve an intermediate LOLR. An alternative for the mechanism is for the LOLR to take into account the opportunity cost of using real resources to rescue the banking system, compared to other government spending. This effectively limits the resources that it has available.

The role of the LOLR in this model is to rescue *insolvent* banks, with the justification that to shut down a bank causes a social loss. In the model the heart of any bank's problem is an inability to insure itself against *systemic* risk. Part of the role of the LOLR is to act as partial insurance against this aggregate shock. As common shocks hit the banking system it becomes impossible for the banking system to insure itself against this aggregate, systemic solvency risk, which justifies the existence of the LOLR.

In the model the assumption will be that any bank is worth more continuing in its original form rather than being sold or liquidated, even when the bank is sold to another bank. This is supported by the empirical evidence such as James (1991). Recent difficulties experienced by the UK government in the attempt to Northern Rock demonstrates that attempts to sell banks in the midst of a crisis is a long and drawn out process, involving a considerable loss of value.

Since the 1990s many banks have grown rapidly to the extent that their liabilities are larger than their home country's GDP. An alternative interpretation of the limited resources of the Lender of Last Resort could be the distortionary cost in raising taxes to provide the resources to bail out a bank,

[1] What I mean is something along the lines that we know that the optimum is usually something involving mixed strategies, but getting the LOLR to play mixed strategies in practice is very difficult: put in lit review

or the increased level of government debt that must be taken on. A Lender of Last Resort rarely acts in isolation, but often needs the approval of the government. This paper asks whether this resource constraint helps to mitigate the moral hazard problem with a lenient LOLR or, whether, instead it raises a new set of distortions.

This paper shows that there is not necessarily a trade off between having the ability to reduce the cost of crises, via a lenient bail-out policy, and the incidences of these crises. However, when the LOLR's resources are limited a new source of moral hazard arises which, to our knowledge, has not previously been studied: banks devote resources to appropriating the LOLR's resources and becoming more likely to be rescued in the event of failure.

Although liquidity can be created relatively quickly and at a low cost[2] *capital and real resources* cannot. Empirical evidence such as Hoggarth (2001), Honohan and Klingebiel (2000) and more recently Laeven and Valencia (2008) as to the cost of resolving banking crises have shown that the resolution can be costly in terms of *fiscal* expenditure. The model in the paper is in line with Goodhart (????) as the LOLR does not have access to unlimited capital with which to perform its rescue operations. In practice a LOLR does not act in isolation, but needs the approval of the national government. Swagel (2009) provides an account of the conflict between the US Treasury and attempts to resolve the banking system. Although the negative repercussions of letting a bank fail may be clear, it may not be possible politically to persuade voters that this is the appropriate use of funds.

The theoretical literature on the LOLR tends to focus on the case of a representative bank or when just one bank fails at once. The LOLR's choice of action for this bank is thus looked at in isolation, for a summary see Freixas and Rochet (1997). However, there have been several systemic banking system crises. Recent theoretical work such as Acharya and Yorulmazer (2007) has focused on bank's incentives to fail together, showing that banks have an

[2]such as printing the money, and increasing inflation

incentive to herd and choose correlated assets to increase the probability of a bailout. In contrast this model, where the resources of a LOLR are limited, rescuing one bank may compromise the ability to rescue another bank in a systemic crisis. The fact that some banks are more likely to be rescued than others is reflected in the market by the fact that the three main rating agencies (Fitch, Moody's and S&P)et al. (2005) include the probability of the bank receiving support as part of their ratings and this element varies *within* countries. [3]

There is a substantial strand of the banking literature which considers the link between competition and market efficiency arguing that competition may lead to excessive risk taking, for example Levi-Yeyati (2003) Suarez (1993), although the empirics of this are debated, for example Boyd and Nicolã (2005) Levi-Yeyati (2003) use the idea of a fully committed LOLR which has a state-contingent bail-out policy to show that a LOLR can induce banks to take less risks. This is achieved as in 'unlucky' states the bank receives a bail-out that acts as a sort of insurance. This insurance increases the value of the bank and also induces the bank to choose safer projects. In contrast this paper examines the case of a LOLR which is unable to commit to a bail-out policy but always bails out when it is 'socially' valuable to do so. In practice it can be difficult to verify the 'state of the world', in this paper the Lender of Last Resort's policy is conditioned on observable values such as the funds needed to pay depositors and the sale or liquidation value of the bank.

The remainder of the paper continues as follows. A review of the related literature in section 1.1. Then we move to the model. First we outline a benchmark model of 'traditional banking' in section 1.2, where banks make *and* hold loans until maturity; then section 1.3 introduces non-bank investors and a market for mortgage backed securities into the original benchmark model. Section 2.3 concludes.

[3] Economist: "Credit ratings No support here" Mar 8th 2007 for the recent decision by Moody's

2.2 The model

In the model there are a continuum of banks, which are potentially infinitely lived. The banks take their decisions independently of each other but take into account the Lender of Last Resort's problem when making their decisions. Depositors play no active role in the model besides investing in the bank. Their decision to invest is simplified by the full insurance of deposits. There is also a government or Central Bank which acts as the Lender of Last Resort, which minimises a social welfare loss function which is increasing in the cost of banking failures. First the problem of the Lender of Last Resort is discussed and then we introduce the problem of a representative bank in the banking system. The model is first solved when there is no LOLR in section 2.2.4, then when there is a LOLR with unlimited resources in section 2.2.4. In section 2.2.4 we introduce a LOLR with limited resources. Section 2.2.5 discusses the effect of changing the LOLR's resources.

2.2.1 The Lender of Last Resort

For simplicity all deposits are insured so the composition of the any failed bank's balance sheet does not play a role. The Lender of Last Resort can either pay depositors their deposits directly (e.g. if the bank is sold) *or* make a loan to the insolvent bank, so the bank pays depositors allowing it to continue operation. Due to the loss of value when any bank is sold rescuing any bank will dominate selling *if* the LOLR has unlimited resources.

A1 The Central Bank (LOLR) attempts to minimise the cost of a crisis, *given that it has occurred*

The Central Bank's problem is to minimise the social cost of its actions, in this case either rescuing the bank, selling to bank to outside investors, or liquidating the bank, *subject* to its resource constraint.

A2 The Central Bank (LOLR) has fixed resources at Λ

Here, for illustration purposes, the LOLR's resources are fixed at Λ. As will be shown later it is not the fixing of resources that is important but that there are *alternative* uses for funds which the LOLR takes into account when bailing out banks, and that these alternative uses are state-dependent.[4] The Central Bank can either save a bank giving it the resources to pay depositors and preserve the entire value of the bank V_i, or sell/liquidate and realise θV_i. The crucial difference between the two actions is that in the former the value of the bank is preserved and it continues operation, in the second the government gains some resources that can be deployed elsewhere, potentially for rescue of other distressed banks. The LOLR makes the decision for *all* banks that have failed simultaneously. Or more formally:

$$\min_{\omega_j} \sum_{j=0}^{J} [\omega_j (1-\theta_j) V_j] \tag{2.2.1}$$

$$\text{s.t}[\sum_{j=0}^{J}[\omega_j(D_j r_j - \theta_j V_j)] + \sum_{j=0}^{J}[(1-\omega_j) D_j r_j] \leq \Lambda \tag{2.2.2}$$

where ω is an indicator variable taking the value *1* if bank j is sold, and *0* if bank j is rescued. $j \in [0, J]$ is the set of banks that are insolvent in the period. The first summation in the constraint is the net cost of selling banks (as depositors must still be paid) whilst the second represents the resources that must be injected to rescued banks.

[4] A plausible alternative would be to let the LOLR's resources vary with the state of the world. For example, raising taxes is more costly in terms of distortions when the state of the economy is bad. Or simply that the cost of raising resources is increasing in the amount that must be raised. However, this simply strengthens the results below and makes it more computationally intensive

Exploiting the fact that $D_i r_d$ must be paid irrespective of the choice of action[5] then (2.2.1) simplifies to:

$$\min_{w_j} \sum_{j=0}^{J} [\omega_j (1-\theta_j) V_j] \tag{2.2.3}$$

$$\text{s.t}[\sum_{j=0}^{J} [\omega_j \theta_j V_j] + \sum_{j=0}^{J} [D_j r_j] \leq \Lambda \tag{2.2.4}$$

It is clear from the above problem that *ceteris paribus* the banks with lower 'θ's will be rescued whilst banks with higher 'θ's will be sold by the Central Bank. For each state of the world and level of the LOLR's resources (Λ) there is a cutoff $\widetilde{\theta}(\Lambda, \gamma)$ such that *failed* banks below the cutoff are rescued and those above are sold. As a result a bank has an incentive to decrease its sale value relative to its continuation value, or, as an alternative interpretation, hold more illiquid assets. Note that this effect is only valuable to a bank in the event of its *failure*, as it is only relevant for determining the probability of being rescued. This effect is only present because the LOLR now takes into account the social cost of the bank's failure. This cutoff value $\widetilde{\theta}$ is increasing in Λ and in the number of other banks that fail simultaneously. This is a new source of moral hazard that been neglected by the literature. Once the LOLR takes into account the social cost of failure in its decision to rescue a bank then the manager of the bank has an incentive to manipulate this cost; this effect is further exacerbated in this model due to the fact that banks must now compete to appropriate the LOLR's resources when they fail at the same time as other banks.

[5] if we look at separation of deposit insurance agency and central bank then there will be some separate issues, in the case of choosing to liquidate the bank but here there are not.

2.2.2 Banks: risky assets and liquidity choice

We now turn to the problem of a representative bank in the economy. The representative bank takes the actions of other banks and the LOLR as given.

The bank is potentially infinitely lived. Due to their monopoly power they have a charter value, which represents the continuation value of the bank, i.e. the present discounted value of future profits.

A3 Due to their monopoly power the bank has a charter value, which represents the continuation value of the bank, i.e. the present discounted value of future profits.

Managers of bank i have a choice of projects, but can only devote their resources to one. Monitoring takes the form of affecting the probability of success at a cost $\phi(p)$[6]. This can also be considered as improving the expected probability of success of the manager's loan portfolio.

A4 The manager's choice of p is unobservable

Assumption 4 means that bail-out policies cannot be conditioned on the manager's choice of p. This can be interpreted as either screening to select the project that is most likely to succeed or If the project is successful then the bank always survives into the next period,and can realise future profits.

Managers can also affect the value of the bank that is preserved if the bank is sold: θ_i[7] at a cost $\xi(\theta)$[8]. This resale value can be interpreted as the liquidity choice of the bank or the level of specialisation of the bank's business. To the extent that such activities a choice is costly, this represents a *pure waste effect* due to a weaker LOLR as it is only worthwhile in the case of failure, in

[6]where $\phi(p)' > 0, \phi(p)'' < 0$ i.e. strictly increasing in p, convex and twice differentiable

[7]to eliminate discontinuous payoffs and to simplify the problem I assume that there is some small random element to θ

[8]Low θ_i makes a bailout more likely, $\xi(\theta)$ is strictly decreasing and convex

states when the bank is successful then this has no use. For a given state of the world the payoffs from $\theta_i \leq \widetilde{\theta}$ where $\widetilde{\theta}$ is the cut-off resale value are equal. For clarity the liquidity choice and the probability of success are unrelated but this need not be the case. A natural interpretation would be that projects that are 'riskier' are also less liquid or more difficult to sell to outsiders, but this strengthens rather than weakens the results.

A5 Banks are subject to an 'aggregate' shock the success probability of each bank's project is also affected by the common state variable: $\gamma \in [0, 1]$

This is to capture macroeconomic or aggregate risk that affects all banks and the systemic nature of banking crises. This assumption is crucial for providing a role for the LOLR, even if γ and p were observable and insurance contracts were possible there would be an element of counterparty risk. A fuller discussion is included in the appendix in section .1.1.[9]. Going forward a simplifying assumption is made that is not possible to write insurance or condition contracts on this 'aggregate risk'.

For computational simplicity let γ be an iid process and:

$$p(X, \gamma) = \gamma p(X) \tag{2.2.5}$$

$$E[p(X, \gamma)] = \mu p(X) \tag{2.2.6}$$

where X is the return of the project in the case of success, so the expected return on the project is $\mu p(X)X$.

A6 The interest rate on any payments to the LOLR ≈ 0

[9]No assumptions are made about the shape of the distribution of γ save that it is continuous with mean μ. (This formulation of how the returns affect risky project success (i.e) linear in γ)is borrowed from Levi-Yeyati (2003) and I use much the same notation.

This final assumption can be justified as the loan is to help the bank and not for commercial reasons. In addition high interest rates on loans can induce a 'gambling for survival' problem.This is not a crucial assumption, unless the LOLR sets the interest rate on a loan high enough such that all future profits are paid to the LOLR. In this case the manager of a bank would be indifferent between being rescued and the bank being liquidated. The manager's problem would be equivalent to the case of no Lender of Last Resort. For *any* interest rate r such that $V_{continuation|rescue} > 0$ the existence of a LOLR has value to the manager. As a result the manager faces an identical problem each period and the manager's problem can be written as:

$$max_{\theta_i,p} V = \frac{\mu p(X)X - \phi(p) - \xi(\theta)}{1 - \delta s(\theta,p)} \tag{2.2.7}$$

Where s is the probability of the bank's survival into the next period.

The probability of survival

If there is no Lender of Last Resort then the probability of surviving into the next period is equal to the probability that the project was successful.

$$s_{noCB} = \int_0^1 \gamma p(X) f(\gamma) d\gamma \tag{2.2.8}$$

However, if there is a possibility of rescue then the probability of surviving into the next period is equal to the probability that the project was successful plus the probability that the bank is rescued *given* that the project failed. Define $\beta(\gamma,\theta)$ as the probability of receiving a rescue loan from the Lender of Last Resort if the bank has failed. Note that β is not only a function of the state of the world and the ease of selling a bank to another institution but *also* the state of other banks. Thus β can only be an expected function of the state of the world.

$$s_{CB} = \int_0^1 [\gamma p(X) + (1 - \gamma p(X))\beta(\gamma, \theta)] f(\gamma) d\gamma \tag{2.2.9}$$

where $\int_0^1 (1 - \gamma p(X))\beta(\gamma, \theta) f(\gamma) d\gamma > 0$ is the increased likelihood of surviving into the following period due to the possibility of rescue.

From the bank manager's perspective it is only whether the bank receives a loan and continues in operation that makes a difference.[10] In practice the management of the bank is sometimes, but not always, replaced in the event of a rescue. The manager often keeps his job due to his specific expertise about the bank's portfolio and business. However, a manager may care about the status of the bank *even if* he is replaced. The most obvious recent example is the case of discretionary bonuses and other payments.[11] If the bank is sold then the manager loses the claim over future profits.

This re-arranges to:

$$s_{i,CB} = p(X)(\mu - \Gamma_i) + \overline{\beta_i} \tag{2.2.10}$$

where the effects of $\Gamma \equiv \int_0^1 \gamma\beta(\gamma, \theta_i) f(\gamma) d\gamma$ and $\overline{\beta_i} \equiv \int_0^1 \beta(\gamma, \theta_i) f(\gamma) d\gamma$ will be discussed in the next section.

Note however, that $\mu, \Gamma_i$and β_i are unaffected by the choice of p. However: Γ_i is a negative function of θ_i as is $\overline{\beta_i}$ [12]

[10] issues of deposit insurance are not a concern of the manager

[11] As an example the Chief Executive of the Royal Bank of Scotland, which received government assistance, was entitled to keep his pension which was considerably higher than the £27,000 which he would have likely received under the Pension Protection Fund for bankrupt companies, if RBS had been liquidated.

[12] Put in the appendix: (to see this: if $\theta_i = 1$ then the bank will always be sold and never rescued $\rightarrow \overline{\beta}_i = 0$ and $\Gamma_i = 0$. i.e. $\frac{\partial \overline{\beta}_i}{\partial \theta} \leq 0$ and $\frac{\partial \overline{\beta}_i}{\partial \theta} \leq 0$).

2.2.3 Optimal choice

2.2.4 Extreme cases

The following three cases solve the model for some of the more conventional cases in the literature: social planner 2.2.4, no Lender of Last Resort 2.2.4 and when the Lender of Last Resort has unlimited resources 2.2.4. When there is no Lender of Last Resort the bank takes on a low level of risk, but banking crises are costly. On the other hand when there is an unlimited Lender of Last Resort crises are frequent, and the bank takes on a high level of risk.

The social planner

The social planner will choose in each period:

$$\max_p \mu p X - r - \phi(p) \tag{2.2.11}$$

$$\rightarrow \mu X = \phi'(p^*) \tag{2.2.12}$$

i.e. so that the marginal expected return from the project equals the marginal cost of increasing the probability of success. The social planner takes into account that depositors r must be paid irrespective of the project's success. The social planner has no desire to negatively affect the resale value of a bank which is why a choice of $\xi(\theta)$ is not included.

Due to the effective call option that the bank has on depositors it only repays depositors in the event of success. Effectively there is no cost to failure.

No LOLR

At the other extreme if there is no Central Bank/Lender of Last Resort then: $s = p$

$$max_{\theta_i,p} V = \frac{\mu p(x-r) - \phi(p)}{1 - \delta s(\theta, p)} \tag{2.2.13}$$

$$\frac{\mu(X-r) - \phi(p)}{[1 - \delta\mu p]} = \phi'(p^*) \tag{2.2.14}$$

as $\delta\mu p < 1$ and $\phi(p) > 0$ it is ambiguous as to whether this involves more or less failures than with an unlimited LOLR. However, the expected social cost in each period of a bank's failure and sale is $\left(\phi'^{(inv)}(p^*)\right)(1 - \theta V)$, which provides an argument for the existence of a LOLR.[13].

Unlimited LOLR

If there is a LOLR which *always* extends a rescue then the bank survives with probability 1, does not choose to negatively affect its resale value, and chooses:

$$\max_p \mu p(X-r) - \phi(p) \tag{2.2.15}$$

$$\rightarrow \mu(X-r) = \phi'(p^{**}) \tag{2.2.16}$$

due to the convexity of $\phi(p)$ $p^* > p^{**}$. In other words, a social planner will chose a higher probability of success than a bank that is not concerned as to its survival into the next period, but simply with maximising current period profits. This would be a motivating factor behind limiting the opportunity to be bailed out.

[13]This gets slightly more complicated as $V = \frac{\mu p^*(X-r) - \phi(p^*)}{1 - \delta\mu p^*}$

Limited LOLR

A representative bank chooses p and θ, taking into account the probability of survival. The probability of survival as shown above is state dependent.

The FOC with respect to p is:[14]

$$[1-\delta[p(\mu-\Gamma_i)+\overline{\beta}_i]]((X)X-\phi'(p))+\delta(\mu-\Gamma)[p(X-r)-\phi(p)-\xi(\theta)]=0 \quad (2.2.17)$$

$$\rightarrow \frac{(X-r)(1-\delta\overline{\beta})-\delta(\mu-\Gamma)[\phi(p)+\xi(\theta)]}{1-\delta[\mu-\Gamma]-\delta\overline{\beta}}=\phi'(p) \quad (2.2.18)$$

Proposition 2.2.1 *If a bank can affect its resale value this involves a lower optimal p^* than when the resale value in the event of failure is fixed.*

Proof No resale effect $\rightarrow \xi(\theta^*)=0$. As $\phi(p)$ is positive then the case where banks have an incentive to alter their resale value must induce less monitoring, as $\phi'(p)^*$v decreases, and therefore a lower probability of success p^* than when a bank cannot affect the [15]resale value is lower than in the case where the bank does not have such an incentive.

2.2.5 The effect of having a LOLR, and one with limited resources

When we introduce a Lender of Last Resort there are two effects. The first is that banking crises become less costly as the Lender of Last Resort is able to give loans to banks to allow them to carry on in business rather being shut down. The second effect is that the *incidence* of crises changes. This is because the possibility of a rescue affects a bank's risk-taking behaviour. In the section below we will show that, from some level of resources, by increasing

[14]FOC wrt θ is also left to section .1 of the appendix

[15]($\phi'(p)$ is smaller and $\phi(p)$ is an increasing convex function $\rightarrow p^*$)

the Lender of Last Resort's resources it can be possible to achieve a Pareto improvement with *less*frequent crises and also at a lower cost. The intuition behind this result is that we are not moving from one extreme (no LOLR) to another (very lenient LOLR), but instead from a limited LOLR to one that is less limited.

Proposition 2.2.2 *For $\Lambda > \Lambda'$ a crisis,* given that it has occurred*, is less costly.*

Proof The cost of a crisis is the loss of value of the banks that were sold, rather than rescued. The cost is given by equation (2.2.19) below where $j \in [0, J]$ is the set of banks that are sold rather than rescued.

$$\sum_{j=0}^{J}(1-\theta_j)V_j \tag{2.2.19}$$

Relaxing the resource constraint simply decreases the size of J for any given crisis.

Although increasing the resources available to the LOLR makes resolving an occurring crisis less costly this has to be balanced against potentially increasing the probability of crises occurring. However, as shown below it is possible that increasing the Lender of Last Resort's Resources can make crises less likely by inducing the bank managers to make a safer asset choice and to divert more resources into monitoring. Increasing the resources available to the LOLR could therefore result in a Pareto improvement whereby bank failures are less frequent and less costly.

Remember that the probability of an individual bank surviving is

$$s_i = p(X)(\mu - \Gamma_i(\Lambda)) + \overline{\beta_i(\Lambda)} \tag{2.2.20}$$

An increase in the LOLR's resources increases the probability that any individual failed bank will receive a bailout for each state, effectively increasing Γ_i and β_i.

There are three effects on the bank's optimal choice that arise from increasing the resources of the LOLR.

The first is the well known *moral hazard* effect.

$$\Gamma_i \equiv \int_0^1 \gamma\beta(\gamma, \theta_i) f(\gamma) d\gamma \qquad (2.2.21)$$

which reduces the effect that the bank's monitoring choice has on its probability of survival. This *decreases* the incentive for a bank to monitor its project.

The second is the *charter value*/safety net effect that increases the value of the bank.

$$\overline{\beta}_i \equiv \int_0^1 \beta(\gamma, \theta_i) f(\gamma) d\gamma \qquad (2.2.22)$$

is the average probability of being 'bailed-out' by the LOLR and is a 'bonus effect, in that it increases the probability of survival *independently* of the p that is chosen. As $V = \frac{\Pi}{1-\delta s()}$ this has a pure *value* effect on V and so reduces risk-taking by the bank due to the increased ability to survive into future periods and make profits. By increasing the value of the bank in the future *if* it survives the manager has an incentive to choose a safer project.

The third effect is an *appropriation of resources effect.* As the LOLR's resources increase for a given state of the world (γ) the expected 'cut-off' resale value of a failed bank increases ($\widetilde{\theta}$). This reduces the incentive for a bank to destroy its own resale value or to invest in illiquid assets. The bank can divert costs more profitably to monitoring.

To illustrate more clearly: compare the situation of two banks i and j each with different resale values θ. If $\theta_i \leq \theta_j$, or in other words bank i is more likely to be bailed out in every state, then:

$$\overline{\beta}_i \geq \overline{\beta}_j \quad (2.2.23)$$

$$\Gamma_i \geq \Gamma_j \quad (2.2.24)$$

This can be seen from the fact that $\overline{\beta}$ is the sum of all the states in which the bank receives a loan to continue in operation from the LOLR; and Γ_i is the sum of all the states in which the LOLR will give the bank a loan multiplied by the state. Relaxing the LOLR's resource constraint increases $\overline{\beta}$ and Γ. Note also that:

$$cov(\beta(\gamma, \theta_i), \gamma) = \Gamma_i - \mu\overline{\beta}_i \leq \Gamma_j - \mu\overline{\beta}_j = cov(\beta(\gamma, \theta_i), \gamma) > 0 \quad (2.2.25)$$

or in other words: an individual bank is more likely to get rescued in *good* states of the world or, alternatively interpreted, in less severe crises. This is because *other banks* are less likely to fail in these state of the world and the bank is therefore more likely to be rescued rather than the assets sold to outsiders. Also:

$$\frac{\partial \Gamma_i}{\partial \Lambda} \leq \frac{\partial \overline{\beta}_i}{\partial \Lambda} \quad (2.2.26)$$

Both (2.2.25) and (2.2.26) are positive.[16] An increase in the Lender of Last Resort's resources (Λ) increases the number of states in which a bail-out can be expected. So $\overline{\beta}$ goes up one-for-one while Γ increases by γ times the number of states. As Λ is relaxed the 'pure subsidy effect' ($\overline{\beta}$) increases more than the moral hazard effect (Γ). As the Lender of Last Resort's resources become unlimited ($\Lambda \to \infty$) and $\Gamma \to \mu$ but $\overline{\beta} \to 1$.

[16] effectively the probability of a bail-out is effectively 0 or 1 for most states: γ

Proposition 2.2.3 *An increase in* Λ can *lead to less frequent crises,* $\frac{\partial p^*}{\partial \Lambda}$ *can be positive.*

Proof The reaction of the bank's optimal monitoring choice when the LOLR has more resources can be found by taking (.1.12) and differentiating with respect to Λ. Due to the assumptions about $\phi(p)$ an increase in $\phi'(p^*)$ means a higher p^* so if $\frac{\partial \phi'(p^*)}{\partial \Lambda} \geq 0$ then increasing the LOLR's resources induces *more* monitoring. to get $\frac{\partial \frac{[\mu - \Gamma_i]}{1-\delta\overline{\beta}_i}}{\partial \Lambda}$

$$\frac{\partial \frac{[\mu-\Gamma_i]}{1-\delta\overline{\beta}_i}}{\partial \Lambda} \tag{2.2.27}$$

$$= \frac{1}{(1-\delta\overline{\beta}_i)^2}[(1-\delta\overline{\beta}_i)(-\frac{\partial \Gamma_i}{\partial \Lambda}) + ([\mu - \Gamma_i]\delta\frac{\partial \overline{\beta}_i}{\partial \Lambda})] \tag{2.2.28}$$

$$\frac{1}{(1-\delta\overline{\beta}_i)^2}\text{must be positive, so} \tag{2.2.29}$$

$$[(1-\delta\overline{\beta}_i)(-\frac{\partial \Gamma_i}{\partial \Lambda}) + ([\mu - \Gamma_i]\delta\frac{\partial \overline{\beta}_i}{\partial \Lambda})] \leq^? 0 \tag{2.2.30}$$

This last expression (2.2.30)can be either positive or negative. This can be seen immediately by setting $\delta = 0$ (very impatient banks) the last term in (2.2.27) becomes: $-(1-\delta\overline{\beta}_i)(\frac{\partial \Gamma_i}{\partial \Lambda})$ which is negative.

Thus it is also not certain that a Commercial Bank that has more chance of receiving a loan from the LOLR (lower θ_i) will take on riskier projects. For some level of the LOLR's resources (Λ) increasing the resources and therefore making bailouts more likely *decreases* the probability of a crisis occurring. This means that may be possible to achieve a Pareto improvement in terms of both less costly and less frequent crises.

2.2.6 Size of the LOLR?

This raises the question of the optimal size of the LOLR, or alternatively put, how much resources to commit to rescuing the banking system. Although committing more resources makes an occurring crisis less expensive to resolve, the resources available also affects the bank manager's willingness to take risk. Risk-taking is 'U' shaped in the level of the LOLR's resources.

Define $\widetilde{\Lambda}$ such that

$$\frac{\partial \frac{[\mu-\Gamma_i]}{1-\delta\overline{\beta}_i}}{\partial\Lambda}|_{\widetilde{\Lambda}} = 0 \tag{2.2.31}$$

so

:

$$\frac{\frac{\partial\Gamma_i}{\partial\Lambda}}{\frac{\partial\overline{\beta}_i}{\partial\Lambda}} = \frac{\delta(\mu-\Gamma_i)}{(1-\delta\overline{\beta}_i)} \tag{2.2.32}$$

For $\Lambda \leq \widetilde{\Lambda}$ the level of resources committed to rescuing banks can be increased without making crises more probable, suggesting that the minimum size of the LOLR is at least $\widetilde{\Lambda}$.

2.3 Conclusion

The effects of the imperfect 'financial innovation' model are fairly straightforward. Following a large positive shock and some innovation that allows loan sales the bank has very good outside opportunities to invest; to take advantage of this opportunity the bank sells its claim to the return on its mortgages even though they are expected to pay a high return. Due to the size of the opportunity the price in the secondary market is high, despite the low anticipated recovery in default. Following this financial innovation, i.e. the invention of a loan sale product, the bank has a mechanism to transform a long term illiquid asset into a short term asset. Due to this innovation the bank makes more mortgage loans in the first period, increasing the price of houses.

If the recovery value of the house in the default state increases then private information as to whether the loan is expected to perform is less of an issue, as the loss given default is small. Certainly this was the case in earlier subprime vintages. But *expected* liquid secondary markets by themselves create the potential for an appreciation house prices, by freeing up banks to extend more housing credit. I conjecture that in an extended overlapping generations model we would find that high house prices and secondary markets for housing loans would be mutually reinforcing. Loan sale markets also cause relationships between the housing market and other investment markets to reverse.

Although the adverse effects of credit dispersion and secondary markets have taken center stage recently this does not necessarily mean they are welfare-reducing. Credit risk transfer markets provide a form of valuable insurance for banks as it enables credit expansion. In this paper welfare is increased for mortgage borrowers, through a lower interest rate and increased access to credit. The bank is also better off as it can take advantage of opportunities in the second period, so its profits increase. However, this does not imply that the move to financial disintermediation is innocuous. The opportunity to sell loans on the secondary market causes a new adverse selection problem in the loan markets. Secondary loan markets allow banks to sell loans that they expect to underperform. This limits the effectiveness of the 'financial innovation', as there are potentially profitable investment opportunities that go unfunded. The private information problem also results in a 'crisis' when the pooling equilibrium collapses. However, the unstable market for mortgage backed securities may be preferred and more efficient than other stable forms of raising finance such as trying to raise deposits or equity.

In terms of policy implications forcing banks to acquire more information about its borrowers may be *welfare destroying*, even if it done costlessly. This is because the first best solution is to acquire no private information about risky borrowers. In terms of assisting mortgage borrowers, which has been a focus of attention recently, giving banks more funds in a ‘recession’ is not useful when the market for mortgage backed securities has broken down. A bank receiving more deposits will store its funds and use in the next period to lend outside the mortgage market. Maintaining ‘regulatory arbitrage’ whereby a bank gets capital relief by selling to a ‘non-bank’ may also be welfare improving as it increases the probability that the bank is selling loans to release value elsewhere, meaning that secondary markets are stable for longer in the cycle. High house prices relative to the interest rate are valuable in this model because they help to reduce the extent of the asymmetric information problem between banks and loan sellers and reduce the level of repayment borrowers have to make on their mortgages. In this context making foreclosure easier and less costly for banks is welfare improving, at least ex ante.

Chapter 3

The Paradox of Liquid Loans

Banks have a reduced incentive to monitor when credit is dispersed because they do not ultimately bear all the credit risk, and this arises in settings such as multiple-bank lending syndicates or when there is a secondary loan market. We present novel evidence on long run borrower performance in favour of the view that the lead bank's monitoring effort, as reflected in its syndicate lending stake, matters. Greater retained interest materially lowers the probability that the borrower defaults and improves profitability and investment-grade status three years after syndication. And this positive effect is priced in by equityholders at the time a syndication is announced. The lead bank's exposure matters more for opaque and weak firms, as well as in times of loose credit standards as reflected in loans syndicated during booms. We illustrate how credit dispersion and transfer exacerbate agency problems in a simple theoretical framework. Monitoring incentives are diluted not only by the fact that each bank is not exposed to the full credit risk, but also by the fact that there are other banks who may potentially monitor. We also show that a situation where banks stop monitoring due to the ability to sell their credit risk in a secondary market is ultimately unstable, although it may be possible for banks to shirk in the short-run.[1]

[1]The views expressed in this paper are those of the authors, and not necessarily those of the Bank of England. This paper developed in discussions with Andy Haldane and we thank him for his insight. We are also grateful to Viral Acharya for helpful comments and suggestions. All errors are our own. Rhiannon would particularly like to extend her gratitude to la Fundación Banco Herrero for financial support.

3.1 Introduction

Developments in the financial system that have enabled credit risk to be spread have allowed financial intermediaries to be potentially better diversified and welfare improved. But credit risk dispersion exacerbates agency problems between the borrower and the lender and between the informed lender and the uninformed outside investors. Only by committing part of its scarce capital into a firm, will a bank have sufficient incentive to carry out due diligence and monitor the borrowers who would otherwise pursue their private benefits at the expense of investing in high return projects. The credibility the bank gains from retaining exposure to the borrower encourages other participants to provide funds, relying on the monitoring effort of the informed bank. This leads to the paradox of liquid loans. Diamond (1984) posits that delegated monitoring means that the banks are not able to sell their loans, as the acquirer would have to incur the cost of monitoring again. In addition, adverse selection in the type of loan the bank chooses to sell contributes to the illiquidity in the loan sale market.

However, until July 2007 banks were able to sell their loans or at least take out some form of insurance against credit risk[2]. For example, the credit derivatives market rapidly expanded from \$1 trn outstanding in 2000 to \$20 trn outstanding in 2006. And syndicated loan issuance in the US increased from \$150 bn in 1987 to \$1.7 trn in 2006. We, therefore, ask whether the insurance provided by a credit risk transfer market dampens the incentive of banks to assess and monitor the loans they originate (of England (2007)). Schumpeter (1939) articulated this view eloquently, "...the banker must not only know what the transaction is which he is asked to finance and how it is likely to turn out but he must also know the customer, his business and even his private habits, and get, by frequently 'talking things over with him', a clear picture of the situation." Has this, however, become redundant as information is easier to collect at arm's length and hard information substitutes for soft information?

[2]Recent evidence of "disarray" in syndicated loan market was reported in the *Financial Times*, 3/2/2008, describing the failure of the banks backing a buy-out of Harrah's entertainment to syndicate \$14bn of the debt.

Or does the ongoing financial crisis point to an endemic problem of lax credit standards bolstered by liquid secondary credit markets? Schumpeter goes on to say that "...traditions and standards may be absent to such a degree that practically anyone can drift into the banking business, find customers, and deal with them according to his own ideas... This in itself...is sufficient to turn the history of capitalist evolution into a history of catastrophes." We will have to wait until the dust settles from the homes of repossessed US sub-prime households to see whether this will have a material effect on financial intermediation.

This paper is divided into two parts. In the first, we place the incentive problem facing banks in a theoretical framework, both when selling loans and also when monitoring duties are shared amongst banks We then take up an empirical analysis of credit risk-sharing in lending syndicates where credit is dispersed among the lead and participant banks. Our paper contributes toward understanding whether the exposure of the lead bank matters for the long run performance of the borrower. In contrast, most of the literature has focused on lending structure, pricing and short run equity reactions. There is strong support for the hypothesis that borrower performance is increasing in the interest the lead bank takes in a borrower, whether performance is measured by defaults or other long run measures of profitability and investment-grade status. This is corroborated with short run evidence from the equity market's response. The asymmetric information effect we find is economically larger and statistically significant when we instrument the lead bank's share. We also find that lower costs of monitoring help to offset the negative effects from lower lead exposure, such as when the lead bank is also based in the US or when the borrower's industry is better known. A lead bank with a greater reputation is also associated with improved performance. Lead exposure matters more for firms that are opaque or performing poorly. And interestingly, loans originated in boom times perform worse but to a lesser extent the greater the stake the lead bank retains in the borrower.

The empirical results support the theory, where we illustrate free-riding among banks in a simple strategic setting. In a syndicated loan setting monitoring incentives are diluted not only by the fact that each bank is not exposed to the full credit risk, but also by the fact that there are other banks who may potentially monitor. In this case each bank has an incentive to free-ride on the monitoring efforts of others. In the appendix we go on to show that when banks can trade their loans in a secondary market with uninformed outsiders, it may be possible for them to shirk as long as the market believes that they are monitoring. This is clearly not sustainable in the long run, and sunspots can cause shifts between monitoring and not-monitoring regimes. Illustrative evidence from the US sub-prime market provides support for this view: Figure 1 plots deliquencies against the price of secondary market sub-prime loans. Even though delinquency rates rose from the middle of 2006, the price response only picked up pace in March and April 2007, as the secondary market abruptly changed its beliefs. Liquidity has since dried up and prices have fallen further by more than 70%.

3.2 A Review of the Related Theory

Monitoring by many small investors is either inefficient (there is duplication) or possibly infeasible (the private benefit outweighs the cost so that in equilibrium there is no monitoring). Banks traditionally got around this problem by holding the loan, exposing the bank to the full credit risk, and monitoring on behalf of their depositors.. The delegated monitoring theory of financial intermediation (e.g. Diamond (1984)) posits that banks have a comparative advantage in monitoring activities. Scale economies in monitoring (e.g. a fixed cost), small investors relative to the size of the investment project, but also low costs of delegation are among the sources of comparative advantage for the bank. Monitoring the delegated monitor is not necessary so long as the monitor is adequately diversified. Atomistic non-monitoring investors are effectively free-riding off the bank's monitoring effort in, for example, the Gorton and Pennacchi (1995b) framework when the bank sells part of the loan. They undertake no monitoring themselves and their returns are entirely determined by the lead bank's monitoring effort. A similar idea occurs in the seminal Holmstrom and Tirole (1997b) model. The holders of market debt 'free-ride' off the bank's monitoring effort, but receive a lower return than the monitoring bank. Once they know the bank is monitoring and has invested sufficient capital then the outsiders invest. The bank's monitoring increases expected returns and benefits all other security holders as all security holders are paid back equally, regardless of whether they monitored or not.

There is a considerable literature on the costs and benefits of banks' use of credit risk transfer markets. An early paper is Gorton and Pennacchi (1995b) who show that a bank, which seeks to sell its loan to alleviate capital constraints, retains part of the loan to maintain monitoring incentives. But its level of monitoring is reduced. Dewatripont and Maskin (1995) show that this dilution of the initial bank's monitoring effort may be beneficial because unprofitable projects no longer get funded (but multiple creditors can also stop funding for profitable but slow projects).

More recent papers have focused on the adverse selection problem arising when banks use their superior information to off-load bad credits. In the seminal papers of Gorton and Pennacchi (1995b) and Holmstrom and Tirole (1997b) show that a bank must retain a stake in a loan to maintain monitoring incentives.Parlour and Plantin (2008b) show that credit risk transfer markets can be inefficient for safer borrowers as banks must commit a higher investment of capital to credibly signal that they are monitoring.[3] Duffee and Zhou (2001) and Morrison (2001) also find that credit risk transfer markets can lead to welfare reductions. One of the limitations of these models is that it is not clear why either banks or borrowers cannot commit *not* to use the credit risk transfer market, in the cases where welfare is ex-ante expected to be lower. A solution for such an entrepreneur could be to insist on the inclusion of a 'no-sale' clause in its original loan contract, given that the use of loan sales reduces welfare. This is reasonably common in other loan contracts; for example in syndicated loans the lead arranger is frequently contracted *not* to sell their stake in the loan. Given the dual dilution of incentives in syndicated loans it is not immediately clear that a firm would optimally choose a syndicated loan with more than one lead arranger. However it is likely that it avoids 'hold up' problems and issues of bank monopoly power in future loans. The firm's incentives to choose a syndicated loan are an issue for substantial further research.

[3]The condition in Holmstrom and Tirole (1997b) paper that the bank invests some of its capital is only a market clearing condition. Incentives to monitor are given by the different expected payoff if the bank monitors the project.

Another positive view on multiple-bank lending is offered by Carletti, Cerasi, and Daltung (2007), in an extension of the Diamond model. A key difference is that banks face limited diversification opportunities, so multiple-bank lending can ease banks' moral hazard problem with depositors. They suggest that multiple-bank lending can be optimal whenever the benefit of greater diversification in terms of higher overall monitoring dominates the costs of free-riding and duplication of efforts.

3.3 Information Asymmetry and Credit Dispersion: A Theoretical Framework

In the model there are three agents. The lead banks, the firm, and the participating banks. The lead banks make a loan to a firm and have the contractual responsibility of monitoring the loan. The firm has an investment project, which requires monitoring by the lead banks to ensure its success. The investment project also requires capital of I to be invested. This could be invested entirely by the lead banks, or, alternatively the lead banks can share the project with participant banks. As multiple banks share responsibility for monitoring the firm, the possibility of free-riding arises. Banks may choose not to monitor in the hope that another bank will monitor, and thereby, save the cost of monitoring. The case of when there are fixed costs of monitoring to be paid is left to the appendix. The model is close to Ivashina (2009) and Gorton and Pennacchi (1995b) in that lead banks face an idiosyncratic cost of credit from investing in the individual firm and so may choose to invest together with parties who are unable to monitor. As a syndicated loan is chosen to be a 'syndicated' loan by the firm at the time of issuance we leave discussion of private information to the appendix in section **??**.

3.4 A simple model with syndication incentives and monitoring

Firms Firms have an investment project of size I. If successful this returns R for the bank and F for the firm. The investment project that the firm has requires monitoring by the bank to improve the probability of success. The reason for this is not explicitly modeled for simplicity but can be interpreted as the bank monitoring to reduce private benefits/shirking, which induces the firm to choose options which lead to a higher overall probability of success for the project. The effort put in by the firm is not observable but the outcome of the project, success or otherwise is observable.

Participant banks Participant banks are price takers and so $(1-\alpha)(pR - I) = 0$. They do not monitor, nor are they able to observe the monitoring activity undertaken by the lead banks. However, they are aware of the incentive problem facing the lead banks.

Banks The lead banks invest in the project and also decide how much to monitor. In addition the lead bank must decide how much of the loan to maintain and how much to sell to outside participants. The monitoring banks have an 'idiosyncratic credit risk' cost of holding the loan, which is increasing in the proportion held → incentive to sell/syndicate part of the loan. This has a parallel with Gorton and Pennachi's model where the main bank sells the loan to participants with a lower funding cost.

Monitoring takes the form of improving the probability of success of the project, or alternatively, decreasing the likelihood of default. Monitoring is costly with $c(M) > 0$, $c'(M) > 0$, $c''(M) < 0$. As the returns on the project are shared amongst *all* participants monitoring is effectively a public good. Monitoring is unobservable and uncontractable.

The bank's problem is solved backwards. First the problem of how much to monitor, given the fraction of the loan that is retained. Then we solve for the optimal retained portion.

Given that a lead bank has a share α it solves the problem of how much to monitor:

$$\max_{M} \alpha p R - c(M) \tag{3.4.1}$$

where p reflects monitoring by (for tractability and easy of exposition) both banks: i and j

$$p = 1 - de^{-\delta(M_i + M_j - \theta M_i M_j)} \tag{3.4.2}$$

4

Properties of the monitoring function As more monitoring is undertaken the probability of success asymptotes to 1 at a rate of δ. Without monitoring the probability of success of the project is $(1 - \delta)$ Both monitoring banks effort decision will depend on the other monitor's decision. The term $\mu M_i M_j$ reflects the potential for duplication of monitoring effort. As lead banks in the syndicate frequently work together in other deals then this θ is expected to be lower in banks that have had a previous working relationship. This will result in a higher probability of success in equilibrium.

Given a share α each lead bank will optimise to get:

$$\alpha R \frac{\partial p}{\partial M_i} = c'(M) \tag{3.4.3}$$

so that the marginal expected payoff for each lead bank in the event of success equals the marginal expected cost of monitoring. Note that this is not the same solution as if monitoring was observable and contractable. If this

[4]Note that the 'diversification'/funding effect does not directly have an impact on the level of monitoring undertaken. In theory a bank could 'over-monitor' as the monitoring could contribute to decreasing the variance of the loan portfolio. Hence, the need to use ex-ante measures of the 'cost-of-holding'. As explained by Ivashina banks frequently use historical measures of default risk in their estimation of default probability and variance.

were the case (3.4.3) would be:

$$R\frac{\partial p}{\partial M_i} = c'(M) \tag{3.4.4}$$

Exploiting the functional form for the probability of success:[5] we get:

$$fail = \frac{c'(M_i*)}{\alpha R\delta(1-\theta M_j*)} \tag{3.4.5}$$

Unsurprisingly, the probability of failure is

- Increasing in the marginal cost of monitoring
- Decreasing in the fraction retained by the lead
- Decreasing in the returns in the event of success
- Decreasing if monitoring is more effective (higher δ)
- Lower for syndicate banks that work efficiently together: θ is low, i.e. little duplication of monitoring effort.

The discussion of the other bank's effort is more involved.

The zero profit condition will pin down R as $I = pR$

Optimal lead bank share

The optimal loan share retained for a lead in the syndicate then solves:[6]

$$\max \alpha pR + (1-\alpha)pR + F - c(M) - \alpha(A-I) \tag{3.4.6}$$

$$+\lambda\left[\alpha\frac{\partial p}{\partial M}R - c'(M)\right] \tag{3.4.7}$$

$$\mu\alpha \leq 1 \tag{3.4.8}$$

[5] Use $fail = \delta(1-\theta M_j)\frac{\partial p}{\partial M}$

[6] For why the problem is set up this way see Gorton and Pennachi

If monitoring were observable then the optimal solution would be for the bank to sell the entire loan to agents not bearing this lack-of-diversification risk and for the fee to compensate for the cost of monitoring. The term $(1-\alpha)pR$ is the proceeds that the bank makes from selling or syndicating the loan. In equilibrium (as participant banks make zero profits $pR = I$.[7] As the bank retains a smaller fraction of the loan the price paid by outsiders for the marginal portion decreases as they are aware of the bank's reduced incentives to monitor the loan. The bank therefore faces a trade-off in terms of selling to reduce the diversification cost, but retaining enough to convince the market of its monitoring effort.

F is the fee for monitoring services to ensure that the lead-bank does not make a loss.

The first order conditions for (3.4.6) are:

$$A - I = \lambda \frac{\partial p}{\partial M} R + \mu \tag{3.4.9}$$

Using the same substitutions as above: the probability of the loan failing is positively related to the difference in funding costs between the lead and participant banks. This is because the optimal level of the loan sold is increasing in the funding advantage of the outside banks.

$$\frac{\partial P}{\partial M} R - c'(M) + \lambda \left[\alpha \frac{\partial^2 p}{\partial M^2} R - c''(M) \right] \tag{3.4.10}$$

Then use the IC constraint (3.4.3), rearrange (3.4.9) to get $\lambda = \frac{A-I-\mu}{\frac{\partial P}{\partial M} R}$ and equation (3.4.10) can be rearranged to get:

$$\frac{\frac{\partial p}{\partial M} R - \frac{A-I-\mu}{\frac{\partial p}{\partial M} R} c''(M)}{\left(\frac{\partial p}{\partial M} R - \frac{A-I-\mu}{\frac{\partial p}{\partial M}} \frac{\partial^2 p}{\partial M^2} \right)} = \alpha \tag{3.4.11}$$

The optimal amount held is decreasing in the 'diversification' cost or relative cost of funding to outsiders and decreasing in the sensitivity of the return on the

[7] Unlike Gorton and Pennacchi we do not consider loan guarantees or the probability of lead-bank insolvency

loan to monitoring. The latter is fairly intuitive as with ineffective monitoring the difference in the roles between an 'insider' bank and 'outsider' bank is smaller, a non-monitoring bank does not have the idiosyncratic credit cost and so it is optimal for a non-monitoring bank to hold more of the loan. The former is because as the funding cost increases, outside bank have a comparative cost in funding the loan to maturity. This has a role in a private-information setup and helps to motivate the instrument, when as the relative cost of funding increases it is less likely that the lead bank is holding a small stake as the loan is expected to perform badly, but rather because it is costly to hold to the loan to maturity.

3.5 Information Asymmetry and Credit Dispersion: Does Lead Bank Exposure Matter?

One key aim of this paper is to test whether the lead bank's credit exposure to a borrower matters in influencing the borrower's long-run performance. As discussed earlier, the credibility the bank gains from retaining exposure to the borrower encourages other participants to provide funds, relying on the monitoring effort of the informed bank. This is empirically supported in the work by Dennis and Mullineaux (2000), *et al* Jones, Lang, and Nigro (2001) and Sufi (2007) who find that the lead bank retains a larger share when there may be significant moral hazard problems and the borrower requires more monitoring in order to ensure a higher likelihood of project success.

Does this more concentrated syndicate structure, however, translate into better outcomes? Most of the existing literature has focused on short-run measures, which we include as a robustness check. Gorton and Pennacchi (1995b) support their theory on monitoring intensity with evidence of a negative relation between lead bank share and loan spreads using data on loan sales. Ivashina (2009) and Focarelli, Pozzolo, and Casolaro (2008) use data on loan syndications and find that the loan spread at origination is reduced the more the lead bank holds and therefore participant lenders accept a lower premium. Ivashina identifies this asymmetric information effect after capturing the concurrent rise in the premium demanded by the lead bank for the contribution the greater exposure makes to its overall loan portfolio credit risk. Focarelli, Pozzolo, and Casolaro (2008)also find that the certification effect of the lead bank retaining greater exposure positively influences abnormal equity returns at the time of syndication.

Scant evidence exists on whether greater lead bank exposure and the resulting higher monitoring effort materially raises the probability of project success. Is the long run performance in line with the positive certification inferred by the market in the short run? It is to this end that our paper contributes. The closest study addressing this question is by Dahiya *et al* who find that the negative certification at the time of a secondary loan sale is born out in the later poor performance of these borrowers. Many of the firms file for bankruptcy within three years of the loan sale, over 40% compared with 6% for firms in comparable industries, even though they are not the weakest firms at the time of sale. One limitation of their study is that their results may not be generalisable to less extreme credit risk transfer and dispersion markets such as loan syndications. Their focus is on the loan sales market, and their sample is dominated by subpar or distressed loans, where, as they note, information frictions are greatest. A second limitation of their study is the small sample of loan sales; although almost a half of the borrowers default within three years of a loan sale, this reflects 22 firms out of a loan sale sample of 53.

We examine a wide sample of borrowers with syndicated loans, relating their subsequent performance with the syndicate structure at the time of sydication. As do Dahiya *et al*, we focus on defaults as an indisputable indication of poor performance. Our measure of defaults derive from defaults on bonds as recorded by Moody's Default Risk Service Database. This is not as severe a measure as bankruptcy filings, but is presumably a negative outcome for equityholders and bank syndicate lenders in addition to the affected bondholders. And the lead bank's *ex ante* due diligence and *ex post* monitoring are intended to avoid such an event. We also examine other measures of long run performance both as a robustness check and because we were able to match less than a quarter of borrowers with bond defaults to those with loan syndications. Specifically, we look at the return on assets (EBITDA/assets) three years after syndication as well as the likelihood that the firm is rated investment grade. And we corroborate our results with the short run reaction of the stock market to the lead bank's stake in a borrower.

3.5.1 Empirical Framework

We relate a borrower's performance to the extent of the lead bank's exposure in the syndicate, with the latter proxied by the share of the loan held by the lead bank. We also use other measures such the number of leads, concentration of the syndicate as measured by the Herfindahl index and the exposure of the lead in dollar amount. These measures capture the null that there will be less monitoring when a credit risk transfer market is available compared with when no such insurance is available to the bank originating the loan. The advantage of using data on syndications is that the share retained by the lead bank is reported, albeit not for all deals. The basic specification we estimate takes the form of a probit:

$$\Pr(Default_{ij}) = f(\alpha+\beta(Lead\ Bank\ Exposure_i)+\gamma X_i+\theta Y_{ij}+Year\ Dummies+\epsilon_i), \tag{3.5.1}$$

where we are interested in the coefficient β, which is expected to be negative under the null: the greater the lead bank's exposure on loan i, the lower is the probability that borrower j with loan i defaults. We control for loan characteristics, X_i, for borrower characteristics at the time of syndication, Y_{ij}, and for syndication year dummies. Standard errors are heteroskedasticity robust, where we allow the individual loan error terms to be correlated for all loans of the same borrower.

We are also able to test other implications from the model outlined in Section **??**. Scale economies in monitoring, small investors relative to the size of the investment project, and low costs of delegation are among the sources of a bank's comparative advantage in monitoring.

Elements affecting the cost of monitoring include the opacity of the borrower, which has been captured in the syndicate structure literature with an indicator for public firms and firms with third party credit ratings. In addition, borrowers in younger industries or industries with less tangible assets and more R&D expenditures would require greater monitoring effort. A borrower will also be better known and less opaque if it has previously borrowed in the syndicated market. The cost of monitoring will also be less for a lead bank if it were a previous lead for the borrower. This "distance" of the lead bank to the borrower can also be captured literally if the two share the same country or state. One novel idea we test is whether the cyclical state of the economy affects the cost of monitoring, so that the cost of monitoring is procyclical. Suppose that recessions are cleansing and it is difficult for a low quality borrower to imitate a high quality borrower in bad times. But it is easier for this low quality borrower to masquerade as a high type in boom times, necessitating a higher effort on the part of the lender to discriminate. So we expect that loans originated in boom times subsequently perform worse. We evaluate each of these hypotheses below.

3.5.2 Data and Descriptive Statistics

We begin with a brief description of the data sources we use. Data on syndicated loans for US borrowers are collected from Loan Pricing Corporation's Dealscan, which covers the period from 1987 to the middle of 2007. We focus on deals where a ticker is available for the borrower (or the borrower's parent company) in order to merge the data with Compustat firm characteristics and Moodys information on bond defaults. This reduces the available sample from 79054 to 32841 loan deals. Descriptive statistics are shown in Table 1. The average loan size in the 1997–07 period is $623 million, with a loan spread of 185 basis points above LIBOR and a maturity of 44 months. There are 7.9 lenders, on average, forming a syndicate, of which 3.7 are in a lead role (of which, an even fewer number are lead arrangers) and 4.2 take a participant role. Some deals have more than a hundred lenders, with a maximum of 288 participant lenders and two leads on one deal.

The lead bank is defined as the bank recorded in Dealscan under "Lead Arranger", as does Sufi (2007). When there is more than one lead arranger on a deal, we calculate the lead's share as the average. There were up to 9 lead arrangers in our sample. The average share of the loan retained by the lead bank has gone down over time; 27.8% during 1997-07 compared with 30% over the sample. Table 1 also depicts various measures that we think affect monitoring costs. The average borrower in the sample had around 3.4 previous syndicated loans, and for roughly 40% of the deals, the lead bank had been a previous lead for the borrower. Note that when we have more than one lead arranger, the indicator takes the value one when any of the leads was a previous lead. A similar method is used to indicate whether the lead bank is in the same country and state as the borrower (Dealscan reports the geographical location of both). A limitation of the Dealscan data on syndications is that the exposure is recorded at origination of the loan, and does not indicate how this share varies over the duration of the loan. Esty and Megginson (2003) and Gande and Saunders (2006) also state that lead banks rarely sell their loans so as not to negatively affect the relationship with both the borrower and other syndicate participants. This means that the lead bank will not be likely to shirk in the presence of a secondary loan market, even if other syndicate participants exploit the secondary market to reduce their exposure. The Dealscan data is merged with Compustat data for firm-level information, including profits (measured as EBITDA/assets), book leverage and size of assets. We also collect the investment-grade status of a firm from Compustat, which is used as one measure of long run performance. Borrowers and borrowers in industries with more tangible assets and less R&D expenditures will be less risky and opaque. We also posit that older borrowers and industries will be better known and require a lower informational investment. Compustat does not record the date of establishment of a company, so we proxy this using the first year when Compustat records information on a firm. The average age of a firm is roughly 25 years in the 1997–07 Dealscan-Compustat matched dataset.

We finally match Moodys bond defaults with the syndicated loan deals of a borrower. Moody's Default Risk Service Database records historical information on bond ratings and defaults for close to 26000 issuers (as of end-2007 update). Of these issuers, about 1200 record a default. Compustat CUSIP identifiers are recorded for some issuers in Moodys but it is not complete and has numerous errors. Therefore, we cross-checked and hand-matched defaulting issuers with matching firms in Compustat. We ended up with 894 unique defaulting firms (some of the defaulting issuers could not be matched and some issuers matched to the same company in Compustat). After obtaining the unique Compustat identifier, we merged the Moodys data with Dealscan. This resulted in matching only about 200 defaulting firms with 1426 loan deals in the sample (and 922 from 1997-07). A second constraint is that the share retained by the lead bank is not available for all deals in Dealscan as observed in Table 1. This translated into a usable sample of about 115 defaulting firms with information on their lenders' exposure on syndicated deals. We also assume that the remaining firms did not default[8]. Because of these data limitations on tracking defaults to lead bank's exposure at origination, we also run robustness checks on other long run performance measures.

3.5.3 The Lead Bank Makes a Difference

The Likelihood of Borrower Defaults

Table 2 presents probit estimates of our primary equation of interest, relating the share of a syndicated loan held by the lead bank to a borrower's likelihood of default at some point in the future[9]. We express the share retained by the lead bank in logs, as do Focarelli *et al* Focarelli, Pozzolo, and Casolaro (2008). This captures our prior that increases in lead bank share from low exposures are expected to have a greater effect than an increase from high exposures, where a bank is sufficiently incentivised to monitor the borrower. Columns (1) – (5) are meant to be illustrative as they do not control for many loan characteristics. At a first pass, lead bank exposure does not appear to significantly affect the probability that a borrower defaults (column (1)). But lead banks are known to hold a larger share of the loans of riskier and more

[8]Our results would be biased toward finding *no* effect for lead bank exposure if the firms that we assume not to default are contaminated with defaults.

[9]Results in the tables are presented for the last decade, from 1997-2007. Results are qualitatively similar for the period from 1987 when the Dealscan dataset begins, but are overall of a lower statistical significance (available upon request). This could be on account of sampling as more defaults are recorded later in the sample, but a more interesting explanation is that explicit lead bank retention of a borrower's loan has become necessary to incentivise the lead to monitor the borrower. There are implicit ties between banks and borrowers when relationship lending is dominant and the costs of monitoring are low. But as financial intermediation has transitioned from relationship to arm's length banking (see Boot and Thakor, 2000, and Rajan, 2005), the lead bank has to explicitly commit greater funds into the borrower's project to ease agency problems.

opaque borrowers (Sufi Sufi (2007)), who are also expected to default more. We, therefore, include the spread on drawn funds for a loan deal in column (2), which captures the borrower's perceived risk. The loan spread depends on the lead bank share, with the asymmetric information effect pushing down the spread the more the lead bank retains. But the lead bank demands a risk diversification premium, which pushes the spread up. This has plagued the literature relating the spread to the lead bank's share in order to identify the asymmetric information effect (see Ivashina **?**, for a novel instrument of lead bank share). By controlling for the loan spread in column (2), we can isolate whether a lead bank mitigates asymmetric information problems by retaining a greater share of the loan. The coefficient estimate is now significantly negative, providing support for our null that a borrower is less likely to default the greater the share retained by its lead. And the significantly positive coefficient on the loan spread captures the borrower's riskiness and its greater chance of defaulting.

Nonetheless, there may still be some observable risk characteristics at the time of syndication that the loan spread is not fully pricing in. Therefore, the negative effect may simply reflect reverse causality in that a high default probability causes the lead bank to demand a lower share. We control for a number of loan and borrower characteristics in the following columns presented in Table 2. A more convincing test is to instrument the lead bank's retained share with a variable affecting the lead bank's exposure decision but which is not related to the overall riskiness of the borrower. Ivashina **?** constructs two such instruments. One is the contribution of the loan to the credit risk of the lead bank's loan portfolio and the second is a measure of the lead bank's lending limit. For example, a lower lending limit shifts the lead's diversification demand curve inwards, allowing the asymmetric information curve to be identified. We use this instrument, which is empirically proxied by the 75th percentile dollar size of the lead bank's share on its loans in the previous three years[10]. Our prior is that the instrument should help in identifying the asymmetric information effect, rather than working against the effect observed in column (2). This follows from the evidence in, for example,

[10]The credit risk contribution instrument is more difficult to construct and requires information about historical industry default correlations to construct a covariance matrix of the lead's existing loan portfolio.

Sufi Sufi (2007) that lead banks retain a larger share of the loans of riskier borrowers. And least squares regressions of the loan spread on the lead bank share have typically found a positive relationship, suggesting that the dominant effect is the positive association between an increase in the lead bank's share and its credit risk exposure.

The first stage regression is shown in column (3). The lead bank lending limit has the expected positive and significant effect on the share retained. We also include the deal amount, which has a negative effect on the share. Both results are consistent with Ivashina's. We also find that a higher loan spread is positively related to the lead bank's share, confirming our prior. The instrumental variables regression follows in column (4), and it substantiates the existence of asymmetric information. The effect is now economically more significant as shown in column (3) compared with column (5), where the lead share is not instrumented. The coefficients reported are the marginal effects evaluated at the mean of the independent variables (the mean lead bank share is roughly 30%, see Table 1). A marginal increase in the lead bank's share reduces the probability of default by 32% compared with 0.49% when not instrumenting. The economic association between the loan spread and subsequent default is now greater and there is a negative association between the deal amount and default.

We report the results of more rigorous specifications in columns (6) through (8), where we control for year and industry dummies and loan characteristics from Dealscan in column (6) and also include firm characteristics from Compustat in columns (7) and (8). The lead bank share continues to exert a negative influence on the likelihood of default, although it is not significant at standard confidence levels when not instrumented. The instrumental variables estimate is significant at the 10% level, and implies a marginal reduction of about 16% when evaluated at the mean.

Most controls enter with the expected sign. In addition to a higher loan spread at origination being associated with a greater likelihood of a borrower's default, so too are indicators for whether a loan is secured or has a guarantor (though not significant). These measures capture the perceived riskiness of the borrower at the time of syndication, with lenders demanding collateral and guarantees in the event of a default. One surprising result is that rated borrowers are more likely to default, but this turns negative in the instrumental variables probit. The first stage regression reveals that the lead bank holds more of the loans of unrated borrowers, which is consistent with the prior literature describing syndicate structure. We also include indicators for loan purpose type. Firms with higher profitability (as measured by earnings to assets) at the time of syndication are less likely to default, while leveraged firms are more likely to default, but these are not statistically significant. Large firms, as measured by asset size, appear to be significantly associated with a higher likelihood of default but this is not robust to instrumental variables. The first stage regression documents a negative relationship between firm size and lead share. We also control for other factors such as the sales size of the firm at the close of the deal, whether the deal includes a term loan and whether there is more than one tranche on the deal[11] (see Sufi Sufi (2007)). Results are not reported in the interest of space, but none of these measures are significant and the effect of lead bank share is robust to their inclusion[12].

The results presented in Tables 3 explore how factors affecting the costs of monitoring relate to borrower default. We test the hypotheses we outlined above in Section 3.5.1. We expect the cost of monitoring to be lower for a lead bank that was a lead on one of a borrower's previous syndications. This is shown to be the case in column (1) of Table 3. Borrowers that are better known because they have previously borrowed in the syndicated market are not found to be less likely to default (the coefficient on the number of previous loans is significantly positive). Column (2) looks at the lead bank's reputation and how much informational investment it has made in the borrower's industry. Borrowers with more reputable leads are less likely to default (reputation is proxied by the lead bank's market share in the previous year as in Sufi Sufi (2007)). The cost of monitoring is expected to fall the more the lead has lent to borrowers in the same industry, and there is evidence to support this hypothesis. And the likelihood of a borrower defaulting is less when there are more borrowers in the same industry. This indicates that these borrowers are easier to monitor overall, regardless of the lead bank's information, because

[11] Results are also robust to including equity returns, market to book ratio, sales growth, tangible assets, age, a dummy for investment grade and industry dummies based on Compustat data.

[12] We don't include an indicator of senior loans because over 95% of the syndicated deals have senior status.

they are in better known industries by other syndicate lenders.

We examine other elements influencing the cost of monitoring in column (3). All borrowers in the sample are based in the US, but lead banks can be based outside the US. We find that when the lead bank is also located in the US, the probability of default decreases by 2%. Borrowers sharing the same state as their lead bank are also less likely to default but the result is not robust to including state dummies. Loans syndicated during upturns in the business cycle are more likely to default. But this effect is mitigated when a lead retains a greater stake in the borrower on loans syndicated during booms (column (5)). The instrumental variables probit is in column (7), where we include all these measures jointly. Significant cost measures are the lead's reputation, industry distance, and whether it was a previous lead for the borrower. Interestingly, the same country dummy and GDP growth at the time of syndication are no longer significant. However, they contribute indirectly to the lead bank's share: the lead keeps a greater interest in borrowers in their country and keeps less during upturns.

Long Run Profitability and the Likelihood of Investment Grade Status

In this section we turn to other measures of borrower performance in the long run as a robustness check on our results for defaults. As mentioned earlier, the matched default sample is a limited one. Moreover, default events may be endogenous in that they depend on the negotiation between the creditors and the firm. For example, when there are fewer lenders and the lead bank has a higher share, publicly observable default may be less likely because of private workouts and loan renegotiations. It is a mitigated concern in our study because we use bond defaults and bondholders are typically dispersed creditors. But it is important to test whether our hypothesis holds for a broader set of long-run borrower performance. Specifically, we focus on return on assets (EBITDA/assets) three years after syndication as well as the likelihood that the firm is rated investment grade, presenting results in Tables 4 – 6. As with previous regressions, we control for loan, firm characteristics and industry and year dummies. It is also important to control for the long run performance of comparable firms. We do this by including the borrower's industry median firm ROA three years after syndication. As expected, both the borrower's ROA at the time of syndication and the industry's long run performance are positively associated with higher ROA for the borrower. But column (1) of Table 4 shows that the share retained by the lead bank does not appear to positively influence return on assets (ROA) three years on. We instrument the lead share with the lead's lending limit in column (2) and the effect is now positively significant at the 10% level: a higher lead share improves long run profitability. The coefficient estimate implies that an increase in the lead share from the 25th to the 75th percentile improves the borrower's future performance by 0.08, all else fixed.

Theory also suggests that the lead bank's interest matters most for firms needing higher monitoring effort. We, therefore, ask whether the lead bank matters for improving the profitability of poorly performing borrowers. And we find support for this hypothesis in column (3): the coefficient on the interaction of a borrower's ROA at the time of syndication with its lead bank share is significantly negative, so that lead exposure (and presumably, its monitoring) is more important for weaker firms. The coefficient on the lead bank's share now enters with a significantly positive sign[13]. The negative coefficient on the interaction term means that a lead bank, holding the average lead share, will increase the future ROA of a firm starting out at the 25th percentile of ROA by 0.02 more than a firm starting out at the 75th percentile of ROA, all else fixed[14]. This is quantitatively large when comparing with an average ROA of 0.115 in this period. A similar result is obtained for the number of leads. A higher number of lead banks hurts the future performance of all firms (and not just the worst performing ones at the time of syndication). But as with the results for lead bank exposure, the impact is greater on firms with poor operating performance. For example, an increase in the number of banks in a lead role from the 25th to the 75th percentile (i.e., from 1 to 4 banks) on average worsens future ROA by 0.0012 (column (4)). But this increase ad-

[13] The results are robust to instrumenting the lead bank share in the interaction specification.

[14] Note that the average lead share in the period from 1997 to 2007 was equal to 27.8% (or 3.02 in logs). And the 25th percentile for ROA was 0.077 compared with 0.164 for the 75th percentile ROA. Therefore the differential effect is equal to $-0.0825 \times (3.02) \times (0.077 - 0.164) = 0.022$.

versely affects the ROA of a poorly performing borrower by 0.0068 more than a strong one (based on the interaction term in column (5)).

Table 5 relates the cost of monitoring proxies to the borrower's profitability. As with the results on borrower defaults, profitability is positively affected by the lead bank's reputation (column(2)) and if the lead bank is also based in the US (column (3)). And borrowers who took out loans originated during booms perform worse in the future, controlling for GDP growth three years on (column (4)). We also find that this adverse effect is offset when the lead bank takes a greater stake in the loan during upturns, as shown in column (5). The coefficient on the interaction of lead bank share with year-on-year GDP growth at the time of syndication is positive, though not significant at standard confidence levels. The same-country dummy and GDP growth at the time of syndication are no longer significant when instrumenting the lead bank share (column (7)), but these two variables affect the lead bank's retained share, consistent with the results of the default probits. The instrumented lead share coefficient is 0.065, which compares with the coefficient in Table 4 (column (2)) and is statistically significant at the 10% level.

The next set of results are shown in Table 6, and these take the form of probit estimations for whether a borrower has an investment-grade rating status three years after syndication (based on Compustat rating information: data280). And these, too, support the conclusion that lead bank exposure matters for the borrower's future performance, as summarised by its rating. A marginal increase in the lead bank's share raises the probability that a borrower will have an investment-grade rating in the future by 16% (on a mean of 57.9%). We also control for borrower's investment-grade status at the time of syndication, and the share of firms in the borrower's industry that are investment grade three years later. Note that the instrumented lead bank share has a positive effect but is not statistically significant at standard confidence levels (column (2)). It is however significant at the 10% level over the full sample from 1987.

Lead bank exposure does not appear to be more important for subinvestment-grade borrowers compared with investment-grade borrowers (the interaction term in column (3) is not significant). In line with previous results, it is the number of leads and not the number of participants that matters. The greater the number of leads, the worse off is the borrower, and its magnitude is strengthened when controlling for the average share held by lead banks (column (4)). The signs on the dummy for same country and for GDP growth are aligned with our earlier results, but are not statistically significant. Other measures of monitoring (not reported) are also insignificant with the exception of previous loans which enters positively.

The results are robust to controlling for the rating dummies in the year of syndication. These are nine rating dummies for AAA, AA,..., D. Degrees of freedom are reduced but the marginal effect on the lead bank share is roughly unchanged (equal to 14%). The coefficient on the lead share is also unchanged when we re-estimate the instrumental variables regression for profitability in Table 4, column(2) but including rating dummies (the sample of observations is reduced to 1050 compared with the original 1775). The coefficient remains 0.07 and is significant at the 10% level. A similar result holds when re-estimating the interaction of lead bank share with firm profitability (Table 4, column (3)). The lead's effect on the likelihood of borrower default is also robust (the instrumental variables effect in Table 2, column (8) remains 15% and even the non-IV effect is statistically significant and equal to 0.56%).

Equity Market Reaction to the Announcement of a Syndicated Loan

In this section, we focus on the short run response of the equity market to a loan syndication. The results are tabulated in Table 7. The market reacts more positively to news of loan syndications in which the lead bank retains a greater share of the loan. We take the loan announcement date to be the earliest of the set of dates recorded in Dealscan (these are deal active, completion, deal input, closed and launch dates) following Saunders and Gande **?**. We then calculate abnormal returns in the event window as $AR_{jt} = R_{jt} - (\hat{\alpha} + \hat{\beta} R_{mt})$, where R_{jt} is the rate of return for the stock of borrower $j$on day t, and R_{mt} is the rate of return on CRSP's dividend-inclusive value-weighted market index (of NYSE, AMEX, and NASDAQ stocks) on day t, which is the market return also used by Saunders and Gande **?**. We generate estimates for α and β by regressing R_{jt} on R_{mt} in the period $T_0 - 150$ to $T_0 - 30$, where T_0 is the announcement date in the daily CRSP sample spanning 1997 to 2006. The regressions reported in Table 7 present the results for abnormal returns on the day after the syndication announcement, which elicit the greatest response (as in Focarelli *et al* Focarelli, Pozzolo, and Casolaro (2008), and Saunders and Gande **?**)[15].

The coefficient on the lead bank's share in column (1) is statistically significant at the 1% level and equals 0.19%, implying that a bank retaining the 75th percentile share has a 0.226% higher abnormal return the day after the syndication announcement compared with a bank retaining the 25th percentile[16]. The magnitude of this coefficient is unchanged and is statistically significant at the 5% level when firm controls are included. These are profitability, leverage, and size as in the previous tables. They are lagged to ensure that there is no contemporaneous correlation with equity returns, but this is not material. The results, therefore, provide more evidence in favour of the ameliorating influence of lead bank exposure on a borrower's performance. And this positive effect is priced in by equityholders at the time a syndication is announced. The results are also in line with those of Focarelli *et al* Focarelli, Pozzolo, and Casolaro (2008) who document a similar result for their sample of borrowers from over 80 countries. They find a somewhat larger effect, but this would be natural in a sample of firms that include many from outside the US, where opacity problems are expected to be greater[17]. The results also resonate with the classic results of James (1987) and Lummer and McConnell (1989) who find support for the specialness of bank loans.

Other measures influencing the cost of monitoring that we explored earlier are not associated with a significant equity response[18]. While there is a posi-

[15]Regressions are also estimated after trimming the top and bottom 5% of the dependent variable (these are -4.5% and 5.1% abnormal returns; similar results are obtained when trimming the top and bottom 2.5%). This is to avoid results driven by outliers in the dependent, which vary greatly as observed in Table 1 (mean abnormal returns are 0.126%, with a range from -38% to 77%). For example, the number of participants appears to have a strong significant negative effect on abnormal returns (but not the number of leads), but this effect is not robust to removing these outliers.

[16]The 75th percentile of lead bank share during the 1997-2007 sample is 36.7% (3.596 in logs) compared with 11.1% (2.407 in logs) for the lead bank share at the 25th percentile (see Table 1). The comparative effect is therefore, $0.0019 \times (3.596 - 2.407) = 0.00226$.

[17]Further, they allow the standard errors of loans to be correlated for all borrowers in the same country. But it is important to cluster standard errors not only on the country but also on all the loans by the same borrower. Therefore, our results provide additional support for a statistically significant effect.

[18]These results are not reported in the interest of space, but are available upon request.

tive response when the lead lender is in the same country as the borrower (or same state) and there is a negative response during boom times, these results are not significant at standard confidence levels. The lead bank's reputation does not elicit a positive response, indeed, the coefficient is negative albeit insignificant. Industry characteristics influencing expected project returns and costs of monitoring generally enter with the expected signs but are also insignificant. Borrowers with a higher number of previous syndicated loans have a positive equity response. More interestingly, lead banks taking a greater stake in borrowers with few previous loans draw out a more positive equity market reaction. For example, the coefficient on the lead bank share increases from 0.18% to 0.22% when narrowing the sample to those borrowers with at most one previous loan in the syndicated market. This highlights the importance of lead bank exposure for less known borrowers. This is mirrored in the results for unrated firms. The coefficient on lead bank share for unrated borrowers rises to 0.33% in column (3) compared with only 0.09% for rated borrowers (rated borrowers elicit 0.91% higher abnormal returns, regardless of lead bank interest).

Finally, a higher number of leads elicits a negative equity market reaction, as shown in column (4). These results are significant at standard levels of significance when proxying syndicate concentration with a Herfindahl index, which enters with the expected positive sign. When controlling for the lead bank share or the Herfindahl index, the negative reaction to the number of leads is greater and implies a 0.02% lower abnormal return when the number of leads increases by one bank. As with borrower defaults, it is the number of leads that matters and not the number of participants, which is line with the theory that uninformed participants rely on lead banks to carry out ex ante due diligence and monitor the borrower.

3.6 Conclusion

We uncover evidence of information asymmetry in the syndicated lending market, in a manner consistent with the theoretical framework outlined in Section 3 and the related theory on agency problems. Borrower performance depends on lead banks and *not* uninformed participant banks. Moreover, what matters is the lead bank's exposure to the borrower, so that the lender applies higher monitoring effort when its capital at stake is greater.

It is likely that other credit dispersion and transfer markets will be more prone to information failures, both stemming from moral hazard and adverse selection. Markets such as securitisations and CDS are more opaque and anonymous, although there are recent proposals to restructure the CDS markets to an exchange-traded system. For example, Downing *et al* **?** find a lemons problem in the mortgage-backed securities market. The underlying pools chosen to back multi-class securities produce lower rates of return compared with those selected for single-class securities.

The focus of the empirical section was on exposing whether and how monitoring effort improved project return. This should also produce a higher secondary market price, and in particular for those loans whose returns are more sensitive to the lender's monitoring effort and are less prone to private information use. An additional implication of the Plantin and Parlour model is that banks with more outside opportunities (i.e. those hit with liquidity shocks) will be less likely to sell because of private information. And they illustrate with how a CDS market develops endogenously as banks are faced with tighter capital or liquidity constraints, such as when Basel 1 was introduced. We did not analyse bank characteristics[19] formally to test these ideas. But one insight from this theory relates to how banks' funding constraints vary over the business cycle. If boom times are times when outside opportunities are greatest, then the secondary market price should be also be higher. But good times will also be associated with a higher cost of monitoring and therefore a lower price. The empirical evidence in Section 4 leans in favour of the latter view, but this merits more research. A related extension for future research is to examine the choice of funding over the cycle. Although participant banks do not take an active role in monitoring it would be reasonable to assume that they also face similar capital or liquidity constraints, or good outside options during boom times. In which case it would be expected that a lead bank does not syndicate the loan but rather underwrites a bond issue which is sold to outside investors. This is not explored in the model, nor is

[19]With the exception of taking advantage of the geographical location of banks in the Dealscan data set.

it accounted for in the empirical section as we only use data from syndicated loans.

In future work we intend to explore the sustainability of selling lemons in the presence of private information by the banks. We expect to see some switching and jumps in the secondary market, as we move across regimes of 'monitoring' and 'not monitoring'. This was illustrated for the sub-prime case in the introduction, and should be relevant for earlier events like Enron. The response to a credit event should be greater for those firms affected. We also expect it to be more for firms with the same bankers as the affected firms, as it is the bank that loses its certification ability, not the firm. Unfortunately, given the current turbulence in the CDS and secondary loan markets this is not immediately viable. In a syndicated loan setting a potential research avenue is to investigate the effect of a default by a firm on the lead bank's ability to syndicate future loans, both in terms of the price effects on future loans but also in the effect of syndicate composition.

It is important to finally emphasise that while the adverse effects of credit dispersion and secondary markets have taken center stage in this paper, this does not mean they are welfare-reducing. After all, these credit risk-sharing markets provide a form of valuable insurance for lenders as it frees up capital and enables credit expansion. This increases access to finance for firms. Rajan, nonetheless, offers a nuanced perspective on why financial developments may not have made the world safer. He argues that while banks are retaining first-loss positions (limiting moral hazard) and off-loading "plain vanilla" risks to outsiders (limiting adverse selection), they are specialising in their comparative advantage, which is in illiquid transactions. Moreover, they may be engaging in excessive risk taking because of managerial incentives to take on tail risk and herd with other managers.

Bibliography

ACHARYA, V. V., AND T. YORULMAZER (2007): "Too many to fail–An analysis of time-inconsistency in bank closure policies," *Journal of Financial Intermediation*, 16(1), 1–31.

ADELSON, M., AND D. JACOB (2008): "The Sub-prime Problem: Causes and Lessons," *Journal of Structured Finance*.

AKERLOF, G. A. (1970): "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism," *The Quarterly Journal of Economics*, 84(3), 488–500.

ALLEN, F., AND D. GALE (????): "Bubbles and Crises," Discussion paper.

ALLEN, F., AND D. GALE (2007): *Understanding Financial Crises*. Clarendon Lectures in Finance.

ALTUNBAS, Y., L. GAMBACORTA, AND D. MARQUÉS (2007): "Securitisation and the bank lending channel," Working Paper Series 838, European Central Bank.

ASHCRAFT, A. B., AND T. SCHUERMANN (2008): "Understanding the Securitization of Subprime Mortgage Credit," *SSRN eLibrary*.

BAGEHOT, W. (1873): *Lombard Street: A Description of the Money Market*. Henry S. King and Co.,, 14 edn.

BHARDWAJ, G., AND R. SENGUPTA (2008): ""Where's the Smoking Gun? A Study of Underwriting Standards for US Subprime Mortgages"," *St. Louis Fed Working Paper*.

BOYD, J. H., AND G. D. NICOLÃ (2005): "The Theory of Bank Risk Taking and Competition Revisited," *Journal of Finance*, 60(3), 1329–1343.

Carletti, E., V. Cerasi, and S. Daltung (2007): "Multiple-bank lending: diversification and free-riding in monitoring," *Journal of Financial Intermediation*, (20061103), available at http://ideas.repec.org/p/mis/wpaper/20061103.html.

Dell'Ariccia, G., D. Igan, and L. A. Laeven (2008): "Credit Booms and Lending Standards: Evidence from the Subprime Mortgage Market," *SSRN eLibrary*.

Demyanyk, Y., and O. Van Hemert (2008): "Understanding the Subprime Mortgage Crisis," *SSRN eLibrary*.

Dennis, S. A., and D. J. Mullineaux (2000): "Syndicated Loans," *Journal of Financial Intermediation*, 9(4), 404–426.

Dewatripont, M., and E. Maskin (1995): "Credit and Efficiency in Centralized and Decentralized Economies," *Review of Economic Studies*, 62(4), 541–55.

Diamond, D. W. (1984): "Financial Intermediation and Delegated Monitoring," *Review of Economic Studies*, 51(3), 393–414.

Diamond, D. W., and P. H. Dybvig (1983): "Bank Runs, Deposit Insurance, and Liquidity," *Journal of Political Economy*, 91(3), 401–19.

Duffee, G. R., and C. Zhou (2001): "Credit derivatives in banking: Useful tools for managing risk?," *Journal of Monetary Economics*, 48(1), 25–54.

Esty, B. C., and W. L. Megginson (2003): "Creditor Rights, Enforcement, and Debt Ownership Structure: Evidence from the Global Syndicated Loan Market," *The Journal of Financial and Quantitative Analysis*, 38(1), 37–59.

et al., R. (2005): "Support Ratings and the Rating of Bank Hybrid Capital and Preferred Stock," Discussion paper, Fitch Ratings.

Focarelli, D., A. F. Pozzolo, and L. Casolaro (2008): "The pricing effect of certification on syndicated loans," *Journal of Monetary Economics*, 55(2), 335–349.

Forbes (2008): "Bad News for the Bailout," *Forbes*.

Frank J. Fabozzi, Laurie S. Goodman, S. L. D. J. L. T. A. Z. (2008): *Subprime Mortgage Credit Derivatives*. Wiley Finance.

Freixas, X., and J.-C. Rochet (1997): *Microeconomics of Banking*. MIT Press.

Gande, and Saunders (2006): "Are banks still special when there is a secondary market for loans?," .

Goodhart, C. A. E. (????): "Myths about the Lender of Last Resort," *Financial Markets Group Special Papers Series*.

Gorton, G. B. (2008): "The Subprime Panic," *SSRN eLibrary*.

Gorton, G. B., and G. G. Pennacchi (1995a): "Banks and loan sales Marketing nonmarketable assets," *Journal of Monetary Economics*, 35(3), 389–411, available at http://ideas.repec.org/a/eee/moneco/v35y1995i3p389-411.html.

——— (1995b): "Banks and loan sales Marketing nonmarketable assets," *Journal of Monetary Economics*, 35(3), 389–411, available at http://ideas.repec.org/a/eee/moneco/v35y1995i3p389-411.html.

Himmelberg, C., C. Mayer, and T. Sinai (2005): "Assessing High House Prices: Bubbles, Fundamentals and Misperceptions," *Journal of Economic Perspectives*, 19(4), 67–92.

Hoggarth, Saporta, R. (2001): "Costs of banking system instability: some empirical evidence," *Financial Stability Review*.

Holmstrom, B., and J. Tirole (1997a): "Financial Intermediation, Loanable Funds, and the Real Sector," *The Quarterly Journal of Economics*, 112(3), 663–91, available at http://ideas.repec.org/a/tpr/qjecon/v112y1997i3p663-91.html.

——— (1997b): "Financial Intermediation, Loanable Funds, and the Real Sector," *The Quarterly Journal of Economics*, 112(3), 663–91, available at http://ideas.repec.org/a/tpr/qjecon/v112y1997i3p663-91.html.

Honohan, P., and D. Klingebiel (2000): "Controlling the fiscal costs of banking crises," Policy Research Working Paper Series 2441, The World Bank.

Ivashina, V. (2009): "Asymmetric Information Effects on Loan Spreads," *Journal of Financial Economics*.

James, C. (1991): "The Losses realized in Bank Failures," *Journal of Finance*, 46(4), 1223–42.

Jones, J. D., W. W. Lang, and P. Nigro (2001): "Recent trends in bank loan syndications: evidence for 1995-1999," *Proceedings*, (May), 328–352.

Julliard, C. (2008): "Money Illusion and Housing Frenzies," *Review of Financial Studies*, 21(1), 135–180.

Laeven, L. A., and F. V. Valencia (2008): "Systemic Banking Crises: A New Database," *SSRN eLibrary*.

Levi-Yeyati, C. . (2003): "Bank bailouts: moral hazard vs. value effect," *Journal of Financial Intermediation*, 12, 300–330.

Mayer, C. J., and K. Pence (2008): "Subprime Mortgages: What, Where, and to Whom?," NBER Working Papers 14083, National Bureau of Economic Research, Inc.

Mian, A. R., and A. Sufi (2008): "The Consequences of Mortgage Credit Expansion: Evidence from the 2007 Mortgage Default Crisis," *SSRN eLibrary*.

Morrison, A. (2001): "Credit Derivatives, Disintermediation and Investment Decisions," *SSRN eLibrary*.

Myers, S. C., and N. S. Majluf (1984): "Corporate Financing and Investment Decisions When Firms Have InformationThat Investors Do Not Have," *Journal of Financial Economics*, (1396).

of England, B. (2007): "Financial Stability Review," Discussion paper, Bank of England.

PARLOUR, C. A., AND G. PLANTIN (2008a): "Loan Sales and Relationship Banking," *Journal of Finance*, 63(3), 1291–1314.

——— (2008b): "Loan Sales and Relationship Banking," *Journal of Finance*, 63(3), 1291–1314.

SCHUMPETER, J. (1939): *Business Cycles*.

SHILLER, R. J. (2005): *Irrational Exuberance*. Princeton University Press.

——— (2007): "Understanding Recent Trends in House Prices and Home Ownership," NBER Working Papers 13553, National Bureau of Economic Research, Inc.

SUFI, A. (2007): "Information Asymmetry and Financing Arrangements: Evidence from Syndicated Loans," *Journal of Finance*, 62(2), 629–668, available at http://ideas.repec.org/a/bla/jfinan/v62y2007i2p629-668.html.

SWAGEL, P. (2009): "The Financial Crisis: An Inside View," Discussion paper, Brookings Papers on Economic Activity.

VIG, E. A. (2008): "Did Securitization Lead to Lax Screening? Evidence from Subprime Loans 2001-2006," *SSRN eLibrary*.

Appendix to chapter I

.0.1 Other potential funding sources for the bank

In the main text it has been assumed that the bank chooses to sell its mortgage loans. The financial innovation occurs but discussion was limited as to why it would be useful, given that banks have historically had other financing options available. As is common in finance theory all suffer from either an asymmetric information problem, or the bank has to pay a higher interest rate on the funding received than it would from financing from uninformed investors.

Deposits are generally inelastic, and usually require a positive return. Whilst the bank may be a considerable player in the mortgage market, its ability to raise new deposits in the middle period may be limited. Although this is not explicitly modeled in the paper a deposit contract is subject to the risk that a depositor has the contractual right to withdraw her funds at any time. One of the original motivations for mortgage loan sales is to make the bank's job of liquidity management easier. An alternative interpretation of the shock in the middle period is that the bank needs to free up its funds to satisfy a demand for withdrawals - i.e. it is suffering a liquidity shock, which is a potential reason why taking in more deposits may not be feasible. If the bank raises more deposits in the first period, in the model without 'financial innovation' then the optimal solution is to store these into the second period.

Other banks may be potentially be considered informed investors. In the model has, by assumption, a problem communicating the 'soft information' to non-bank investors. However, this may not be the case when dealing with other banks. Selling the portfolio to other banks may be an option. However, other banks may also have outside opportunities to use their funds and require a positive expected return on the loans to buy them. This can potentially reduce the price below that offered by uninformed investors. In the case of symmetric banks (or at least when all banks k have an expectation of $\delta_k \in (0, \delta_k^*]$ i.e. that they will use secondary mortgage markets, they have no funds with which to purchase the other banks' loans. Interbank lending is feasible in the model of traditional banking. I posit the solution will be that all banks will lend to the bank with the best outside option (who will pay an interest rate equal to the bank with the second best outside option). However, as mentioned above the financial innovation of loan sales means that the interbank market breaks down.[20] In reality interbank lending is unsecured and short term, which makes it immediately more expensive. From a pure regulatory perspective the retained securitisation positions held by originating banks benefit from a cap on the maximum amount of capital required to be held, but this cap is not available for securitization exposures purchased by investing banks. Non-bank investors are also not required to hold this capital.

A secured loan secured on the bank's assets - interest rate will be conditional on the expectation of the mortgage loans paying off. A loan is typically made by one party, although in the model the non-bank investors are risk neutral and have deep pockets there are reasons why in reality an investor may not choose to be exposed to such a large degree to one particular bank. An alternative representation for non-bank investors would have been a similarly standard market based finance where there are infinite non-bank investors but each with 1 unit of funds to invest. This would automatically shut down to possibility of a loan to the bank.

Equity - the bank's situation closely mirrors the classic Myers and Majluf (1984) case where issuing shares at a bargain price may outweigh the NPV of the investment opportunity as the bank has inside information. Although inside information is a problem in the asymmetric information loan sales case, in the situation where house prices are high and interest rates are low, the level of asymmetry is also low.

[20] Possibly they would sell their mortgage loans to invest in each other's portfolios

.0.2 Technical aspects of the bank's optimisation problem

This section is a discussion of the bank's optimisation problem, looking at some of the constraints, and providing an intuitive look at the solution.

$$\max_{M,B} \left(p(1+r_m(M)) + (1-p)\frac{1+E(g)}{(1-\alpha)} \right) M + BE(1+\rho) \qquad (.0.1)$$

$$D \geq B + M \qquad (.0.2)$$

$$M = M(r_m) \qquad (.0.3)$$

$$B \geq 0 \qquad (.0.4)$$

$$M \geq 0 \qquad (.0.5)$$

Rewrite $\left(p(1+r_m(M)) + (1-p)\frac{1+E(g)}{(1-\alpha)} \right) M$ as $g(M)$ As a 'monopolist' the bank can either choose the price R or the quantity M in the mortgage market. As the principal interest in this model is the bank's portfolio allocation I do the maximisation with respect to B and M.

First order conditions are:

$$E(1+\rho) + \mu = \lambda \qquad (.0.6)$$

and

$$g'(M) + \nu = \lambda \qquad (.0.7)$$

If demand for mortgages is not 'too' downward sloping, then $g(r_m, M)$ has the usual properties i.e. $g(0) = 0$, $g'(M) > 0, g''(F) < 0$. If $g'(0) = \infty$ then constraint .0.5 will never bind (i.e. the bank never wants to make negative mortgage lending as part of its optimal decision i.e. $\nu = 0$). It is possible that this condition does not hold especially in very risky populations, i.e. there is no r_m such that $p(1+r_m)L + (1-p)H > LE(1+\rho)$[21] i.e. the loan is profitable

[21] as the one borrower i gets the entire housing stock

and $U_{i=0} > \underline{U}_{i=0}$ even the most enthusiastic borrower does not want to enter the contract. As $E(1+\rho) > 1$ then constraint (.0.2) will always bind (i.e. λ is strictly positive): the bank makes profits in expectation from investing in the second period, and these profits are not subject to diminishing returns. As a result having more funds to invest will always result in higher expected profits. Combining (.0.6) and (.0.7) we get $g'(M) = E(1+\rho) + \mu$. For a corner solution then $\mu > 0$, which can be interpreted as mortgage lending is so profitable at the margin that the bank would like to lend all of its funds out as mortgage loans and forego the expected opportunities in the second period. In the paper I have assumed (because it is the interesting case, to compare with the introduction of a market for loan sales) that the solution is the interior solution i.e. $\mu = 0$. Note that the corner solution when the bank has access to a loan sale technology is a necessary outcome of the model and explicitly *not* an assumption. Optimal M, for the interior solution, is just found by $g'^{inv}(M)\Big|_{g'=E(1+\rho)}$. As $g(M)$ is monotonically increasing and concave as $E(1+\rho)$ increases then M^* decreases.

.0.3 A simple securitisation

Securitisation increased in popularity partly due to the 1988 Basel Capital Accord (the 1988 Accord), whereby banks were able to decrease their regulatory capital requirements through securitisation techniques but without reducing the economic risk. This immediately gave banks an incentive to sell off their loan portfolio. As a 'Special Purpose Vehicle' (SPV) is not a bank it is not subject to Basel I rules. Figure 1 illustrates a simplified securitisation. The bank (originator) of the loans 'sells' the loans to the SPV, and any income stream from the loans becomes 'remote' from the bank. The stream of income from the mortgage loans is effectively 'ring-fenced' by the issuer i.e. isolated from any outside risk and appropriation. This protects investors from bankruptcy of the bank but also protects the bank from losses on the mortgage loans that it sold. The SPV is responsible for issuing and structuring securities backed by the loans and selling them to investors.

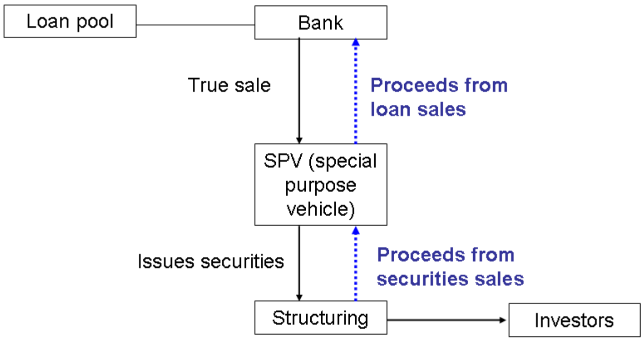


Figure 1: The process of securitisation, ensuring the pledgability of payments on the mortgages

.0.4 Consumers

As the main focus of interest in this paper is the interaction between banks and secondary markets the borrower problem is deliberately kept as simple as possible. When a bank makes a mortgage loan it is for the *specific* purpose of buying a house, and the borrower cannot spend the funds elsewhere. By assumption consumers only have potential access to bank finance, and any cash balance that they may have. This simplifies the welfare analysis as all funding, and therefore utility is determined by the interest rate offered by the bank, and the amount of housing received.[22]

Borrowers

All consumers are assumed to be identical in terms of preferences, utility function, probability of success in a project and initial cash balances. As the focus of this model is on the quantity of funds being lent and the private information

[22]This assumption is not microfounded in this model, but can easily be explained by high transaction costs in raising 'outside' finance e.g. from the bond market, especially when compared to the relatively small size of the loan.

problem between banks and non-bank investors in the model, borrowers differ *only* in their outside option U_i. There is a continuum of consumers indexed by i ordered in terms of their outside option, who may choose to be borrowers, with mass 1 , $i \in (0,1)$. A representative consumer is deliberately not used in this model, to avoid allowing the bank to extract the entire consumer surplus. The difference in the outside option is to allow the model to be tractable and to pin down an optimal contract between the bank and consumers; and to allow something to be derived about the level of credit extended.

Consumers derive utility from consumption goods $U(Consumption)$ and from housing, denoted by $V(X)$. Utility is additively separable in housing and consumption goods. Consumption goods are either are purchased from income I after the loan repayment $L(1+r_m)$ has been paid, or from income I and cash c if the consumer does not enter the loan contract. Consumers all have the same income I in the third period with probability p. To keep the focus on aggregate shocks I assume that the consumers either *all* fail or succeed together. In the context of the housing model, the projects can be thought of as consumers with identical jobs but with probability $1-p$ they loose their job and have insufficient income to pay the debt. The contract is a standard debt contract with payment of R in the case of the loan being repaid and sale and recovery of the purchased house if the consumer defaults.

Consumers also differ in deriving disutility if they enter the loan contract and default as it aversely affects their credit rating. This can equivalently be represented as utility of keeping their current credit record. This is the only source of heterogeneity amongst consumers and is denoted by Φ_i. To stop the bank extracting all the consumer surplus this Φ_i is assumed to be private information.

A consumer's expected utility if he enters the contract:

$$p\left(U(I-L(1+r_m))+V(X)\right)+(1-p)\left(U(0)+V(0)\right) \tag{.0.8}$$

A consumer's expected utility if he does not accept the offered contract:

$$p\left(U(I+c)+V(0)+\right)+(1-p)\left(U(c)+V(0)\right)+\Phi_i=\underline{U_i} \tag{.0.9}$$

A consumer will enter the contract if (.0.8) $\geq$ (.0.9), that is their participation constraint is satisfied:

$$p\left(U(I - L(1 + r_m)) + V(X)\right) + (1 - p)\left(U(0) + V(0)\right) \geq \quad (.0.10)$$
$$p\left(U(I + c) + V(0)+\right) + (1 - p)\left(U(c) + V(0)\right) + \Phi_i \quad (.0.11)$$

which immediately gives a downward sloping demand curve for repaying loans. Due to identical preferences (besides the utility of maintaining the credit rating) and the inability of the bank to discriminate all loan contracts and consumption of goods and housing will be the same in equilibrium and the utility of all borrowers who accept the contract will have the same utility as the indifferent borrower: for whom (.0.10) holds with strict equality. The indifferent borrower is denoted by $\widetilde{i}$, with utility $\underline{U_{\widetilde{i}}}$. $\widetilde{i}$ is a function of $L(1 + r_m), X$.

The homogeneity assumption of the probability of success is not crucial for the analysis but adding extra layers of heterogeneity complicates the analysis without adding meaningful insights. This is further discussed in the appendix in section .0.5.

Borrower utility is higher with secondary markets

Proposition .0.1 $U_{sm} \geq U_{nosm}$ *i.e. borrower utility is increased when secondary markets are introduced.*

Proof From the borrower's participation constraint (.0.10) it is is clear that all borrowers, who accept the contract, have the same utility; which is equal to the reservation utility of the indifferent borrower $\underline{U_{\widetilde{i}}}$. With no secondary markets $R = R_{nosm}$ and all borrowers have utility $\underline{U_{\widetilde{i}_{nosm}}}$. When secondary markets emerge $L(1 + r_m)_{sm} < L(1 + r_m)_{nosm}$ and borrowers who previously did not enter the contract borrow from the bank. $\widetilde{i}_{sm} > \widetilde{i}_{nosm}$ and therefore $\underline{U_{\widetilde{i}_{nosm}}} < \underline{U_{\widetilde{i}_{sm}}}$. All borrowers accepting the contract have the same utility $\underline{U_{\widetilde{i}}}$ and are better off after secondary markets are introduced. Consumers who do not enter the contract do so because their participation constraint is not satisfied and so their utility is unaffected by the introduction of secondary markets. Welfare is therefore increased for all consumers.

.0.5 The importance of aggregate shocks and aggregate private information

The model has concentrated on the issue of a simple aggregate shock with borrowers which all have the same probability of success but there is an aggregate shock to their success. Although buying a diversified pool of loans protects against idiosyncratic risk it cannot protect against any aggregate shocks to the pool of loans. The model can be extended to allow borrowers to be heterogeneous in the probability of success but without adding significant insights to the main results; although there are interesting implications for how to structure the sale and a potential source of market failure.

If the bank knows perfectly the exact probability of each borrower p_i and loan buyers know the distribution of borrowers in the population and the number of loans made the outcome here is the same as the full information outcome. Buyers know that loans will be sold in order of their expected return and there is a 1-to-1 mapping of the loan sold and the expected return on the loan; effectively recovering the full-information outcome.
As a simple example: if loans are revealed to be either of type $\underline{p}$ with probability α or $\overline{p}$ with probability $1 - \alpha$ then: the first α proportion of loans will be sold at a price $\underline{p}$ and the remainder at price $\overline{p}$. Selling a bundle of loans leads to a price equal to the average expected payoff of the loans. The price is increasing in the fraction (and therefore quantity of loans sold). Effectively the bank faces an upwards facing demand curve in the quantity & fraction of loans sold. However, there is a potential source of failure in this market if the bank actually originates and 'pretends to distribute' and sells loans to itself, for example if it sells to an investment vehicle that is bank owned.

If idiosyncratic defaults are the source of adverse selection between banks and loan buyers it does not inhibit loan sales but infact *forces* the bank to sell more of its loans. One of the conventional explanations why banks would historically not sell their loans was because loan buyers would know that a bank will sell its worst loans first.

In this model the investors are risk neutral and identical. In which case only the *expected* return on securities is important. This implies that a meanpreserving shock to the *shape* of the distribution does not alter the overall price paid for the entire bundle of securities, but can affect particular tranches. When loan sales are 'structured' into tranches they are typically not backed by a particular loan but by an ordering of payments in the entire pool of loans. A lack of trading and therefore illiquidity is effectively 'built in' to the structure.

Appendix to Chapter II

.1 Liquidity choice: First order conditions

No Central Bank but banks have charter values

If there is no Central Bank/Lender of Last Resort then: $s = p$ and $\xi(\theta_i)*$=1 (there is no point in incurring the cost)

Bank's problem becomes:

$$max_{\theta_i,p} V = \frac{\mu p(x-r) - \phi(p)}{1 - \delta\mu p} \tag{.1.1}$$

FOC's

$$\frac{1}{(1-\delta\mu p)^2}[(1-\delta\mu p)(\mu(x-r)-\phi'(p)) + (\mu p(x-r) - \phi(p))\delta\mu] = 0 \tag{.1.2}$$

$$\rightarrow [(1-\delta\mu p)(\mu(x-r)-\phi'(p)) + (\mu p(x-r) - \phi(p))\delta\mu] = 0 \tag{.1.3}$$

$$\mu(x-r) = \phi'(p)[1-\delta\mu p] + \phi(p) \tag{.1.4}$$

$$\frac{\mu(x-r) - \phi(p)}{[1-\delta\mu p]} = \phi'(p) \tag{.1.5}$$

When there is no need to affect the resale value/probabilty of support but there is a Central Bank

The Bank's problem becomes:

$$max_{\theta_i,p} V = \frac{\mu p(x-r) - \phi(p)}{1 - \delta[p(\mu - \Gamma_i) + \overline{\beta}_i]} \tag{.1.6}$$

The FOCs are

$$[1-\delta[p(\mu-\Gamma_i)+\overline{\beta}_i]]((X-r)-\phi'(p))+\delta(\mu-\Gamma)[p(X-r)-\phi(p)] = 0 \quad (.1.7)$$

$$(X-r)-\phi'(p)-\delta p(\mu-\Gamma)\phi'(p)-\delta\overline{\beta}(X-r)+\delta\overline{\beta}\phi'(p)-\delta(\mu-\Gamma)\phi(p) \quad (.1.8)$$

$$\rightarrow \frac{(X-r)(1-\delta\overline{\beta})-\delta(\mu-\Gamma)\phi(p)}{1-\delta[\mu-\Gamma]-\delta\overline{\beta}} = \phi'(p) \quad (.1.9)$$

The big problem

$$max_{\theta_i,p}V = \frac{\mu p(x-r)-\phi(p)-\xi(\theta)}{1-\delta s(\theta,p)} \quad (.1.10)$$

Use (**??**) to get $\frac{\partial s}{\partial p} = \mu - \Gamma_i$ and also sub in(**??**) to get $s = p(\mu-\Gamma_i)+\overline{\beta}_i$

Taking derivatives WRT θ

$$[1-\delta(p(\mu-\Gamma)+\overline{\beta})]\xi'(\theta)-\delta[p\frac{\partial\Gamma}{\partial\theta}+\frac{\partial\overline{\beta}}{\partial\theta}](p(X-r)-\phi(p)-\xi(\theta)) = 0 \quad (.1.11)$$

Taking derivatives WRT p

$$[1-\delta[p(\mu-\Gamma_i)+\overline{\beta}_i]]((X-r)-\phi'(p))+\delta(\mu-\Gamma)[p(X-r)-\phi(p)-\xi(\theta)] = 0 \quad (.1.12)$$

$$\rightarrow \frac{(X-r)(1-\delta\overline{\beta})-\delta(\mu-\Gamma)[\phi(p)+\xi(\theta)]}{1-\delta[\mu-\Gamma]-\delta\overline{\beta}} = \phi'(p) \quad (.1.13)$$

.1.1 Why can banks not write insurance contracts on aggregate risk

An assumption has been made that the banks do not insure amongst themselves. The usual moral hazard argument applies for banks making insurance contracts. In a bank is able to buy insurance that pays out Dr in the event of failure the bank will optimally set $\xi(p) = 0$, meaning that any insurance writer will be unwilling to issue insurance. An possibility would be to write insurance contracts which are conditional on γ. The most obvious answer to this is that would be that, just as for the LOLR, this variable is not observable. However, the model does not depend on the observability or otherwise of γ as the LOLR has no commitment and will potentially extend a rescue to an insolvent bank even in states of the world when γ is high because of the preservation of the bank's value. An alternative for any individual bank would be to buy credit protection on *other* banks failing, which would act as an effective hedge against aggregate or macroeconomic risk. This has the potential to be effective as it would lead to higher payments in lower states of the world, which is when the bank's own project is more likely to fail. However, if the protection is bought from another bank the contract is subject to counterparty risk as the probability of payment in state I for protection against bank A bought from bank C is not the probability that Bank A is insolvent but= Pr(Bank A is insolvent $\cap$ Bank C is solvent). To see immediately that aggregate risk cannot be diversified in this case, simply set state I such that $\gamma = 0$. Ultimately γ is an *aggregate* shock and the banking system cannot insure itself against aggregate shocks, although some partial insurance may be possible so long as the banking system as a whole is solvent. To be fully effective the insurer would have to be an entity that was unexposed to the aggregate risk (e.g. a non-bank) and with the resources to honour the written contracts in all states of the world. This is not explicitly ruled out theoretically, but perhaps in practice.

.1.2 Increasing the LOLR's resources

Take the FOCs:

$$\frac{(X-r)(1-\delta\overline{\beta}) - \delta(\mu-\Gamma)[\phi(p)+\xi(\theta)]}{1-\delta[\mu-\Gamma]-\delta\overline{\beta}} = \phi'(p) \qquad (.1.14)$$

Take the derivative of this wrt Λ

$1-\delta[\mu-\Gamma]-\delta\overline{\beta}$ cannot be 0 as $\delta \leq 1$ and $\Gamma \leq \mu$

Note that an increase in $\phi'(p)$ means a higher p so if $\frac{\partial\phi'(p)}{\partial\Lambda} \geq 0$ then increasing the LOLR's resources induces *more* monitoring.

The FOCs WRT Λ become:

$$[1-\delta[\mu-\Gamma]-\delta\overline{\beta}][(X-r)\delta\frac{\partial\overline{\beta}}{\partial\Lambda}+\delta\frac{\partial\Gamma}{\partial\Lambda}[\phi(p)+\xi(\theta)]+\delta(\mu-\Gamma)(\frac{\partial\phi(p)}{\partial\Lambda}+\frac{\partial\xi(\theta)}{\partial\Lambda})] \quad (.1.15)$$

$$-[(X-r)(1-\delta\overline{\beta})-\delta(\mu-\Gamma)[\phi(p)+\xi(\theta)](\delta\frac{\partial\Gamma}{\partial\Lambda}-\delta\frac{\partial\overline{\beta}}{\partial\Lambda}) \quad (.1.16)$$

Then divide by $1-\delta[\mu-\Gamma]-\delta\overline{\beta}$ to get

$$[(X-r)\delta\frac{\partial\overline{\beta}}{\partial\Lambda}+\delta\frac{\partial\Gamma}{\partial\Lambda}[\phi(p)+\xi(\theta)]+\delta(\mu-\Gamma)(\frac{\partial\phi(p)}{\partial\Lambda}+\frac{\partial\xi(\theta)}{\partial\Lambda})]-\phi'(p*)(\delta\frac{\partial\Gamma}{\partial\Lambda}-\delta\frac{\partial\overline{\beta}}{\partial\Lambda}) \quad (.1.17)$$

Term 1

Term	Sign
$(X-r)\delta\frac{\partial\overline{\beta}}{\partial\Lambda}$	+ ve
$\delta\frac{\partial\Gamma}{\partial\Lambda}$	+ ve
$\phi(p)$	+ ve
$\xi(\theta)$	+ ve
$\delta(\mu-\Gamma)$	+ve
$\frac{\partial\phi(p)}{\partial\Lambda}$	??
$\frac{\partial\xi(\theta)}{\partial\Lambda})$	- ve

$\frac{\partial\xi(\theta)}{\partial\Lambda}\leq 0$

Term 2

Term	Sign
$\phi'(p*)$	+ ve
$\delta(\frac{\partial\Gamma}{\partial\Lambda}-\frac{\partial\overline{\beta}}{\partial\Lambda})$	-ve

But note that although term 2 is negative, it is being subtracted. Thus, $\frac{\partial\phi'(p)}{\partial\Lambda}$ is positive, until $\frac{\partial\xi(\theta)}{\partial\Lambda}$ dominates.

Optimum Λ is either when (.1.15)=0 or when $\phi'(p*)$ becomes the same as with the social planner. I.e. when $\phi'(p^*)=\mu X$. To see why it is not when (.1.15)=0 remember that achieving a higher p involves a cost so with a charter value as the LOLR's resources increase the bank may take on a level of monitoring that is too high, due to the value effect.

Appendix to Chapter III

Table 1: Descriptive Statistics

	Number	Mean	sd	Min	25 ptile	Median	75 ptile	Max
Syndicated Loan Characteristics, Dealscan, 97 - 07								
Spread on drawn funds (all-in-spread), basis points	21650	184.88	135.73	-95.00	75.00	162.50	255.00	980.00
Deal amount, US$ million	24174	623.00	1500.00	0.14	82.50	224.00	600.00	37200.00
Maturity, months	22336	43.745	25.656	1.000	18.000	44.000	60.000	366.000
Borrower sales size at close of deal, US$ million	22395	4170.00	15500.00	0.16	219.00	754.00	2670.00	549000.00
Secured	14770	0.722	0.448					
Guaranteed	24178	0.082	0.274					
Rated	24129	0.553	0.497					
Loan purpose type								
Working capital and corporate purposes	24177	0.482	0.500					
Acquisitions	24177	0.188	0.390					
Debt repayment	24177	0.149	0.356					
Backup line	24177	0.099	0.299					
Other	24177	0.083	0.275					
Syndicate Structure, Dealscan, 97 - 07								
Number of lenders	24135	7.894	8.959	1	2	5	10	290
Number of leads	24135	3.669	3.942	0	1	2	5	46
Number of participants	24135	4.225	7.031	0	0	2	6	288
Lead bank share of loan retained, in %, all sample	10196	30.041	23.69	0.00	12.00	22.20	42.80	100.00
in logs	10196	3.072	0.946	-4.605	2.485	3.100	3.757	4.605
Lead bank share of loan retained, in %, 97 - 07	5968	27.758	23.395	0.000	11.100	19.925	36.450	100.000
in logs	5968	3.016	0.789	-4.605	2.407	2.992	3.596	4.605
Lead bank retained amount, in US$ million	5968	86.9	187.0	0.0	27.4	45.0	83.4	7250.0
Overall syndicate concentration, Herfindahl	6232	0.240	0.239	0.000	0.080	0.146	0.328	1.000
Lead bank lending limit, in US$ million	21185	107.7	100.2	1.5	55.5	84.9	125.0	2052.0
Indicators of Monitoring Costs								
Previous Loans	24177	3.428	3.913	0.000	1.000	2.000	5.000	40.000
Lead was a previous lead (dummy)	23423	0.413	0.492					
Lead bank reputation, lead bank's market share in previous year	21846	0.063	0.078	0.000	0.003	0.024	0.111	0.323
Lead bank industry information, share of loans to borrower's industry in previous year	19668	0.279	0.222	0.000	0.113	0.241	0.371	1.000
Dealscan borrowers in same industry (2 digit) as the borrower	24059	0.036	0.026	0.000	0.014	0.029	0.051	0.113
Lead in same country (US) (dummy)	23383	0.934	0.248					
Lead in same state (dummy)	19374	0.162	0.369					
GDP growth, year-on-year in the quarter of syndication	23670	0.0297	0.0125	0.0023	0.0187	0.0313	0.0404	0.0473
Firm Characteristics, Compustat, 97-06								
Profitability (EBITDA/assets)	16875	0.115	0.250	-20.000	0.077	0.116	0.164	0.906
Investment Grade Status	10547	0.568	0.495					
Total assets, book value US$ million, in logs	17915	7.426	2.033	-6.908	6.065	7.349	8.772	14.449
Leverage, book debt/assets	17878	0.354	0.285	0.000	0.193	0.333	0.477	15.000
Age of firm, ln(1+years)	19315	3.245	0.558	2.398	2.773	2.996	3.871	4.043
R&D expenditures to assets	7891	0.034	0.079	0.000	0.000	0.010	0.035	2.190
Tangible assets (net) to assets	16766	0.322	0.248	0.000	0.111	0.262	0.504	1.000
Defaults, Moodys								
All sample, 1987-2006	32841	0.043	0.204					
1997-2006	24177	0.038	0.192					
Abnormal Equity Returns, CRSP								
1997-2006	16030	0.00126	0.03771	-0.38183	-0.01154	-0.00049	0.01120	0.76894

Table 2: Lead Bank Syndicate Exposure and the Likelihood of a Borrower's Default

Probit Estimation (the dependent variable is whether a borrower subsequently defaults on its bonds), 1997 - 2007

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Instrumenting with lead bank lending limit					
			1st stage	IV	Not instrumented			IV
Lead bank share, logs	-0.0037	-0.0065		-0.3249	-0.0049	-0.0028	-0.0019	-0.1596
	(1.18)	(2.52)**		(2.37)**	(2.32)**	(1.51)	(1.15)	(1.84)*
Spread on drawn funds		0.0050	0.1192	0.0422	0.0048	0.0035	0.0035	0.0204
		(4.73)***	(9.40)***	(2.61)***	(4.14)***	(2.09)**	(2.18)**	(1.99)**
Deal amount, logs			-0.3745	-0.1165	0.0023	0.0005	-0.0031	-0.0472
			(39.18)***	(2.31)**	(1.50)	(0.28)	(2.13)**	(1.91)*
Lead bank lending limit			0.0004					
			(2.33)**					
Secured						0.0002	0.0004	0.0002
						(0.06)	(0.10)	(0.07)
Loan with Guarantor						0.0048	0.0036	0.0020
						(0.51)	(0.46)	(0.26)
Maturity, logs						-0.0005	0.0009	-0.0099
						(0.25)	(0.55)	(1.51)
Rated						0.0081	0.0046	-0.0140
						(1.98)**	(1.26)	(1.38)
Purpose: corporate						-0.0065	-0.0076	-0.0402
						(1.31)	(1.69)*	(1.95)*
Purpose: acquisitions						-0.0083	-0.0077	-0.0156
						(2.26)**	(2.48)**	(2.45)**
Purpose: refinancing						-0.0049	-0.0052	-0.0099
						(0.99)	(1.33)	(1.82)*
Purpose: backup line						-0.0063	-0.0070	-0.0201
						(1.28)	(1.86)	(2.17)**
Profitability (ROA)							-0.0275	-0.0170
							(1.28)	(0.97)
Leverage							0.0108	0.0035
							(1.28)	(0.36)
Size, log of assets							0.0041	-0.0057
							(2.70)***	(1.07)
Dependent variable mean	0.0118	0.0116		0.0111	0.0111	0.0202	0.0276	0.0301
Number of loans	5870	5601	5219	5219	5219	2923	2136	1795
Pseudo R^2	0.01	0.04	0.51	0.08	0.04	0.19	0.28	0.31

Notes:
Coefficients reported are marginal effects evaluated at the mean.
Robust z-statistics in parentheses, with standard errors clustered on the borrowing firm.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Columns (6) - (8) also include year and industry dummies.
The omitted loan purpose type is other purpose.

Table 3: Costs of Monitoring and the Likelihood of a Borrower's Default

Probit Estimation (the dependent variable is whether a borrower subsequently defaults on its bonds), 1997 - 2007

	(1)	(2)	(3)	(4)	(5)	(6)	(7) IV	(8) 1st stage
Lead bank share, logs	-0.0018	-3.65E-07	-0.0018	-0.0021	0.0043	-0.0010	-0.0587	
	(1.16)	(1.08)	(1.14)	(2.34)**	(1.35)	(1.41)	(3.80)***	
Spread on drawn funds	0.0032	7.20E-07	0.0032	0.0019	0.0020	0.0023	0.0073	0.1053
	(2.21)**	(2.36)**	(2.18)**	(2.30)**	(2.40)**	(3.28)***	(4.27)***	(4.19)***
Deal amount, logs	-0.0031	-3.95E-07	-0.0027	-0.0018	-0.0018	-0.0014	-0.0164	-0.2750
	(2.23)**	(1.37)	(1.89)*	(1.55)	(1.63)	(1.58)	(4.01)***	(15.24)***
Lead bank lending limit								0.0008
								(3.72)***
Secured	0.0001	9.27E-08	0.0008	0.0014	0.0013	0.0006	0.0005	0.0033
	(0.02)*	(0.12)	(0.23)	(0.52)	(0.50)	(0.31)	(0.56)	(0.10)
Loan with Guarantor	0.0032	dropped	0.0041	-0.0009	-0.0011	dropped	dropped	0.0116
	(0.46)		(0.53)	(0.24)	(0.31)			(0.30)
Maturity, logs	0.0011	2.59E-07	0.0008	-0.0004	-0.0005	-0.0001	-0.0032	-0.0560
	(0.78)	(0.86)	(0.48)	(0.37)	(0.43)	(0.14)	(3.25)***	(3.14)***
Rated	0.0041	1.71E-06	0.0045	0.0013	0.0011	0.0035	-0.0054	-0.0753
	(1.31)	(2.04)**	(1.26)	(0.48)	(0.43)	(1.59)	(2.56)***	(2.40)**
Purpose: corporate	-0.0077	-1.11E-06	-0.0079	-0.0139	-0.0134	-0.0075	-0.1258	-0.1986
	(1.90)*	(0.95)	(1.80)*	(3.46)***	(3.43)***	(2.27)**	(4.39)***	(2.97)***
Purpose: acquisitions	-0.0071	-9.33E-07	-0.0079	-0.0048	-0.0047	-0.0027	-0.0061	-0.1724
	(2.65)***	(1.74)*	(2.80)***	(2.20)**	(2.16)**	(1.40)	(3.78)***	(2.27)**
Purpose: refinancing	-0.0055	-5.66E-07	-0.0055	-0.0023	-0.0023	-0.0011	-0.0038	-0.1429
	(1.62)	(0.82)	(1.47)	(0.82)	(0.82)	(0.44)	(3.23)***	(2.09)**
Purpose: backup line	-0.0061	-6.75E-07	-0.0071	-0.0049	-0.0048	-0.0025	-0.0076	-0.2597
	(1.83)*	(1.21)	(2.01)**	(2.15)**	(2.08)**	(1.33)	(4.00)***	(3.47)***
Profitability (ROA)	-0.0246	-6.20E-06	-0.0249	-0.0186	-0.0189	-0.0130	0.0021	0.1269
	(1.28)	(2.11)**	(1.20)	(2.03)**	(2.12)**	(2.51)**	(0.53)	(0.99)
Leverage	0.0094	1.15E-06	0.0099	0.0085	0.0083	0.0041	0.0012	-0.0315
	(1.37)	(0.76)	(1.30)	(2.16)**	(2.14)**	(1.14)	(0.67)	(0.42)
Size, log of assets	0.0033	6.73E-07	0.0039	0.0023	0.0023	0.0017	-0.0027	-0.0618
	(2.38)**	(2.45)**	(2.58)***	(2.19)**	(2.19)**	(1.91)*	(2.58)***	(4.64)***
Ln(1+previous loans)	0.0038					0.0012	-0.0003	-0.0187
	(1.70)*					(0.92)	(0.36)	(0.98)
Lead was a previous lead	-0.0044					-0.0017	-0.0017	-0.0087
	(1.74)*					(0.98)	(2.20)**	(0.34)
Lead bank reputation		-5.24E-06				0.0001	-0.0340	-0.6349
		(2.25)**				(0.01)	(3.74)***	(3.81)***
Lead bank industry information		-2.43E-06				-0.0090	-0.0074	-0.0509
		(2.33)**				(2.66)***	(4.18)***	(0.76)
Share of borrowers in same industry		-1.97E-05				-0.0681	-0.0536	-0.4465
		(1.62)				(2.18)**	(3.47)***	(0.82)
Same country			-0.0147			-0.0167	0.0006	0.0590
			(1.74)*			(1.85)*	(0.56)	(0.79)
GDP growth, year-on-year				0.4049	0.9200	0.3404	-0.0648	-2.8860
				(3.61)***	(3.34)***	(4.37)***	(1.04)	(3.13)***
Lead bank share x GDP growth					-0.1756			
					(2.01)**			
Dependent variable mean	0.0276	0.0205	0.0277	0.0182	0.0182	0.0205	0.0208	
Number of loans	2136	2294	2132	3243	3243	2291	2259	2838
Pseudo R^2	0.29	0.38	0.28	0.25	0.26	0.33	0.39	0.53

Notes:
Coefficients reported are marginal effects evaluated at the mean.
Robust z-statistics in parentheses, with standard errors clustered on the borrowing firm.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Also included are industry and year dummies (year dummies are omitted when GDP growth at time of syndication is included).
The omitted loan purpose type is other purpose.

Table 4: Lead Bank Syndicate Exposure and Long Run Borrower Profitability

The dependent variable is the return on assets (EBITDA/assets) of a borrower three years after syndication, 1997-2007

	(1)	(2) IV	(3)	(4)	(5)
Lead bank share, logs	-0.0010	0.0734	0.0089		
	(0.42)	(1.68)*	(1.89)*		
Lead bank share x Profitability			-0.0825		
			(2.43)**		
Number of leads				-0.0004	-0.0034
				(1.65)*	(4.88)***
Number of participants				-0.00004	-0.0001
				(0.39)	(0.58)
Number of leads x Profitability					0.0261
					(4.46)***
Spread on drawn funds	-0.0011	-0.0078	-0.0011	-0.0031	-0.0030
	(0.59)	(1.49)	(0.59)	(2.72)***	(2.80)***
Deal amount, logs	0.0030	0.0251	0.0032	0.0045	0.0045
	(1.34)	(1.82)*	(1.51)	(3.04)***	(3.13)***
Secured	9.3E-06	0.0036	0.0002	-0.0046	-0.0032
	(0.00)	(0.74)	(0.06)	(1.76)*	(1.26)
Loan with Guarantor	-0.0061	-0.0099	-0.0060	-0.0055	-0.0050
	(1.25)	(1.45)	(1.23)	(1.53)	(1.40)
Maturity, logs	0.0023	0.0027	0.0022	0.0007	0.0009
	(1.29)	(1.13)	(1.25)	(0.49)	(0.66)
Rated	0.0057	0.0078	0.0046	0.0025	0.0013
	(1.52)	(1.45)	(1.24)	(0.96)	(0.53)
Purpose: corporate	0.0020	0.0154	0.0026	0.0012	0.0021
	(0.33)	(1.50)	(0.43)	(0.29)	(0.52)
Purpose: acquisitions	0.0048	0.0176	0.0058	0.00001	0.0018
	(0.72)	(1.64)	(0.86)	(0.00)	(0.41)
Purpose: refinancing	-0.0004	0.0102	0.0006	0.0018	0.0029
	(0.07)	(1.13)	(0.09)	(0.42)	(0.70)
Purpose: backup line	0.0062	0.0233	0.0067	0.0051	0.0055
	(0.95)	(1.84)*	(1.01)	(1.09)	(1.21)
Profitability (ROA)	0.3526	0.3608	0.6095	0.1792	0.1174
	(9.99)***	(8.63)***	(4.94)***	(4.31)***	(2.79)***
Leverage	0.0366	0.0476	0.0350	0.0321	0.0305
	(3.94)***	(2.99)***	(3.90)***	(4.31)***	(4.20)***
Size, log of assets	-0.0063	-0.0015	-0.0061	-0.0073	-0.0065
	(3.96)***	(0.46)	(4.00)***	(5.67)***	(5.72)***
Industry profitability, 3 years later	0.0546	0.0631	0.0531	0.0498	0.0494
	(2.15)**	(1.99)*	(2.10)**	(2.53)**	(2.55)**
Ln(1+previous loans)					
Lead was a previous lead					
Lead bank reputation					
Lead bank industry information					
Share of borrowers in same industry					
Same country					
GDP growth					
GDP growth, 3 years later					
Lead bank share x GDP growth					
Observations	1909	1775	1909	5045	5045
R-squared	0.35	0.37	0.36	0.25	0.27

Notes:
Robust t-statistics in parentheses, clustered on the borrowing firm.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Regressions are estimated after trimming the top and bottom 5 percentile of the dependent variable.
Also included are industry and year dummies. The omitted loan purpose type is other purpose.

Table 5: Costs of Monitoring and Long Run Borrower Profitability

The dependent variable is the return on assets (EBITDA/assets) of a borrower three years after syndication, 1997-2007

	(1)	(2)	(3)	(4)	(5)	(6)	(7) IV	(8) 1st stage
Lead bank share, logs	0.0087	0.0104	0.0084	0.0088	0.0041	0.0097	0.0645	
	(1.86)*	(2.11)**	(1.79)*	(1.91)*	(0.72)	(2.03)**	(1.64)*	
Lead bank share x Profitability	-0.0813	-0.0900	-0.0824	-0.0819	-0.0842	-0.0873		
	(2.40)**	(2.57)**	(2.44)**	(2.46)**	(2.55)**	(2.57)**		
Spread on drawn funds	-0.0011	-0.0008	-0.0010	-0.0007	-0.0007	-0.0003	-0.0086	0.1193
	(0.57)	(0.40)	(0.54)	(0.40)	(0.37)	(0.17)	(1.50)	(6.77)***
Deal amount, logs	0.0031	0.0016	0.0029	0.0030	0.0030	0.0016	0.0200	-0.2859
	(1.45)	(0.67)	(1.35)	(1.42)	(1.42)	(0.67)	(1.74)*	(15.97)***
Lead bank lending limit								0.0006
								(2.72)***
Secured	0.0003	0.0008	0.0003	0.0002	0.0002	0.0010	0.0041	-0.0506
	(0.08)	(0.20)	(0.09)	(0.05)	(0.05)	(0.25)	(0.80)	(1.39)
Loan with Guarantor	-0.0056	-0.0054	-0.0052	-0.0050	-0.0049	-0.0037	-0.0080	0.0711
	(1.11)	(1.03)	(1.06)	(1.05)	(1.04)	(0.70)	(1.17)	(1.59)
Maturity, logs	0.0023	0.0018	0.0023	0.0028	0.0028	0.0025	0.0018	0.0067
	(1.29)	(0.94)	(1.27)	(1.55)	(1.57)	(1.26)	(0.79)	(0.32)
Rated	0.0043	0.0019	0.0041	0.0049	0.0049	0.0023	0.0069	-0.0322
	(1.15)	(0.47)	(1.10)	(1.31)	(1.31)	(0.57)	(1.32)	(0.90)
Purpose: corporate	0.0023	-0.0014	0.0034	0.0039	0.0040	0.0004	0.0106	-0.1541
	(0.38)	(0.22)	(0.56)	(0.64)	(0.66)	(0.07)	(1.16)	(2.54)**
Purpose: acquisitions	0.0058	0.0045	0.0065	0.0038	0.0040	0.0020	0.0134	-0.1712
	(0.86)	(0.65)	(0.96)	(0.56)	(0.58)	(0.28)	(1.25)	(2.71)***
Purpose: refinancing	0.0003	-0.0011	0.0014	-0.0011	-0.0009	-0.0027	0.0065	-0.1360
	(0.05)	(0.18)	(0.22)	(0.17)	(0.15)	(0.44)	(0.72)	(2.18)**
Purpose: backup line	0.0069	0.0052	0.0072	0.0071	0.0070	0.0066	0.0181	-0.1736
	(1.04)	(0.79)	(1.07)	(1.07)	(1.04)	(0.97)	(1.69)*	(2.51)**
Profitability (ROA)	0.6047	0.6188	0.6082	0.6053	0.6117	0.6060	0.3397	-0.0939
	(4.91)***	(4.95)***	(4.96)***	(5.03)***	(5.11)***	(5.01)***	(8.24)***	(0.50)
Leverage	0.0350	0.0370	0.0350	0.0335	0.0335	0.0349	0.0460	-0.1762
	(3.89)***	(3.90)***	(3.91)***	(3.79)***	(3.79)***	(3.72)***	(2.93)***	2.44)**
Size, log of assets	-0.0062	-0.0054	-0.0059	-0.0059	-0.0059	-0.0053	-0.0020	-0.0678
	(4.07)***	(3.33)***	(3.87)***	(3.85)***	(3.85)***	(3.29)***	(0.65)	(4.67)***
Industry profitability, 3 years later	0.0529	0.0470	0.0534	0.0603	0.0613	0.0555	0.0721	-0.2629
	(2.11)**	(1.77)*	(2.11)**	(2.41)**	(2.45)**	(2.12)**	(2.43)**	(1.34)
Ln(1+previous loans)	0.0019					0.0021	0.0028	-0.0116
	(0.90)					(0.91)	(0.92)	(0.58)
Lead was a previous lead	-0.0020					-0.0051	-0.0039	-0.0118
	(0.64)					(1.50)	(0.88)	(0.38)
Lead bank reputation		0.0532				0.0462	0.0784	-0.4819
		(2.80)***				(2.45)**	(2.66)***	(3.21)***
Lead bank industry information		-0.0057				-0.0073	0.0055	-0.1094
		(0.77)				(0.95)	(0.53)	(1.56)
Share of borrowers in same industry		-0.1432				-0.1285	-0.0955	-0.7417
		(1.78)*				(1.61)	(1.00)	(1.21)
Same country			0.0132			0.0048	-0.0075	0.1767
			(2.38)**			(0..73)	(0.70)	(2.48)**
GDP growth				-0.2414	-0.6999	-0.2470	-0.1299	-2.0656
				(2.19)**	(2.04)**	(2.09)**	(0.77)	(1.85)*
GDP growth, 3 years later				0.1812	0.1829	0.2470	0.4429	-2.4321
				(1.56)	(1.58)	(2.02)**	(2.50)**	(2.09)**
Lead bank share x GDP growth					0.1547			
					(1.32)			
Observations	1909	1620	1906	1909	1909	1618	1591	1591
R-squared	0.36	0.39	0.36	0.35	0.35	0.38	0.05	0.54

Notes:
Robust t-statistics in parentheses, clustered on the borrowing firm.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Regressions are estimated after trimming the top and bottom 5 percentile of the dependent variable.
Also included are industry and year dummies. The omitted loan purpose type is other purpose.

Table 6: Lead Bank Syndicate Exposure and Long Run Likelihood of an Investment Grade Rating

Probit Estimation (the dependent variable is whether a borrower has an investment grade rating three years after syndication), 1997 - 2007

	(1)	(2) IV	(3)	(4)
Lead bank share, logs	0.1603	1.0368	0.1429	0.1428
	(3.54)***	(1.32)	(2.44)**	(3.07)***
Lead bank share x Investment-grade			0.0291	
			(0.38)	
Number of leads				-0.0123
				(2.02)**
Number of participants				0.0031
				(0.81)
Spread on drawn funds	-0.1066	-0.2179	-0.1055	-0.1086
	(2.62)***	(1.89)*	(2.55)**	(2.66)***
Deal amount, logs	0.1269	0.3294	0.1277	0.1560
	(3.46)***	(1.75)*	(3.42)***	(3.79)***
Secured	-0.0274	-0.0567	-0.0273	-0.0162
	(0.36)	(0.72)	(0.36)	(0.22)
Loan with Guarantor	-0.1619	-0.1310	-0.1631	-0.1684
	(1.68)*	(1.25)	(1.69)*	(1.75)*
Maturity, logs	-0.0818	-0.0541	-0.0809	-0.0841
	(2.64)***	(1.57)	(2.60)***	(2.64)***
Rated	0.2173	0.3576	0.2176	0.1973
	(2.20)**	(2.50)**	(2.20)**	(2.01)**
Purpose: corporate	0.0633	0.0855	0.0657	0.0569
	(0.46)	(0.62)	(0.48)	(0.42)
Purpose: acquisitions	-0.1416	-0.1439	-0.1377	-0.1417
	(1.16)	(1.15)	(1.14)	(1.20)
Purpose: refinancing	-0.0472	-0.1461	-0.0455	-0.0537
	(0.42)	(1.07)	(0.40)	(0.49)
Purpose: backup line	-0.0767	-0.0367	-0.0730	-0.0875
	(0.58)	(0.27)	(0.55)	(0.67)
Profitability (ROA)	1.8030	2.0304	1.8028	1.8231
	(2.90)***	(3.03)***	(2.90)***	(2.95)***
Leverage	-0.1655	-0.0876	-0.1647	-0.1637
	(0.57)	(0.32)	(0.56)	(0.56)
Size, log of assets	0.0148	0.0782	0.0151	0.0197
	(0.45)	(1.22)	(0.46)	(0.61)
Investment-grade	0.7279	0.6661	0.6822	0.7343
	(10.32)***	(7.21)***	(3.57)***	(10.39)***
Industry investment-grade share, 3 years later	0.5548	0.5852	0.5538	0.5609
	(2.33)**	(2.31)**	(2.33)**	(2.31)**
Dependent variable mean	0.5788	0.5846	0.5788	0.5788
Number of loans	1142	1088	1142	1142
Pseudo R^2	0.61	0.59	0.61	0.61

Notes:
Probit Estimation, coefficients reported are marginal effects evaluated at the mean.
Robust z-statistics in parentheses, with standard errors clustered on the borrowing firm.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Also included are industry and year dummies.
The omitted loan purpose type is other purpose.

Table 7: Lead Bank Syndicate Exposure and Abnormal Returns

The dependent variable is the abnormal return on the equity of a borrower in the day following the announcement, 1997 - 2006

	(1)	(2)	(3)	(4)
Lead bank share, logs	0.0019	0.0019	0.0033	0.0015
	(2.67)***	(2.34)**	(3.14)***	(1.65)*
Number of leads				-0.0002
				(1.32)
Number of participants				-0.00001
				(0.21)
Spread on drawn funds	0.0002	0.0005	0.0006	0.0005
	(0.36)	(0.73)	(0.80)	(0.76)
Deal amount, logs	0.0002	0.0013	0.0013	0.0016
	(0.44)	(2.05)**	(2.19)**	(2.43)**
Secured	0.0010	0.0005	0.0005	0.0005
	(1.02)	(0.44)	(0.49)	(0.44)
Loan with Guarantor	0.0021	0.0016	0.0017	0.0016
	(1.91)	(1.31)	(1.39)	(1.31)
Maturity, logs	-0.0007	-0.0008	-0.0008	-0.0008
	(1.25)	(1.41)	(1.39)	(1.36)
Rated	0.0008	0.0015	0.0091	0.0014
	(0.77)	(1.32)	(2.41)**	(1.20)
Lead bank share x Rated			-0.0024	
			(1.99)**	
Purpose: corporate	-0.0006	-0.0026	-0.0026	-0.0028
	(0.21)	(0.82)	(0.84)	(0.88)
Purpose: acquisitions	-0.0011	-0.0037	-0.0037	-0.0039
	(0.34)	(1.10)	(1.09)	(1.14)
Purpose: refinancing	-0.0002	-0.0023	-0.0023	-0.0026
	(0.06)	(0.69)	(0.67)	(0.77)
Purpose: backup line	-0.0004	-0.0025	-0.0026	-0.0026
	(0.12)	(0.73)	(0.78)	(0.75)
Profitability (ROA), first lag		-0.0094	-0.0086	-0.0095
		(1.92)*	(1.76)*	(1.94)*
Leverage, first lag		-0.0011	-0.0009	-0.0010
		(0.38)	(0.32)	(0.37)
Size, log of assets, first lag		-0.0009	-0.0009	-0.0008
		(2.16)**	(2.18)**	(1.99)**
Number of loans	2954	2480	2480	2480
R-squared	0.02	0.03	0.03	0.03

Notes:
Robust t-statistics in parentheses, clustered on the borrowing firm.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Regressions are estimated after trimming the top and bottom 5 percentile of the dependent variable.
Also included are industry and year dummies. The omitted loan purpose type is other purpose.

Table 8: Adverse Selection or Moral Hazard?

Restricting the sample of deals to refinancing deals

	(1)	(2)	(3)	(4)
	Dependent variable:			
	Pr (Default)	Profitability	Pr(Investment Grade)	Abnormal Equity Return
Lead bank share, logs	-0.0139	0.0135	0.2773	0.0044
	(1.68)*	(1.90)*	(5.47)***	(2.17)**
Spread on drawn funds	0.0100	0.0044	-0.0685	-0.0013
	(3.64)***	(1.21)	(0.71)	(0.84)
Lead bank share x Profitability		-0.1043		
		(2.05)**		
Deal amount, logs		0.0025	0.2476	0.0015
		(0.59)	(2.85)***	(0.81)
Secured		-0.0128	-0.0009	-0.00002
		(1.90)*	(0.01)	(0.01)
Loan with Guarantor		-0.0095	-0.1816	-0.0006
		(0.81)	(2.07)**	(0.10)
Maturity, logs		0.0032	-0.2873	0.0031
		(0.72)	(3.06)***	(1.59)
Rated		0.0079	0.1663	-0.0005
		(1.17)	(1.39)	(0.15)
Profitability (ROA)		0.7020	2.9545	0.0246
		(4.46)***	(3.02)***	(1.46)
Leverage		-0.0026	-0.9964	0.0070
		(0.16)	(3.01)***	(0.89)
Size, log of assets		-0.0065	-0.0460	0.0003
		(2.17)**	(0.60)	(0.28)
Number of loans	1006	444	200	322
R-squared	0.04	0.33	0.79	0.09

Notes:
Robust t-statistics in parentheses, clustered on the borrowing firm.
* significant at 10%; ** significant at 5%; *** significant at 1%.
Regressions for long-run profitability and abnormal returns are estimated after trimming the top and bottom 5 percentile of the dependent variable, respectively.
Also included are industry and year dummies. The omitted loan purpose type is other purpose.