Essays on bank monitoring, regulation and competition

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Chapter 7

Demand Deposits and Bank Monitoring

Abstract

This chapter provides a novel rationale for why banks combine lending and deposit taking. I show that demand deposits may commit banks to monitoring in an environment in which monitoring is most valuable for long-term projects. Demand deposits, contrary to straight short-term and long-term debt, help commit a bank not to overleverage itself and this commits the bank to monitoring. I show that banks prefer demand deposits if the cost of early liquidation of borrowers is intermediate and if bank monitoring is costly.

Keywords: Demand Deposits, Bank Monitoring, Competition
JEL CLASSIFICATION: G21

7.1 Introduction

One of the important characteristics of banks is that they provide (withdrawable) demand deposits to investors and at the same time lend to borrowers and monitor them. This chapter addresses the question of why banks combine lending and deposit taking. The key idea developed in this paper is that banks may have a problem committing not to overleverage themselves; existing investors of the bank might suffer from subsequent new lending to their bank. What I show is that the specificness of demand-deposit contracts can be understood as a commitment device that prevents banks from excessive refinancing. That is, the threat of withdrawals of demand deposits disciplines the bank choice of the level of debt.

I analyze these issues in a multi-principal agent model in which investors (principals) contract with a bank (the agent). The bank's monitoring affects the success probability of its borrowers (i.e., companies that need bank financing). However, monitoring is costly and uncontractable, and a bank might be unable to commit to it.

I show that in the setting in which monitoring is most valuable for long-term projects, a bank may commit to monitoring using demand-deposit contracts as a costly commitment mechanism. In particular, (expected) withdrawals on demand-deposit contracts could force banks to liquidate some of their borrowers early to repay debt and, in doing so, limit debt financing in later periods. Although partial liquidation is less profitable than continuation, it allows the bank to realize (small) profits that can be used as equity in the second period. This partial equity financing alleviates moral hazard.

This still does not explain why short-term borrowing could not accomplish the same. Observe that the bank has to commit to prematurely liquidating some borrowers. With a single investor, the bank achieves this by borrowing short-term. With short-term borrowing, the single investor can limit funding to the bank and, in doing so, force the bank to liquidate some borrowers. Consequently, if the bank is forced to only borrow from a single investor, the bank can successfully commit to monitoring as in Bizer and DeMarzo (1992).

However, borrowing from multiple investors complicates matters: investors can no longer control the amount of bank borrowing because the bank may raise additional funds from other investors. Hence, the bank can avoid liquidation of borrowers and the commitment to monitoring is more difficult. This is reminiscent of the commitment problem of borrowers vis-à-vis their bank in Bizer and DeMarzo (1992) in which the existing bank suffers if a competing bank additionally lends to its borrowers.

Interestingly, borrowing from multiple investors using demand deposits resolves the refinancing problem. In particular, the bank may now credibly offer low rates and promise to monitor its borrowers. Investors with demand deposits only accept low rates if the bank has low levels of debt. If the bank reneges on this, investors anticipate higher bank risk (i.e., no bank monitoring) and withdraw their demand deposits. The threat of withdrawals on demand deposits therefore serves as a commitment device. Interestingly, if a bank could renege and take on more debt, the subsequent withdrawals reduce bank debt and, via forced liquidation, induce banks to monitor again (unless of course the liquidations are too costly and losses are realized; this then would make a bank run come about).

The intuition for the use of demand deposits differs somewhat from the established theories. In my analysis, withdrawals are not a consequence of exogenous liquidity needs of investors as in Diamond and Dybvig (1983), but serve as a threat to good behavior (as in Calomiris and Kahn (1991) and Diamond and Rajan (2001)).[1] Note however that the actual withdrawals in my analysis could help induce good behavior (i.e., bank monitoring). That is, the role of demand deposits in my analysis is to balance the bank's debt to the level where the bank can still commit to monitoring. This expands the notion of Flannery (1994), who argues that short-term debt, and demand deposits in particular, contain the incentives of banks to shift risk to investors. In contrast to Flannery (1994), my analysis directly connects demand deposits with the bank's role on the asset side; that is, with monitoring borrowers. It shows that demand deposits prevent the bank from overleveraging itself and this commits it to monitoring. Bizer and DeMarzo (1992) indicate that putable and callable bonds could play a similar role.[2]

This analysis is related to the rationale that Jensen (1986) and Tirole (2006, p. 204) offer on the use of short-term and long-term debt. They argue that an entrepreneur would like to commit to not overinvesting in the interim period; that is, paying out cash that is not needed. Although the entrepreneur can simply make a promise not to excessively invest, such a promise is not credible. To resolve this, the entrepreneur borrows short-term. This *forces* him in the future to pay out cash flows to short-term debt holders. In this way, the entrepreneur commits himself to release the cash rather than excessively invest.

My analysis differs from Tirole (2006) in that he suggests that excessive investment might be contained with a combination of short-term and long-term claims. I point to the *refinancing* problem that may arise in the case of multiple investors. Using a demand deposit contract could mediate this problem. This also distinguishes my analysis from that of Jensen (1986) and Stulz (1990), who point to the potential cost of underinvestment when insufficient funds are available.

A few other studies identify the benefits of the coexistence of demand deposits and lending to borrowers. Berlin and Mester (1999) argue that access to core deposits enables banks to insulate borrowers against exogenous credit shocks. Core depositors respond less to a potential change in the interest rate. Consequently, banks more heavily funded with core deposits can smooth loan rates more. Kashyap, Rajan, and Stein (2002) claim that banks provide liquidity both on the asset side and on the liability side. If the demand for

[1]Whereas in my analysis demand deposits prevent the bank from exploiting some investors and refinancing from others, in Gorton and Pennacchi (1990), demand deposits serve to protect uninformed investors from being abused by informed investors. See also Hart and Tirole (1990), McAfee and Schwartz (1994), and Segal and Whinston (2003) for an analysis of contracting problems with multiple principles and multiple agents.

[2]Myers and Rajan (1998) highlight that (excessively) liquid bank assets create potential expropriation problems on the part of the bank. That is, those liquid assets can "disappear" easily. Sufficient illiquidity might be needed to commit the bank not to abscond with the assets. The bank run literature (Diamond and Dybvig (1983), Jacklin and Bhattacharya (1988), etc.) emphasizes the opposite: lack of liquidity is problematic. In my analysis I point to the need for sufficient liquidity. Thus, there is a careful balance that could possibly reconcile the different theories.

liquidity by depositors and borrowers is imperfectly correlated, banks may realize synergies in combining both functions. Song and Thakor (2004) argue that banks use core deposits to prevent withdrawals based on disagreement between investors and banks, which is the most acute for the most opaque relationship loans. They conclude that banks match the highest-value liabilities with the highest-value loans.

My analysis also yields the following empirical prediction. As the liquidation cost of bank borrowers increases, banks have greater difficulties in committing to monitoring. Banks have to liquidate more borrowers (to realize higher short-term profits) to commit themselves to higher monitoring. That is, the total amount of bank lending contracts.

This chapter is organized as follows. In Section 7.2, I present model specifications. Section 7.3 compares long-term and short-term borrowing and using demand deposits. Section 7.4 extends the analysis and lists empirical predictions. Section 7.5 concludes the chapter. All proofs are relegated to Appendix.

7.2 Model Specification

7.2.1 Preliminaries

There are three types of players in the model: borrowers (companies asking for loans), investors, and commercial banks. All players are risk neutral.

Banks specialize in lending and borrow from investors. Banks monitor their borrowers by establishing a long-term relationship with them. Monitoring of a bank prevents a borrower's opportunistic behavior and increases the long-term success probability of borrowers (and of a bank). However, monitoring is costly and to save this cost a bank may decide not to monitor some of its borrowers. Summarizing, moral hazard problems show up in future periods, and not in the short-term. A bank may also prematurely liquidate lending to borrowers to earn some (albeit small) short-term profits.

The funding of banks comes from investors. Banks may borrow short-term or long-term, or use demand deposits. In the case of demand deposits, an investor may withdraw his funds at $t = 1$. In this setting, investors face two problems. First, bank monitoring is unobservable. Banks may stop monitoring, knowing that investors bear most of the potential down-size loss. Second, the bank may borrow from multiple investors. The bank may exploit this and (re)finance from some investors in a way that may be unfavorable for others.

7.2.2 Model details

Borrowers: The basic characteristics of borrowers are as follows. At $t = 0$, borrowers undertake projects that demand \$1 of investment in total. Because borrowers have no initial funds, they must borrow from a bank. At $t = 2$, the project yields R in the case of a success and \$0 in case of a failure. If the borrower becomes safe, he always succeeds. However, the borrower can become risky. Risky borrowers fail if a systematic shock in the economy occurs. That is, the success probability of a risky borrower is only $p < 1$.[3] Without bank monitoring, borrowers always become risky because then they gain additional high private benefits.

Banks: At $t = 0$, each bank initially receives \$1 of funds from investors. It lends these funds to borrowers. The bank can liquidate a proportion x of its borrowers at $t = 1$. In this case, the return R per \$1 of the borrower's project is lowered by the liquidation cost c_L, such that the bank receives $x[R - c_L]$. Subsequently, the bank may monitor borrowers that are not liquidated; each at a cost c_M. That is, the cost of monitoring m borrowers is mc_M. If monitored, the borrower must become safe.[4] The bank is a monopolist; namely, it can take all the returns from the borrowers' projects. Bank monitoring is profitable; that is,

$$R - c_M > pR > 1 \text{ and } R - c_M > R - c_L > 1. \tag{7.1}$$

I assume that the bank must borrow all funds needed from investors in the form of debt. There is no deposit insurance.[5] The bank may borrow either short-term from $t = 0$ to $t = 1$ with a gross interest rate r_{S1} or from $t = 1$ to $t = 2$ with a gross interest rate r_{S2}, or long-term from $t = 0$ to $t = 2$ with a gross interest rate r_L or with demand deposits. In the case of demand deposits, the bank promises a gross interest rate r_{D1} for early withdrawals (at $t = 1$). At $t = 1$, the bank sets a gross interest rate r_{D2} for late withdrawals (at $t = 2$).

Investors: Investors are risk neutral and demand a competitive risk free return, which is normalized to 1.[6]

Timeline: The bank gathers funds at $t = 0$. That is, the bank offers to investors the type (short-term, long-term borrowing, or demand deposits) and promised rate of a contract. Investors then decide whether they supply funds. The bank lends the raised funds to borrowers. At $t = 1$, the bank may again borrow from investors in the short-term. The bank sets the second period rate on demand deposits. The bank also needs to repay potential short-term investors or potential early withdrawals of demand deposits. Investors with demand deposits decide whether to withdraw in sequential order. The bank may liquidate some borrowers. The bank may then choose to monitor the remaining borrowers. At $t = 2$, payoffs are realized. The bank repays the remaining investors from the funds collected from borrowers. See Figure 7.1.

[3]Borrowers' returns are correlated as in Holmstrom and Tirole (1997). In the case of diversified returns, banks could always commit to monitoring; see Diamond (1984).

[4]Note that monitoring affects the long-term success probability of the borrower. This is aligned with evidence in Lummer and McConnell (1989). They distinguish between new bank loans and renewals, and show that renewals have a positive announcement effect but new bank loans do not. This suggests that banks monitor their borrowers through long-term relationships; see also Boot (2000).

[5]For the rationale on the use of bank capital, see Chapter 3 and Allen, Carletti, and Marquez (2007).

[6]In Diamond and Dybvig (1983), banks only provide liquidity if depositors are risk averse and if they value sufficiently long-term returns. In this analysis I focus on risk-neutral depositors.

$t = 0$:	$t = 1$:	$t = 2$:
♠ The bank borrows short-term or long-term, or raises demand deposits from investors. ♠ The bank lends the funds to borrowers.	♠ The bank can again borrow short-term from investors and sets the second period rate on demand deposits. ♠ The bank has to repay investors with short-term contracts and early withdrawals of demand deposits. The bank can liquidate some borrowers. ♠ The bank decides whether to monitor its borrowers.	♠ Payoffs are realized. ♠ Investors are repaid, if possible.

Figure 7.1: Timeline

7.3 Optimal Bank Borrowing

Now I analyze different types of borrowing by the bank. The bank may borrow long-term, or short-term from a single investor, or short-term from mutliple investors, or use demand deposits.

7.3.1 Long-term borrowing

Now I analyze the bank's incentives to monitor if it borrows long-term funds and there exists a single investor. First, I analyze the bank's profits if it does not monitor its borrowers. Second, I allow for bank monitoring and show that the bank either monitors all borrowers or none. Third, I analyze the conditions under which long-term borrowing induces bank monitoring.

The bank's expected profit conditional on not monitoring its borrowers is as follows. With long-term borrowing, the bank does not need to liquidate any borrowers at $t = 1$; hence, $x = 0$. Borrowers repay the bank R with probability p. The bank promises a long-term gross interest rate r_L to the investor. Hence, the expected profit of the bank conditional on not monitoring its borrowers $\Pi_{NM}(x, r_L)$ is

$$\Pi_{NM}(0, r_L) = p[R - r_L]. \tag{7.2}$$

Alternatively, the bank may choose to monitor a proportion m of its borrowers. In this case, it incurs an additional cost of monitoring mc_M; however, monitored borrowers now succeed with probability 1. That is, with additional probability $1 - p$ the bank gains mR from the borrowers but has to pay r_L to the investor (if possible). Hence, the expected profit of the bank $\Pi(x, m)$ is

$$\Pi(0, m) = \Pi_{NM}(0, r_L) + [1 - p] \max(mR - r_L, 0) - mc_M. \tag{7.3}$$

Observe that (7.3) is convex in m. Hence, it has its maximum either at $m = 0$ or at $m = 1$.

For $m = 0$, (7.3) is given in (7.2). For $m = 1$, (7.3) becomes

$$\Pi_M(0, r_L) = R - c_M - r_L. \tag{7.4}$$

The bank only monitors its borrowers if it has an incentive to do so. That is, the bank's profit conditional on monitoring in (7.4) must be larger than the one without monitoring in (7.2). Rearranging yields the following condition.

$$[1-p][R-r_L] \geq c_M \tag{7.5}$$

If the investor anticipates bank monitoring, he supplies funds at $r_L = 1$. Use this with (7.5) to see that the bank monitors as long as $c_M \leq \bar{c}_M$, where

$$\bar{c}_M \equiv [1-p][R-1]. \tag{7.6}$$

For $c_M > \bar{c}_M$, the bank can no longer commit to monitoring; hence, it only succeeds with probability p. The investor anticipates this and only supplies funds at $r_L = \frac{1}{p}$. This immediately yields the following proposition.

Proposition 7.1. *If the bank borrows long-term, it can commit to monitoring for a low cost of monitoring (i.e., for $c_M \leq \bar{c}_M$, where $\bar{c}_M = [1-p][R-1]$) but not for a high cost of monitoring (i.e., for $c_M > \bar{c}_M$).*

The intuition for Proposition 7.1 is the following. The investor cannot write a contract with a bank contingent on the bank's monitoring. This creates the moral hazard problem. In particular, the bank may stop monitoring to save the cost of monitoring, knowing that the investor carries most of the downsize loss. For a small monitoring cost, the moral hazard problem is small and the bank can commit to monitoring. The investor anticipates bank monitoring and supply funds at $r_L = 1$. However, for a high monitoring cost, the moral hazard problem becomes dominant and the bank can no longer commit to monitoring, although monitoring is the first best option (see the condition in (7.1)). The investor anticipates no bank monitoring and only supplies funds at high rate $r_L = \frac{1}{p}$.

7.3.2 Short-term borrowing: A single investor

Now I show that the bank may mediate the moral hazard problem through *short-term* borrowing. I continue to assume that there exists a single investor. I proceed as follows. I first compute the expected profit of the bank at $t = 2$ conditional on liquidation of a proportion of x borrowers at $t = 1$. I show that the bank either monitors all borrowers or no one. Second, I analyze the conditions under which the bank can commit to monitoring.

In the first period, the bank can borrow short-term at the risk-free rate (i.e., $r_{s1} = 1$). That is, the investor anticipates that he can be repaid at $t = 1$ because the bank can always liquidate a sufficient amount of borrowers (the condition in (7.1) guarantees that liquidation of borrowers yields more than the investor requires; i.e., $R - c_L > 1$). If the bank liquidates x borrowers, it earns $x[R - c_L]$ and repays this amount to the investor at $t = 1$. That is, in the second period the investor lends $1 - x[R - c_L]$ to the bank.[7]

If the bank does not monitor its borrowers, it realizes the following expected profit at $t = 2$. Proportion $1 - x$ of borrowers is not liquidated and continues with projects. These projects yield R with probability p; thus, the bank expects a revenue of $p[1 - x]R$. The bank promises a gross interest rate r_{S2} to the investor. If successful, the bank must repay $\{1 - x[R - c_L]\}r_{S2}$ to its investor at $t = 2$. Hence, the profit of the bank conditional on not monitoring its borrowers is

$$\Pi_{NM}(x, r_{S2}) = [1 - x]pR - p\{1 - x[R - c_L]\}r_{S2}. \tag{7.7}$$

Alternatively, the bank may choose to monitor a proportion m of its borrowers. In this case, it incurs additional cost of monitoring mc_M; however, monitored borrowers now succeed with probability 1. That is, with additional probability $1 - p$ the bank gains $[1 - x]mR$ from the borrowers but has to pay $\{1 - x[R - c_L]\}r_{S2}$ to the investor (if possible). Hence, the expected profit of the bank is

$$\Pi(m) = \Pi_{NM}(x, r_{S2}) + [1 - p]\max([1 - x]mR - \{1 - x[R - c_L]\}r_{S2}, 0) - [1 - x]mc_M. \tag{7.8}$$

Observe that (7.8) is convex in m. Hence, it has its maximum either at $m = 0$ or at $m = 1$. For $m = 0$, (7.8) is given in (7.7). For $m = 1$, (7.8) becomes

$$\Pi_M(x, r_{S2}) = [1 - x][R - c_M] - \{1 - x[R - c_L]\}r_{S2}. \tag{7.9}$$

The bank only monitors its borrowers if it has an incentive to do so. The bank's profit conditional on monitoring in (7.9) must be larger than the one without monitoring in (7.7). Rearranging yields the following condition.

$$[1 - x][R - \frac{c_M}{1 - p}] - \{1 - x[R - c_L]\}r_{S2} \geq 0. \tag{7.10}$$

The incentive constraint of the bank in (7.10) deserves a further discussion. Observe that liquidation of borrowers at $t = 1$ helps the bank more successfully commit to monitoring (compare (7.10) and (7.5)). This is because liquidation of borrowers allows the bank to realize some (small) profits that can be used as equity in the second period. This partial equity financing alleviates moral hazard in the second period and the bank can successfully commit to monitoring.

Now I analyze under which conditions the investor is willing to invest in a bank for another period; that is, from $t = 1$ to $t = 2$. These conditions crucially depend on the amount of liquidated borrowers, which defines whether the bank can commit to monitoring.

[7] I assume that the bank cannot expropriate the investor by liquidating the borrowers and directly taking funds out of the bank without paying the investor.

First, the bank may merely stop monitoring and offer $r_{S2} = \frac{1}{p}$. In this case, the investor anticipates no monitoring. He accepts the bank's offer and continues to provide full financing to the bank; that is, no borrower is liquidated. With probability p, the bank succeeds, gains R, and repays r_{S2} to the investor. Hence, the profit of the bank is

$$\Pi_{NM}(0, \frac{1}{p}) = pR - 1. \tag{7.11}$$

Second, the bank may offer a low rate $r_{S2} = 1$. In this case, the investor only partially refinances the bank (the condition in (7.10) has to hold). The bank must liquidate some borrowers and realize (small) profits that can be used as equity financing in the second period and can commit the bank to monitoring. In this case, the condition (7.10) becomes

$$R - 1 - \frac{c_M}{1-p}[1-x] - c_L x \geq 0. \tag{7.12}$$

The bank's profit is (insert $r_{S2} = 1$ into (7.9))

$$\Pi_M(x, 1) = R - 1 - c_M[1-x] - xc_L. \tag{7.13}$$

Hence, the bank that commits to monitoring solves the following maximization problem.

$$\begin{aligned} \Pi_M(x^*, 1) \quad &= \quad \max_x R - 1 - c_M[1-x] - xc_L, && (7.14) \\ &\quad\ \text{s.t.} \\ &\quad\ R - 1 - \frac{c_M}{1-p}[1-x] - c_L x \geq 0. && (7.15) \end{aligned}$$

That is, the bank maximizes its profit in (7.13) under the constraint in (7.15). The constraint in (7.15) is identical to (7.12) and guarantees that the bank has an incentive to monitor its borrowers.

The bank decides whether to commit to monitoring and offer $r_{S2} = 1$ to the investor and gain (7.14) or not to commit to monitoring and offer $r_{S2} = \frac{1}{p}$ to the investor and gain (7.11). Figure 7.2 graphically depicts the maximization problem of the bank. The bank maximizes (7.14) at the constraint in (7.15); that is, $\Pi_M(x, 1) > \Pi_{NM}(x, 1)$, and at the constraint that (7.14) is bigger than (7.11); that is, $\Pi_M(x, 1) > \Pi_{NM}(0, \frac{1}{p})$.

I can now show the following proposition.

Proposition 7.2. *With a single investor and short-term borrowing, one has*

- *For a low monitoring cost $c_M \leq \bar{c}_M$, the investor fully refinances the bank at $r_{S2} = 1$. The bank liquidates no borrowers but monitors them.*

- *For a high monitoring cost $\bar{c}_M \leq c_M$ and for a low liquidation cost $c_L \leq \bar{c}_L(c_M)$, the investor only partially refinances the bank at $r_{S2} = 1$. The bank liquidates x^* of borrowers and monitors the others.*

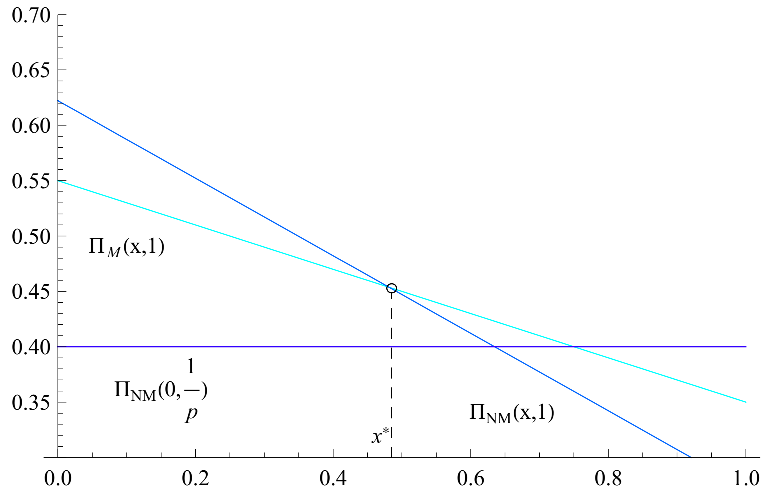

Figure 7.2: The bank's profits.

- *For a high monitoring cost $c_M > \bar{c}_M$ and for a high liquidation cost $c_L > \bar{c}_L(c_M)$, the bank does not monitor. The investor fully refinances the bank at $r_{S2} = \frac{1}{p}$.*

Proposition 7.2 shows that there exist three regions of bank financing. For a low monitoring cost $c_M < \bar{c}_M$, the bank can easily commit to monitoring. In this region, liquidation of borrowers is not necessary (i.e., it would only lower the total profit of the bank). However, for a high monitoring cost $c_M \geq \bar{c}_M$, commitment to monitoring is more difficult. Two regions can be distinguished. For a low liquidation cost $c_L < \bar{c}_L$, the investor at $t = 1$ only partially refinances the bank, forcing it to liquidate a part of its borrowers at $t = 1$. This commits the bank to monitoring. For a high liquidation cost $c_L > \bar{c}_L$, however, liquidation no longer helps commit the bank to monitoring. The bank neither monitors nor liquidates its borrowers.

The argument why liquidation of some borrowers commits banks to monitoring deserves further explanation. Monitoring helps the long-term ($t = 2$) success rate of the borrower (and hence of the bank), but not the short-term ($t = 1$) success rate. The bank may liquidate borrowers at $t = 1$ to gain some (albeit limited) profits. These profits can be used as equity (i.e., the investor can be partially repaid at $t = 1$) and partial equity financing alleviates moral hazard. Note that the investor limits funding to the bank and, in doing so, forces the bank to liquidate some of its borrowers. Hence, the bank can successfully commit to monitoring.[8]

The next corollary connects the monitoring cost with the proportion of liquidated borrowers.

Corollary 7.1. *The proportion of liquidated borrowers x^* increases in a monitoring cost c_M and in a liquidation cost c_L (i.e., $\frac{\partial x^*}{\partial c_M} > 0$ and $\frac{\partial x^*}{\partial c_L} > 0$).*

[8] In this analysis, banks commit to monitoring by borrowing short-term. Allen, Carletti, and Marquez (2007) argue that in order to commit to monitoring banks may raise excessive levels of capital.

Corollary 7.1 builds on the intuition that banks with high monitoring costs must liquidate more borrowers. Only then do they realize sufficient profits that serve as partial equity financing and commit them to monitoring.

I also obtain the following empirical prediction. As the liquidation cost of bank borrowers increases, banks have to liquidate more borrowers (to realize higher short-term profits) to commit themselves to higher monitoring (i.e., x^* increases in the liquidation cost; see Corollary 7.1). Consequently, the total amount of bank lending contracts.

7.3.3 Short-term borrowing: Multiple investors

Now I extend the previous analysis to allow for *multiple* investors. At the refinancing stage, at $t = 1$, the bank may again borrow short-term, in this case, from multiple investors. More specifically, investors sequentially decide whether they lend their funds to the bank at the rates offered.

With multiple investors the following problem occurs. Now the bank can neither commit to equal rates to all investors, nor can the bank commit to limit the amount of short-term borrowing. Proposition 7.2 shows that with a single investor the bank partially refinances but must still liquidate x^* borrowers and this commits it to monitoring. A single investor would anticipate higher risk and demand higher return for all its investment if the bank wants to refinance more and liquidate fewer than x^* borrowers. With multiple investors, however, the bank may deviate and refinance more and liquidate fewer than x^* borrowers. Additional investors anticipate that the bank stops monitoring and demand a higher rate to be compensated for additional risk; however, the initial investors can no longer change their rates and may now be worse off.

The profit of the bank that refinances is as follows. It stops monitoring; hence, the expected borrowers' return is pR. Initial $\{1-x[R-c_L]\}$ investors anticipated that the bank would monitor. They demanded $r_{S2} = 1$. However, the bank deviates to no monitoring and the expected payment to the initial investors is $p\{1-x[R-c_L]\}$. The bank also refinances at additional $x[R-c_L]$ investors. They anticipate no monitoring and demand $r_{S2} = \frac{1}{p}$. Hence, the expected payment to additional investors is $x[R-c_L]$. Summarizing, the bank that refinances now earns

$$\Pi_R(x) = pR - p\{1 - x[R - c_L]\} - x[R - c_L]. \tag{7.16}$$

Rearranging (7.16) yields

$$\Pi_R(x) = p[R - 1] - pxc_L + pxR - xR + xc_L. \tag{7.17}$$

The bank monitors its borrowers if its profit conditional on monitoring in (7.9) is larger than that with refinancing and without monitoring in (7.17). Rearranging yields the following

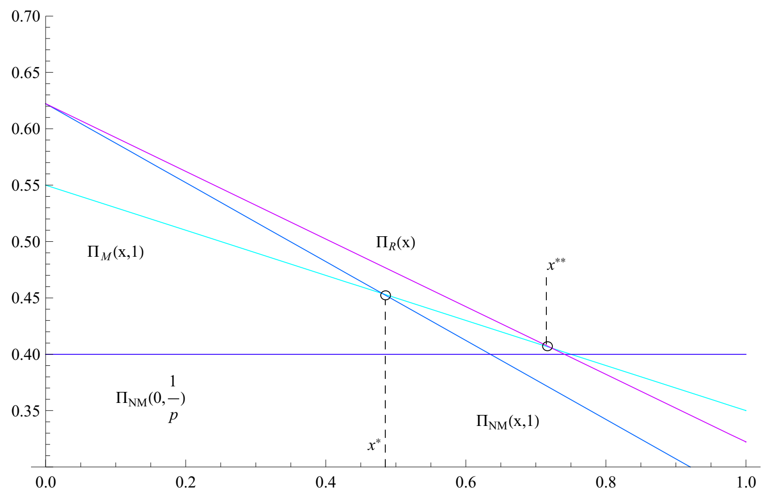

Figure 7.3: The bank's profits (if $c_L > R[1-p]$).

condition.

$$R - 1 - \frac{c_M}{1-p}[1-x] - c_L x - \frac{x[R - c_L - pR]}{1-p} \geq 0, \tag{7.18}$$

The profit of the bank if it commits to monitoring is

$$\begin{aligned}
\Pi_M(x^*, 1) \quad &= \quad \max_x R - 1 - c_M[1-x] - c_L x, && (7.19)\\
& \quad\ \text{s.t.} \\
& \quad\ R - 1 - \frac{c_M}{1-p}[1-x] - c_L x \geq 0, && (7.20)\\
& \quad\ R - 1 - \frac{c_M}{1-p}[1-x] - c_L x - \frac{x[R - c_L - pR]}{1-p} \geq 0. && (7.21)
\end{aligned}$$

That is, the bank maximizes its profit in (7.19) conditional on two constraints. First, the bank must have incentives to monitor at the promised liquidation level x; see (7.20). Second, the bank must have no incentives to refinance and then stop monitoring; see (7.21).

Figure 7.3 graphically depicts the maximization problem of the bank. The bank decides to monitor its borrowers if the solution to (7.19) is higher than (7.11); that is, if $\Pi_M(x, 1) > \Pi_{NM}(0, \frac{1}{p})$. In addition, the bank must have incentives to monitor at liquidation level x; that is, $\Pi_M(x, 1) > \Pi_{NM}(x, 1)$. Furthermore, the bank must have no incentive to refinance; that is, $\Pi_M(x, 1) > \Pi_R(x)$.

I can now show the following result.

Proposition 7.3. *With multiple investors and short-term borrowing, one has:*

- *For a low monitoring cost $c_M \leq \bar{c}_M$, investors fully refinance the bank at $r_{S2} = 1$. The bank liquidates no borrowers, but monitors them.*

- *For a high monitoring cost $c_M > \bar{c}_M$ and for a low liquidation cost $c_L < R[1-p]$, the investors only partially refinance the bank at $r_{S2} = 1$. The bank liquidates x^* of borrowers and monitors the others.*

- *For a high monitoring cost $c_M > \bar{c}_M$ and for an intermediate liquidation cost $R[1-p] \leq c_L \leq \hat{c}_L(c_M)$, where $R[1-p] \leq \hat{c}_L(c_M) < \bar{c}_L(c_M)$, investors only partially refinance the bank at $r_{S2} = 1$. The bank liquidates x^{**} (where $x^{**} > x^*$) of borrowers and monitors the others.*

- *For a high monitoring cost $c_M > \hat{c}_M$ and for a high liquidation cost $c_L > \hat{c}_L(c_M)$, investors fully refinance the bank at $r_{S2} = \frac{1}{p}$. The bank does not monitor.*

The intuition for Proposition 7.3 is the following. With many investors, the bank's ability to commit to monitoring crucially depends on the liquidation costs of the bank's borrowers. For a low liquidation cost, the bank can commit to monitoring as easily as in Proposition 7.2. However, for an intermediate liquidation cost (i.e., for $R[1-p] \leq c_L \leq \hat{c}_L$), the bank is confronted with the additional refinancing option. In particular, the bank may avoid liquidation by refinancing more at other investors. Investors anticipate this refinancing problem and are only willing to fund the bank up to the lower level of indebtedness. That is, the bank is forced to liquidate more borrowers than in the case of a single investor (i.e., $x^{**} > x^*$ borrowers). Because liquidation is costly, the bank is worse off in this region compared to the situation with a single investor. For a high liquidation cost $c_L > \hat{c}_L$, the bank can no longer commit to monitoring in the case of multiple investors, although this may be possible with a single investor (i.e., in the region $\hat{c}_L < c_L < \bar{c}_L$; see Proposition 7.2).

7.3.4 Demand deposits

Now I show that demand deposits contain the refinancing problem. With demand deposits, the timing of the model is the following. At $t = 1$, the bank may first refinance, depositors then sequentially decide whether to withdraw or not, and the bank liquidates borrowers if necessary.

I can show the following result.

Proposition 7.4. *In the case of multiple investors with demand deposits, Proposition 7.2 still applies.*

Interestingly, offering demand deposits resolves the refinancing problem. That is, banks with demand deposits can no longer abuse investors and refinance at $t = 1$. In particular, if banks refinance, investors anticipate no monitoring and withdraw their demand deposits unless they are compensated for additional risk. The threat of withdrawals of demand deposits disciplines a bank's choice of the level of debt. Interestingly, even if the bank raises additional debt and renege on liquidation, the subsequent withdrawals reduce bank debt and, via forced liquidation, induce the bank to monitor again.

Demand deposits are important for a high monitoring cost $c_M > \bar{c}_M$ and for an intermediate liquidation cost $R[1-p] \leq c_L < \bar{c}_L(c_M)$. In this region, demand deposits contain the refinancing problem that occurs with straight short-term borrowing from multiple investors (compare Proposition 7.2 with Proposition 7.3).

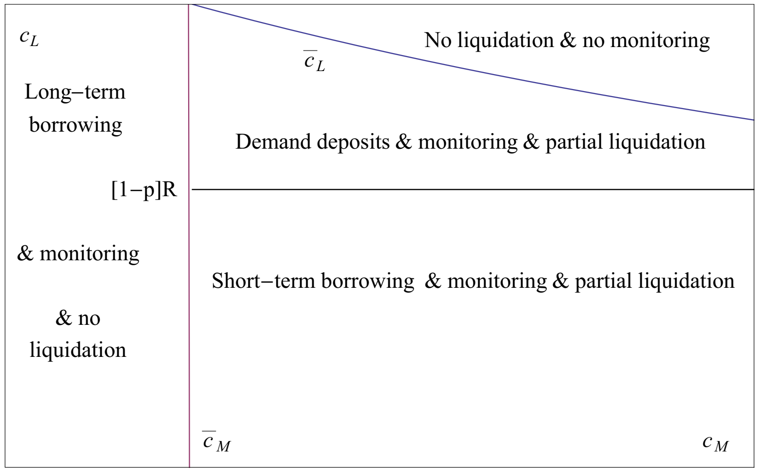

Figure 7.4: Different regions of bank financing.

Figure 7.4 combines the predictions of Proposition 7.1, Proposition 7.2, Proposition 7.3 and Proposition 7.4 to show that different regions of bank financing exist. Only in the first region, in which a monitoring cost is low $c_M < \bar{c}_M$, can banks borrow entirely long-term and commit to monitoring. For a higher cost of monitoring (i.e., for $c_M \geq \bar{c}_M$), three additional regions exist. For a low liquidation cost (i.e., if $c_L < R[1-p]$), the bank can borrow short-term. For an intermediate liquidation cost (i.e., if $R[1-p] \leq c_L \leq \bar{c}_L(c_M)$), the bank raises demand deposits. For a high liquidation cost $c_L > \bar{c}_L(c_M)$, the bank cannot commit to monitoring and liquidates no borrower.

The following corollary shows that the bank may combine demand deposits with long-term or short-term borrowing.

Corollary 7.2. *For $c_M > \bar{c}_M$ and for $R[1-p] < c_L < \hat{c}_L$, the bank can combine demand deposits with (not more than $1 - x^{**}[R - c_L]$) short-term or long-term borrowing, liquidates x^* of borrowers, and commits to monitoring.*

The intuition for this corollary is the following. The bank can only borrow long-term and short-term to the extent that it can still successfully commit to monitoring. First, the bank has to commit to liquidate at least x^* borrowers. Note that investors with demand deposits force the bank to liquidate at least x^* borrowers (the bank borrows short-term or long-term $1 - x^{**}[R - c_L]$, which is less than $1 - x^*[R - c_L]$). That is, investors with demand deposits withdraw such that the bank is forced to liquidate x^* of borrowers and this commits the bank to monitoring.

Moreover, with the combination of demand deposits and short-term (or long-term) borrowing as given in Corollary 7.2, the bank cannot refinance at $t = 1$ to prevent liquidation of its borrowers. To see this, note the following. Proposition 7.3 shows that refinancing is not possible if the bank liquidates x^{**} borrowers; that is, the bank can borrow $1 - x^{**}[R - c_L]$ short-term or long-term and still has no incentives to refinance. However, at this stage (i.e., at $1 - x^{**}[R - c_L]$ short-term or long-term debt), the bank may additionally raise demand deposits. This is because investors with demand deposits can defend against bank refinancing (see Proposition 7.4); that is, they can withdraw if the bank tries to refinance.

7.4 Extensions and Empirical Predictions

This section first extends the analysis to the situation of different liquidation costs of bank borrowers. Second, it presents empirical predictions of the analysis.

7.4.1 Borrowers with different liquidation costs

Now I allow for different liquidation costs of borrowers. In particular, I assume that in addition to borrowers with liquidation cost c_L there also exist otherwise identical borrowers but with liquidation cost R. Hence, liquidation of such borrowers yields zero profit (i.e., $R - c_L = 0$). Such borrowers may have no collateral that the bank can seize in the case of early liquidation; thus, the total return in the case of liquidation is zero.

The above analysis predicts that the bank cannot lend only to such borrowers. In particular, Proposition 7.2 shows that, for a high monitoring cost $c_M > \bar{c}_M(c_M)$, banks can only lend to borrowers with a sufficiently low liquidation cost $c_L < \bar{c}_L(c_M)$. Liquidation of borrowers with low liquidation costs allows the bank to earn (small) profits and this commits it to monitoring in the second period. This shows that borrowers with a high liquidation cost $c_L > \bar{c}_L(c_M)$ and a high monitoring cost $c_M > \bar{c}_M$ could not obtain financing directly from investors on the financial markets.

Interestingly, if the bank combines lending to borrowers with different liquidation costs, it can still commit to monitoring, as the following Proposition shows.

Proposition 7.5. *The bank may lend to x^* of borrowers with a liquidation cost c_L and to $1 - x^*$ of borrowers with a liquidation cost R.*

The intuition for Proposition 7.5 is the following. The bank needs to liquidate x^* of borrowers to commit to monitoring (see Proposition 7.2). However, the bank does not liquidate other borrowers. Hence, the liquidation costs of other borrowers do not matter.

Proposition 7.5 connects this analysis to Jacklin and Bhattacharya (1988). They show that banks may invest partially in liquid and illiquid projects and, in doing so, optimally serve the liquidity needs of depositors. My analysis shows that investing in liquid projects helps the bank commit to monitoring. More specifically, depositors withdraw and force the bank to liquidate its liquid projects. This limits the bank's indebtedness and commits the bank to monitoring in the later period. In this way, the bank can also finance illiquid projects that are not viable on a stand-alone basis.

This brief extension shows that banks may combine lending to borrowers with different liquidation costs. Lending to several borrowers also gives the bank the ability to monitor borrowers for which commitment to monitoring is difficult.

7.4.2 Implications and empirical predictions

Now I list the empirical/stylized facts that are consistent with the predictions following from my analysis.

1. Proposition 7.3 predicts that banks may borrow long-term for a low monitoring cost. For a higher monitoring cost, banks may borrow short-term if they lend to borrowers with low liquidation costs. Banks that lend to borrowers with intermediate liquidation costs will predominately use demand deposits.

2. This analysis highlights some drawbacks of narrow banking proposals. Narrow banking proposals call for the separation of the two core activities of the bank such that demand deposits should be invested in liquid securities whereas illiquid loans should be financed with noncheckable long-term liabilities (see Bryan (1988)). Proposition 7.3 and Proposition 7.4 show that the separation of demand deposits and lending may diminish bank monitoring for a high monitoring cost $c_M > \bar{c}_M$ and for an intermediate liquidation cost $R[1-p] < c_L < \bar{c}_L$. This yields the prediction that narrow banking proposals may have the worst effect in developing economies, where the cost of monitoring is high. In contrast, the separation of lending and deposit taking may not have a negative effect in developed economies if the cost of monitoring is low.

3. Calomiris (1999) and Calomiris and Litan (2000) argue that market forces could help fine tune bank regulation. They propose that banks above a certain size threshold should be mandated to finance a certain portion of their assets by long-term, uninsured subordinated debt. Corollary 7.2 shows that the mandated long-term debt should not be too high, otherwise banks may become risky exactly because of this regulatory measure.

4. Corollary 7.1 shows that banks respond to a higher monitoring cost and to a higher liquidation cost of their borrowers by tightening their lending. This is related to Dell'Ariccia and Marquez (2006), who show that banks may loosen their credit standards if information asymmetries decrease.

7.5 Conclusions

This chapter presents a novel rationale for why banks combine demand deposits with lending to borrowers that need monitoring. It shows that a demand-deposit contract may serve as a commitment device. In particular, withdrawals on demand-deposit contracts could force the bank to liquidate a proportion of its borrowers. Liquidation yields (small) profits that can be used as equity in the second period. Partial equity financing alleviates moral hazard and commits the bank to monitoring.

I also show that demand deposits resolve a refinancing problem that appears with short-term borrowing. More specifically, if a bank borrows straight short-term debt from multiple investors, they can no longer control the level of bank debt: the bank may refinance from other investors rather than liquidate borrowers. Demand deposits resolve this refinancing problem. If the bank reneges on the promised level of liquidation, investors anticipate higher risk. They withdraw their demand deposits and, via forced liquidation, induce the bank to monitor again. This points to the novel role of demand deposits: demand deposits balance bank debt to the level where the bank can still commit to monitoring.

7.6 Appendix

Proof of Proposition 7.1

For $c_M \leq \bar{c}_M$, the condition in (7.5) is satisfied. In addition, use (7.2) and (7.4) to see that $\Pi_{NM}(0, \frac{1}{p}) < \Pi_M(0, 1)$. ■

Proof of Proposition 7.2

First, note that as long as $c_M \leq \bar{c}_M$, where $\bar{c}_M$ is defined in (7.6), the condition in (7.15) is satisfied for $x = 0$. Hence, the bank can commit to monitoring even without liquidating borrowers.

Now I analyze the situation in which $c_M > \bar{c}_M$. In this case, the investor only refinances the bank up to a certain degree to commit the bank to monitoring. However, liquidation is costly for the bank. To see this, differentiate (7.14) w.r.t. x to obtain

$$\frac{\partial \Pi_M(x,1)}{\partial x} = R - c_L - [R - c_M],$$

which is negative because of the condition in (7.1). Hence, x has to be as low as possible; that is, the incentive constraint in (7.15) is satisfied with equality. Solving (7.15) for x, one obtains

$$x^* = \frac{c_M - [R-1][1-p]}{c_M - c_L[1-p]}. \tag{7.22}$$

If the bank liquidates x^* borrowers, it can commit to monitoring. The question is whether the bank wants to commit to monitoring; that is, whether (7.14) is greater than (7.11). Insert (7.22) into (7.14) to obtain

$$\Pi_M^* = \frac{R-1-c_L}{c_M - c_L[1-p]}[1-p][R-c_M] - \{1 - \frac{c_M - [R-1][1-p]}{c_M - c_L[1-p]}[R - c_L]\}.$$

Rearranging yields

$$\Pi_M^* = pc_M \frac{R-1-c_L}{c_M - c_L[1-p]}. \tag{7.23}$$

This is lower than (7.11) as long as

$$pc_M \frac{R-1-c_L}{c_M - c_L[1-p]} < pR - 1. \tag{7.24}$$

This condition is identical to $c_L > \bar{c}_L(c_M)$, where

$$\bar{c}_L(c_M) \equiv \frac{c_M[1-p]}{pc_M - [1-p][pR-1]}. \tag{7.25}$$

Observe that, for $c_M > \bar{c}_M$, one has $pc_M > [1-p][pR-1]$. Hence, (7.25) is positive.

Observe also that, for $c_M > \bar{c}_M$ and $c_L > \bar{c}_L(c_M)$, the bank does not commit to monitoring because (7.11) is greater than (7.23). The investor anticipates that the bank does not monitor. Hence, he only provides funding if the bank offers at least $r_{S2} = \frac{1}{p}$. ■

Proof of Corollary 7.1
Rewrite (7.22) as

$$x^* = 1 - [1-p]\frac{R - 1 - c_L}{c_M - c_L[1-p]}. \tag{7.26}$$

For $c_L \leq \bar{c}_L(c_M)$ and $c_M > \bar{c}_M$, one has $c_L \leq \frac{c_M}{1-p[R-\frac{c_M}{1-p}]}$ and $\frac{c_M}{1-p[R-\frac{c_M}{1-p}]} < \frac{c_M}{1-p}$. Hence, $c_L < \frac{c_M}{1-p}$. Hence, (7.26) is positive. Consequently, $\frac{\partial x^*}{\partial c_M} > 0$. ■

Proof of Proposition 7.3
For $x = 0$, the conditions in (7.20) and (7.21) are simultaneously satisfied if $c_M \leq \bar{c}_M$, where $\bar{c}_M$ is as defined in (7.6). In this case, the bank can commit to monitoring even without liquidation. Hence, $r_{S2} = 1$.

Now I analyze the situation in which $c_M > \bar{c}_M$. If $c_L < R[1-p]$, the constraint in (7.20) is more binding than (7.21). Hence, (7.21) can be dismissed. In this case, Proposition 7.2 holds. That is, the bank liquidates x^* borrowers and commits to monitoring, and investors accept $r_{S2} = 1$.

If $c_L \geq R[1-p]$, the constraint in (7.21) is more binding than (7.20). Hence, (7.20) can be dismissed. Because liquidation is costly for the bank, x must be such that the incentive constraint in (7.21) is satisfied with equality. Solving for x yields

$$x^{**} = \frac{[R-1][1-p] - c_M}{c_L[1-p] - c_M - R[1-p] + c_L}. \tag{7.27}$$

Compare with (7.22) to see that $x^{**} > x^*$. If the bank liquidates x^{**} borrowers, it can commit to monitoring. The question is whether the bank wants to commit to monitoring; that is, whether (7.14) is greater than (7.11). This is true if

$$[1 - x^{**}][p_H R - c_M] - [1 - x^{**} R_{liq}] > p_L R - 1. \tag{7.28}$$

Inserting (7.27) into (7.28) yields the condition

$$c_L < \hat{c}_L \text{ where } \hat{c}_L(c_M) = \frac{c_M[R-1] - R^2[1-p]}{c_M - R - 1 + pR}. \tag{7.29}$$

For $c_M > \bar{c}_M$ and for $c_L > \hat{c}_L(c_M)$, investors anticipate that the bank refinances and does not monitor. Hence, they only provide funding if the bank offers at least $r_{S2} = \frac{1}{p}$. ■

Proof of Proposition 7.4
If the bank refinances, investors with demand deposits withdraw if they are not compensated for higher risk. That is, refinancing as in (7.17) is no longer possible. Hence, the bank solves the optimization problem as put forth in (7.14) and Proposition 7.2 holds. ■

Proof of Corollary 7.2
Note that the only difference between Proposition 7.2 and Proposition 7.3 occurs in the region $\hat{c}_L(c_M) \leq c_L \leq \bar{c}_L(c_M)$. The situation with demand deposits is the following. If the

bank starts refinancing, demand depositors withdraw (if not offered $\frac{1}{p}$), to such extent that x^* borrowers are liquidated. In this case, Proposition 7.2 shows that the bank can commit to monitoring. Hence, the bank can only refinance and stop liquidating x^* borrowers if it offers $\frac{1}{p}$ to all depositors. However, Proposition 7.2 shows that this is not profitable. ■

Proof of Proposition 7.5

Note that Proposition 7.2 shows that the bank can commit to monitoring if it liquidates x^* borrowers and continue lending to $1 - x^*$ borrowers. Hence, it suffices that the bank lends to x^* borrowers with low liquidation costs c_L and can lend to $1 - x^*$ borrowers with high liquidation costs R. At $t = 1$, the bank only liquidates the borrowers with low liquidation costs and continue lending to the borrowers with high liquidation costs. ■