Liquid Assets in Banks: Theory and Practice

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Abstract

This paper summarizes theoretical findings on the determinants of liquid assets held by banks. The findings are summarized in a series of predictions, some of which are tested using a panel data set on Mexican banks. Surprisingly, we find that banks with relatively more demand deposits have relatively less liquid assets, in contrast with the theoretical prediction. We further exploit a period characterized by a prolonged aggregate liquidity shock on the Mexican banking system to shed light on the question: are there banks that rely more than others on liquid assets to meet their liquidity needs? We find that only small banks seem to rely on liquid assets to meet severe liquidity shocks.

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1 Introduction

The subject of this paper is liquid assets held by banks. Our objective is to provide a comprehensive picture of this issue, by reviewing existing theory and empirical findings, and by providing some tests of theoretical predictions, using new data.

Broadly, the two main activities of banks are to accept funds through deposits and to grant loans. A bank may however choose not to invest all its available funds in (typically long-term) loans; indeed, it may keep some of the funds in cash (or reserves at the central bank) and/or invest in marketable securities such as Treasury bills and bonds. The main feature distinguishing these assets from regular bank loans is that they are more liquid. But liquidity usually comes at a price, since liquid assets yield lower returns. A glance at banks' balance sheets[1] reveals that a substantial part of available funds are indeed invested in liquid assets: adding up securities, dues from depository institutions, and cash, the average holding of liquid assets in U.S. commercial banks in 1998 was 24.4% of total assets. Since the returns are typically low, the question is: why do banks hold liquid assets?

Our analysis of this question begins with a review of existing theories, including those which do not focus directly on how banks determine their level of liquid assets, but which do carry implications for that. We distinguish four broad categories of theories. In the first one, the portfolio management theory developed in the 50's and 60's, risk aversion plays an important role in explaining the level of liquid assets chosen by a bank. In contrast, all other theories assume that banks are risk neutral. The second group of theories analyzes the determinants of credit supply and deposit demand, viewing liquid assets as the residual between, on the one hand, the bank's equity and liabilities, and on the other hand, the credit portfolio. These two first categories of theories do not explicitly take into account one of the specificities of banks, namely, that they face potentially large, random liquidity shocks (due to unpredictable deposit withdrawals, and or unpaid credits). Presumably, banks that aim at staying in business wish to keep a good reputation concerning its ability to meet liquidity demands. As a result, banks may want to keep liquid assets in order to be able to

[1] See the appendix for a brief introduction to the items on a bank's balance sheet. For a detailed explanation, the reader may consult Garber and Weisbrod (1992) or Hempel, Simonson and Coleman (1994), for instance.

meet large liquidity shocks, as suggested by the "liquid assets as a buffer" theories. These theories are however silent on one important question: to what extent may banks rely on increased liabilities to raise liquidity on short notice (e.g., by selling CDs or borrowing from other banks)? Indeed, these theories assume an exogenously given penalty rate if the bank is not able to meet a liquidity need, without modeling the liability side of the bank's liquidity management. This is an important shortcoming, since increased liabilities at first sight do appear as a cheap substitute for liquid assets: indeed, by relying on liabilities, banks do not need to tie up important sums of money during long periods of time in order to withstand occasional future shocks. Recent theories have started investigating the trade-off between assets and liabilities to meet liquidity needs. These theories focus on information asymmetries to explain a bank's limited borrowing capacity.

We summarize the theoretical results in a series of empirical predictions. We also make the observation that most predictions relate to a bank's choice of liquid assets before a liquidity shock occurs. In reality, banks face liquidity shocks every day, together with the decision of how to invest in liquid assets for future needs, the net effect still being an unresolved theoretical question. In our empirical analysis, introduced next, we exploit the fact that our data covers a period with a dramatic liquidity shock to shed some light on the question: can we distinguish banks that rely more on liquid assets to meet their liquidity needs than others?

The empirical analysis first provides tests of some of the theoretical predictions. We use a panel data set for the Mexican banking system, from January 1997 to March 1999. Based on the observation of several facts (tightening of monetary policy, political uncertainty related to the banking system, and a strain on the Mexican economy due to a sharp decrease in the oil prices and the worldwide financial crisis in 1998), and comforted by econometric tests, we are able to distinguish two periods: one characterized by "normal" conditions (January 1997-Fabruary 1998), and the second one characterized by an aggregate, prolonged liquidity shock on the Mexican banking system (March 1998-March 1999). As a result, we use the first period to test the predictions concerning buffer-building, and the second one to shed some light on the above mentioned question, i.e., which banks rely more heavily on liquid assets to meet their liquidity needs.

2 Review of Theoretical Findings

Before starting the review, it is necessary to provide a more precise definition of liquid assets. An asset is liquid if it can be sold quickly without significant losses. What determines the liquidity of an asset is still a disputed issue among theorists, and we will not review that literature here.[2] Instead, we will adopt the conventional wisdom found in the bank management literature,[3] an asset is liquid if it is widely known to have low risk (such as government debt) and if it has a short maturity (a short maturity implies that the asset's price is less sensitive to interest rate movements, making large capital losses unlikely). The typical bank assets which are liquid according to that definition include cash, reserves representing an excedent as compared to reserves required by law[4], securities (e.g., government debt, commercial paper), and interbank loans with very short maturity (one to three days).

2.1 The portfolio management theory

According to Pyle (1971) and Hart and Jaffee (1974), a bank's assets and liabilities may all be viewed as securities. As a result of this interpretation, the whole bank may actually be considered as a portfolio of securities. Once that view is postulated, it is possible to apply the portfolio theory developed in the 50's and 60's to the asset-liability management of a bank. The following simple model, adapted from Freixas and Rochet (1997, p.236) illustrates the main ideas.

Assume for simplicity that there is only one risky financial security (which may be interpreted as loans), and one risk-free security (the liquid asset), with returns $\tilde{r}_L$ and r, respectively. Starting with initial wealth $E + D$ (equity and deposits, taken as an exogenously given amount here), the bank manager determines the amounts x_L to invest in the risky security, the rest being invested in the risk-free, liquid asset.[5] A positive amount is

[2] See the literature initiated by Kyle (1985), and also O'Hara (1995) for a review.

[3] See Garber and Weisbrod (1992) and Hempel et al. (1994) for instance.

[4] Indeed, reserves (i.e., funds held in the account at the central bank) are totally illiquid if they serve to comply with a reserve requirement.

[5] In this model, the bank manager is assumed to act fully in line with the bank owners objectives, i.e., there are no agency problems here.

interpreted as being on the asset side of the balance sheet, and a negative amount on the liability side. Assuming for simplicity that the interest rate on deposits is zero, the random payoff is equal to:[6]

$$\tilde{\pi} = r(E + D) + (\tilde{r}_L - r)x_L.$$

The bank manager is risk averse, and assumed to have mean-variance preferences: $U(E(\tilde{\pi}), \text{var}(\tilde{\pi}))$, with U increasing in the expected profit, and decreasing in the variance. Given these premises, the following result obtains: if the expected returns are ordered in the following way, $\bar{r}_L > r > 0$ then $x_L > 0$.

When it comes to the amount invested in liquid assets, $E + D - x_L$, the most important determinant is risk, i.e., both the level of risk aversion, and the riskiness of the returns on loans. First, $E + D - x_L$ is increasing in the degree of risk aversion of the manager (for low degrees of risk aversion, it may be negative). Hence, banks with relatively more liquid assets should be more risk averse. Furthermore, for a given function U, and for given excess returns $(\bar{r}_L - r)$, the amount invested in liquid assets is increasing in $\text{var}(\tilde{r}_L)$, keeping $\bar{r}_L$ constant. An empirical implication is that, when the volatility of interest rates increases, banks should decrease the amount of loans, and increase the holdings of liquid assets.

Another important implication of this theory is that, if deposits and equity are also interpreted as securities (i.e., if E and D are endogenized), then the size of the bank is indeterminate. This follows simply from the fact that in that case, any multiple of the portfolio which is optimal for a given level of equity and deposits, is also optimal. As a result, size should be a random variable, and the proportion of liquid assets to total assets should be independent of size.

2.2 Liquid assets as a residual: the role of supply and demand

The portfolio management theory of banking described above assumes that the bank manager is risk averse. Such an assumption could be defended for small, manager-owned banks.

[6] In a more realistic model, the deposit interest rate would have to be determined endogenously. Here that is disregarded, the focus being on the effect of risk aversion on the bank's balance sheet.

However, for banks owned by shareholders who have well-diversified stock portfolios, risk neutrality seems to be a more appropriate assumption. Henceforth, risk neutrality is assumed. Given that the returns on liquid assets are typically lower than those on regular bank loans, the question immediately arises of why any bank would invest in liquid securities at all.

One way of dealing with the question is to view liquid assets as the difference between equity plus deposits and credits, and apply a classical microeconomic analysis of the determinants of deposits and credits in terms of supply and demand (taking equity as given). This contrasts with the portfolio management theory in which the supply of deposits and demand of credits are perfectly elastic.

According to this theory, banks sell credit, using deposits as inputs. Accepting deposits imply certain administrative costs, as does giving credits. These costs may be summarized in two separate cost functions. If the demand for credit and supply of deposits are exogenously given functions, then the standard marginal cost equals marginal revenue rule may be applied to determine the amounts of credits supplied and deposits demanded by the bank. From basic microeconomic analysis, we know that these will depend on the shape of the cost functions and market structure. Thus for a given market structure, differences in balance sheet compositions could be traced to differences in cost functions. As a bank's cost functions are not observable by outsiders, it is however difficult to state meaningful empirical implications using this approach.

A conceptually different determinant of credit supply is introduced when considering borrowers' default risk. Indeed, as shown by Stiglitz and Weiss (1981) and Bester and Hellwig (1987),[7] adverse selection or moral hazard may lead to credit rationing, in the sense that there does not exist an interest rate for which the (competitive) market clears. For instance, in the adverse selection case, an increase in the credit interest rate leads to a riskier population of borrowers, which in turn potentially implies a non-monotonic credit supply. If the supply and demand curves do not intersect, credit is rationed. Compared to the competitive outcome mentioned above, credit supply is smaller, and *ceteris paribus*, the investment in

[7] Although the models in these papers do not include banks' decisions to invest in liquid assets, we believe the ideas exposed in them can be used to (partially) explain why a bank, for a given amount of deposits, would limit its credits, thereby investing part of the funds available through deposits in liquid assets.

liquid assets should then be larger. An implication of that theory is that, given a level of deposits, the liquid assets held by banks should increase if the population of borrowers is believed to have become more risky, as could be expected during an economic recession for instance.

2.3 Liquid assets as a buffer

All the above mentioned models make an important simplification: they do not take into account the unpredictability of deposit withdrawals, or other factors affecting the uncertainty of flows in and out of the bank, and the effects thereof. In contrast, a number of researchers have sought to model the effects of the liquidity risk implied by these uncertainties. We review the insights concerning liquid assets, starting with models in which banks invest in liquid assets for purely precautionary motives. That line of research was initiated by Edgeworth (1888), and was further developed during the 1960's (see, e.g., Porter (1961), and Kane and Malkiel (1965)).

A simple model, taken from Freixas and Rochet (1997, p.228), is useful to develop the main insights. The two-period model features a bank deciding the amount x to invest in liquid assets out of the funds available through an exogenously given amount of deposits and equity, $x_D + E$, the rest being invested in illiquid loans. Interest rates are given and ordered as previously: $r_L > r > r_D$. A period after the investment decision, some deposits are withdrawn and new deposits arrive; the net result is the realization w of the random variable $\tilde{w}$ (this is the only uncertainty in the model). If w exceeds the reserves x, the bank suffers a liquidity shortage; it must then pay a penalty $r_P(w - x)$ (we will comment further on the interpretation of r_P below), where $r_P > r_L$. Assuming again for simplicity that $r_D = 0$, the objective of the bank is to maximize the expected profit:

$$\Pi(x) = r_L(x_D + E - x) + rx - r_P E[\max(0, \tilde{w} - x)].$$

The first-order condition is:

$$\Pi'(x) = -(r_L - r) + r_P \text{Prob}[\tilde{w} \geq x].$$

This expression determines the optimal amount of liquid assets x^* as follows:[8]

$$\text{Prob}[\tilde{w} \geq x^*] = \frac{r_L - r}{r_P}.$$

The empirical implications are clear and intuitively appealing. First, the amount invested in liquid assets decreases with the opportunity cost of investing in liquid assets, $r_L - r$. Second, it increases when high values of $\tilde{w}$ become more likely in the sense of first-order stochastic dominance. Note however that if the distribution of $\tilde{w}$ becomes more risky in the sense of second-order stochastic dominance, the effect on x^* is not clear; it could go either way, depending on the exact shift in the distribution. Finally, it is increasing in the penalty rate r_P.

Several different interpretations of the penalty rate are possible. In a system where banks can easily turn to the central bank for advances, it can be interpreted as the discount rate (i.e., the rate charged by the central bank), which in such a system is typically higher than other rates. In a system where such credits are not automatically given, it could be the rate at which the bank may obtain funding on the financial markets or the interbank market, or the cost of liquidating illiquid assets.

In their model on why banks traditionally tie together the activities of deposit-taking and lending, Kashyap, Rajan and Stein (1998) analyze a situation very similar to the one described above. The main difference is that the expected deposit withdrawal is proportional to the total amount of deposits. One prediction obtained in that paper is that banks with relatively more demand deposits should hold relatively more liquid assets (an increase in demand deposits corresponding to a shift in the shock distribution in the sense of first order stochastic dominance).

[8] Again risk aversion is not necessary for positive amounts of liquid assets to obtain. Nevertheless, the amount of liquid assets would be affected by the introduction of deposit insurance. Indeed, deposit insurance should lead banks to maximize risk, as shown by Merton (1977). Banks may however be interested in investing in liquid assets despite deposit insurance, for instance in order to protect their charter value, as suggested by Marcus (1984).

2.4 Liquid assets and liabilities: the role of market imperfections

The above mentioned approach does not explicitly model the liability side of a bank's balance sheet as a liquidity source. It is only implicitly present through the penalty rate. This rate being exogenous and independent of the needed amount $\tilde{w} - x^*$, the cost of increasing liabilities (e.g., by issuing CDs, by borrowing from other banks or from the central bank) is assumed exogenous, and the bank's access to these liabilities is not restricted. Recognizing the importance of liabilities as a liquidity source, Poole (1968) includes interbank borrowings in a classical inventory model applied to banking. The model suggested by Poole is however not entirely satisfactory, since it takes the supply of funds on the interbank market as perfectly elastic. The approach found in the recent literature seems more promising in yielding new insights into the liquid assets question; in sharp contrast with preceding theories, this approach seeks to explain why banks may only have limited access to liabilities.

The market imperfections that have been studied are due to informational asymmetries. Holmström and Tirole (1998) analyze the effects of moral hazard, whereas Lucas and McDonald (1992) focus on adverse selection.

In the model suggested by Holmström and Tirole (1998), firms (and therefore banks) encounter problems when raising external finance due to moral hazard (i.e., the manager misallocates resources unless given proper incentives). Moral hazard implies that the bank cannot pledge the full value of an investment project to outside investors. The bank makes a long-term investment which may need extra funding at an interim stage due to a liquidity shock. The crucial insight is that due to the moral hazard an inefficient decision may be taken at that stage: indeed, there exist liquidity shocks which are small enough to make further investment economically viable, but which are at the same time large enough to make outside investors unwilling to invest (since they cannot recover the full value). A way to avoid this inefficiency is to invest in liquid assets beforehand, as this removes any need to seek external finance at the critical interim stage. The authors determine the amount of liquid assets chosen by the bank. Due to the linearity of the model, the only relevant factor for the determination of the amount of liquid assets is the distribution of the liquidity shock. When the distribution of the liquidity shock is riskier in the sense that larger shocks become more likely overall (i.e., in the sense of first-order stochastic dominance) the optimal

amount of liquid assets is larger.[9] However, when the distribution of the liquidity shock is riskier in the sense of a mean preserving spread (second-order stochastic dominance), the optimal amount of liquid assets decreases. This results from the fact that when the distribution is riskier in that sense, on the margin the investment in liquid assets implies a lower increment of insurance: the achieved increase in the probability of continuation is smaller than with the less risky distribution. Therefore, the bank "buys" less insurance, and instead invests more in the illiquid project.[10] [11]

Lucas and McDonald (1992) build on the insight of Myers and Majluf (1984) that private information about asset quality affects a bank's (or more generally, a firm's) ability to raise external finance.[12] They consider a bank which may need external finance due to a deposit shortcoming. As opposed to deposits, external finance is uninsured, and thus sensitive to information about the bank's asset quality, which may be high or low. The asset quality being private information, good and bad banks would pay the same rate for external funding if they could not signal their quality (i.e., in a pooling equilibrium). Good banks therefore have an incentive to signal themselves as good, and the signaling device they use is the level of liquid assets. The intuition is as follows: while the benefit of being perceived as a good bank instead of a bad one is the same for both types of banks (through the lower funding cost), the cost of investing in liquid assets is higher for the bad banks. This follows from the fact that bad banks survive only if they receive a high return on future loans: conditional upon surviving, bad banks therefore have a high average return per unit invested. As a result, the opportunity cost of investing in liquid (low-yield) assets is high. By contrast, a good bank survives even if the return on future loans is low. Hence, conditional upon surviving, good banks have a lower average return per unit invested than

[9] Note that this result again obtains in a model with only risk-neutral agents.

[10] The above predictions are valid for banks' investments in securities, only insofar as stored liquidity is preferred to credit lines. Indeed, as the authors point out, in their framework a perfect substitute for storing liquid assets through securities is the negotiation of an irrevocable credit line up to the desired amount.

[11] Rochet and Tirole (1996) propose an extension of this model, applied to interbank lending. They analyze how peer monitoring affects the liquidity needs of lending and borrowing banks. Since the liquidity shock structure is similar to the one in Holmström and Tirole (1998), the model yields similar predictions concerning liquid assets.

[12] The paper endogenizes the level of liquid assets (financial slack), which was exogenous in Myers and Majluf (1984).

bad banks, implying a lower opportunity cost. Therefore, good banks may signal themselves by investing in liquid assets, and they find that profitable under certain conditions. The model proposed by Lucas and McDonald thus leads to the prediction that, given a level of deposits and a withdrawal distribution function, good banks should invest more in liquid assets than bad banks.

2.5 Liquid assets and the interbank market

Last, we consider two papers that are concerned with interbank markets. Bhattacharya and Gale (1987) and Alger (1999) analyze the role of interbank markets for the allocation of liquidity. In both papers, and in a similar vein to some of the above mentioned models, banks choose the amounts to invest in liquid assets and in high-yield but illiquid loans, given that there is uncertainty concerning the amount of deposit withdrawals before the loans mature. Assuming away any aggregate uncertainty concerning the early deposit withdrawals, efficiency (in the sense that there is not aggregate under-investment in loans) may be attained through the existence of an interbank market: all banks choose the level of liquid assets corresponding to the expected deposit withdrawal, and when the withdrawals realize, banks with a liquidity shortage borrow from banks with a liquidity surplus. Bhattacharya and Gale (1987) and Alger (1999) analyze two different potential sources of imperfection of the interbank market, with different empirical implications.

Bhattacharya and Gale (1987) focus on the implications of asymmetric information about the amount invested in liquid assets. If this amount is not observable to outsiders, a free rider problem arises, implying that there is an aggregate shortage of liquidity when the early deposit withdrawals occur. The authors suggest that reserve requirements could be an answer to such a market failure.

Alger (1999) assumes that the amount of liquid assets is observable, and instead analyzes an interbank market characterized by credit risk. At the time the banks seek additional liquidity, they have private information about their solvency. The credit risk may lead the interbank market collapse; hence in this framework, the interbank market is not always able to provide liquidity insurance to banks, as it would without the adverse selection problem. This affects the banks' investment in liquid assets, which is determined before banks know

whether they are solvent or not. If banks foresee that the interbank market will collapse, they store a sufficient amount of liquid assets to withstand large deposit withdrawals.[13] In that case, there is over-investment in liquid assets compared to the situation in which the interbank market functions properly. Furthermore, banks with relatively more equity, having a higher stake at risk, invest relatively more in liquid assets.

The model also carries implications in terms of economic cycles. Indeed, the model incorporates the notion of correlation between the banks' returns. Thus, a high (resp. low) probability that the bank is solvent combined with a high correlation between the banks' returns, may be interpreted as an economic boom (resp. recession). The results of the model thus indicate that the risk of an interbank market collapse is greater during economic recessions, or if the correlation between the banks' returns is highly negative. Thus, if a recession is expected, banks should invest more in liquid assets.

2.6 Summary of predictions

Before turning to the empirical evidence, we summarize the predictions obtained through the above described theories.

Prediction 1 *The relative amount of liquid assets increases when their opportunity cost (i.e., the difference in returns on loans and on securities) decreases.*

Most of the above theories yield this prediction, which may at first seem trivial.[14] Interestingly, however, the prediction challenges the conventional wisdom that high levels of liquid assets imply low returns. Indeed, due to technological[15] and strategic[16] differences, the

[13] In a sense, this is related to the models focusing on liquid assets as a buffer; in the case of interbank market collapse, the penalty rate r_P of those models is infinitely high.

[14] Note that in a general equilibrium framework, the level of liquid assets chosen would in turn affect the opportunity cost.

[15] Examples include differences in management quality, in credit analysis models used by the bank, and in securities analysis.

[16] For instance specialization of the loan portfolio in different sectors, or of the securities portfolio in different instruments.

returns on both the loans and the securities portfolios may differ across banks. Therefore a high level of securities does not necessarily imply a lower level of returns.[17]

Prediction 2 *The relative amount of liquid assets is higher if larger liquidity shocks are more likely in the sense of first order stochastic dominance.*

This intuitively appealing prediction obtains in the buffer theory and in Holmström and Tirole (1998). Now, when do larger liquidity shocks become overall more likely? An occurrence which immediately comes to mind is seasonal fluctuations. For instance, all banks face larger withdrawals before holidays. Also, banks lending to sectors affected by seasonal patterns in their production (such as the agricultural sector) do experience larger withdrawals during certain months of the year. Furthermore, the level of deposits may affect the expected liquidity shock. One may assume that banks that withdrawals are proportional to the level of deposits, as in Kashyap et al. (1998). In other words, more deposits simply means that the distribution of withdrawals shifts to the right. Hence, given that assumption:

Prediction 3 *Banks with relatively more demand deposits have relatively more liquid assets.*

The following prediction obtains in Holmström and Tirole (1998) and in Rochet and Tirole (1996).

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[17] The following simple portfolio model (adapted from section 2.1) illustrates this. The bank has to determine the amount x_L to invest in loans, given a liability size $E + D$, the rest being invested in the risk-free liquid asset. Suppose that the manager has the following specific mean-variance utility function: $U(E(\tilde{\pi}), \text{var}(\tilde{\pi})) = E(\tilde{\pi}) - \frac{1}{2}\text{var}(\tilde{\pi})$. Letting $\text{var}(\tilde{\pi}) \equiv \sigma^2$ be the constant variance of the return $\tilde{r}_L$, we get: $U(E(\tilde{\pi}), \text{var}(\tilde{\pi})) = r(E+D) + (\tilde{r}_L - r)x_L - \frac{1}{2}\sigma^2 x_L^2$, giving the first-order condition: $x_L = \dfrac{(\tilde{r}_L - r)}{\sigma^2}$. Hence, the amount invested in the liquid asset $(E + D - x_L)$ is decreasing in its opportunity cost $(\tilde{r}_L - r)$. Now, one bank (say bank A) may, for the reasons mentioned in the text, have higher returns than bank B both on its security portfolio, and on its loans. Using a superscript to denote the individual bank: $r^A > r^B$ and $r_L^A > r_L^B$. Given this, it may well be that $r_L^A - r_A < r_L^B - r_B$, i.e., that the opportunity cost of investing in securities is smaller in the more profitable bank. Hence, banks with relatively more liquid assets need not be the least profitable.

Prediction 4 *If large and small shocks become more likely, and average-sized shocks become less likely (i.e., if a distribution of shocks is riskier in the sense of second-order stochastic dominance), the amount of liquid assets decreases.*

The intuition behind this is clear as well: when the distribution of shocks is affected in the sense of second-order stochastic dominance, the marginal benefit of investing in liquid assets may become smaller (the probability that the liquid asset will enable the bank to survive a liquidity shock becomes smaller when large shocks become more likely). An example of the distribution of liquidity shocks becoming more risky in the sense of second-order stochastic dominance, is an overall increase in the volatility of interest rates and foreign exchange rates, for instance.

Prediction 5 *The relative amount of liquid assets increases with the volatility of the returns on risky assets (loans).*

This obtains in two theories. First it is implied by risk aversion in the portfolio management theory. Second, even if the bank is risk neutral, it follows from the credit rationing argument developed by Stiglitz and Weiss (1981): if the credit seeking population is believed to have become more risky, the bank should decrease its loans, and therefore increase its liquid assets.

Prediction 6 *The relative amount of liquid assets increases with the refinancing cost.*

The buffer theory yields this prediction if one interprets the penalty rate r_P as the refinancing cost. Also, in Alger (1999) banks invest more in liquid assets if the interbank market collapses, which can be interpreted as an infinitely high refinancing cost. This prediction is thus related to the substitutability of liquid assets and liabilities: if liabilities are more expensive, the bank should make a heavier use of liquid assets as a liquidity source.

Prediction 7 *Banks should hold more liquid assets when the banking sector is expected to suffer from low returns.*

This prediction, which obtains in Alger (1999), is related to the previous one, since low returns in the banking sector may decrease the supply of funds on the interbank market, implying a higher refinancing cost. Thus, if a recession is expected, banks should invest more in liquid assets in order to avoid expensive liabilities.

The next predictions relate the relative amount of liquid assets to balance sheet characteristics. The first one is a result in Alger (1999).

Prediction 8 *Banks with relatively more equity should invest relatively more in liquid assets, for a given liquidity shock distribution.*

The intuition is that banks with more equity have more to lose if they are not able to withstand liquidity shocks, and therefore benefit more from investing in liquid assets.[18]

Prediction 9 *Banks with high asset quality should have relatively more liquid assets.*

Lucas and McDonald (1992) obtain this result in a model where good banks use liquid assets as a signaling device.

Prediction 10 *The relative amount of liquid assets should be independent of bank size.*

This last prediction obtains in the portfolio management theory, under the assumption that all balance sheet entries, including equity, can be viewed as securities. In that case, any multiple of an optimal portfolio is also optimal, implying that the size of the bank is indeterminate. In turn, this implies that the amount of liquid assets is independent of bank size.

Nevertheless this prediction does not take into account several issues related to refinancing cost. Intuition suggests that large banks have better access to liability funding. First, we

[18]Note, however, that the distribution of the liquidity shock might actually be related to the relative amount of equity. Banks relying more heavily on deposits could face larger liquidity shocks (see prediction 3).

can argue that large banks are better known than small banks; for instance large banks may be more closely monitored and there may be more information sources, e.g., stock prices. Second, creditors may view large banks as less risky (too-big-to-fail argument) implying a lower refinancing cost. We will comment further on this in the empirical section.

We conclude this section by a general remark concerning some of the above predictions. Many of them were derived in models where banks invest in liquid assets in order to meet future liquidity shocks; in other words, in these models the decision to invest in liquid assets is separated from the decision to use them to meet a liquidity shock. In reality, such a separation is not easily done. Indeed, every day banks must deal both with immediate liquidity needs (which are not perfectly predictable) and with planning for future liquidity needs. It is therefore possible that opposing forces are at work simultaneously: the bank may wish to sell securities in order to meet an immediate liquidity need, and at the same time build up a buffer of securities to withstand future liquidity needs. The net effect is not trivial. In the empirical analysis below, we believe we are able to shed some light on this question.

3 Empirical evidence

In this section we provide empirical evidence, by analyzing data on the Mexican banking system, and by reviewing existing evidence from the U.S.. The data set is a panel of 27 monthly balance sheets, income statements and call reports for 32 Mexican banks.[19] These 32 banks represent 98.4% of the systemwide value of total assets. It covers the period from January 1997 to March 1999.

The benefit of analyzing a developing country to study liquidity is that aggregate liquidity shocks are more volatile than in developed ones, because investors' capital is more volatile. Furthermore, in the data set we can distinguish two periods with quite different liquidity conditions for the banking sector.

The first period, from January 1997 to February 1998, is characterized by quite "normal"

[19]The data set is published by the National Banking and Securities Commission. Most of it is available on their web-site http://www.cnbv.org.mx.

conditions: although Mexico as a whole encountered economic problems during this period, the banking system was not particularly constrained. In contrast, the period from March 1998 to March 1999 is characterized by three events that put a strain on the banking sector. First, the monetary policy shifted from neutral to tight.[20] Second, the banking sector became a major political issue in Mexico: the opposition attacked the government for its management of the deposit insurance corporation FOBAPROA during the 1994-95 crisis. As a result, the future of banking regulation became highly politicized and uncertain. In particular, future government aid for banks in trouble became more unlikely, making the banking sector a more risky investment. Third, as an emerging and oil-exporting economy, Mexico was hurt by the severe crisis which hit other emerging economies in 1998,[21] and by the sharp decline in oil prices.[22]

These facts led us to believe that aggregate liquidity in the banking system might have changed significantly between the two periods. As we will see below, descriptive statistics and econometric analysis give strong support to that belief. We will therefore interpret the first period (January 1997 to February 1998) as the initial (buffer-building) period of the theoretical models, and the second (March 1998 to March 1999) as the period in which the liquidity shock occurs. Hence, we will use the first period to test some of the above predictions in Sections 3.1 and 3.2. Then, in Section 3.3 we use the data from the second period to determine which banks effectively use liquid assets as a liquidity source in times characterized by an overall liquidity squeeze.

[20] In Mexico, each day the central bank determines the sum of the banks' balances in their central bank accounts through different interventions (purchases and sales of government securities, repurchase agreements, credits, deposits, etc). If the sum is zero, the monetary policy is neutral. There is a zero reserve requirement in Mexico; if a bank's balance is negative on average over a period of two weeks, it must pay twice the CETES rate (the Mexican equivalent of T-Bills). During the period January 1997 to February 1998, the policy was neutral. Beginning in March 1998, the policy became tight, and remained so until (and beyond) March 1999. On March 6 1998, the central bank created a "corto" (shortage) of 20 million pesos (approximately USD 2 million). On July 22, it increased to 30 million pesos, and then to 50 on August 10, to 70 on August 27, to 100 on September 10, to 130 on November 30, and finally to 160 million pesos on January 12, 1999.

[21] The crisis started in South-East Asia, and then spread, to culminate with Russia's debt default and the LTCM crisis in September 1998.

[22] The oil price decreased from USD 17.5 per barrel in October 1997 to USD 7.96 in September 1998.

3.1 Descriptive statistics and stylized facts

Table 1 provides descriptive statistics for the period January 1997 to February 1998. Before proceeding to the predictions, we list a few stylized facts for the buffer-building period, based on the figures in Table 2. There we have divided banks into three groups according to their size relative to the banking sector: a small bank represents less than 1% of the banking system, a medium bank between 1% and 10%, and a large bank above 10%. According to this definition, there are 32 small banks, 12 medium banks, and 3 large banks. Table 2 indicates that for some important items in the financial statements, small banks are quite different from large and medium banks.

To begin, small banks hold on average 42.9% of total assets in liquid assets (defined as securities plus cash and short-term interbank loans), the figures for medium and large banks being 20.8% and 18.2%, respectively.[23] This is in line with previous results for U.S. banks. Using quarterly data between 1992 and 1996, Kashyap et al. (1998) find that the median large bank held on average 27% of their assets in cash and securities; the figure for the median medium-sized bank was 29%, whereas for the median small bank it was 35%.[24] Similarly, Lucas and McDonald (1992) find that in 1987, on average large U.S. banks held 29% of total assets in cash and securities, medium-sized banks 33%, and small banks 39%. We therefore consider the following to be a stylized fact: on average, small banks hold more liquid assets relative to total assets than large and medium banks.

Furthermore, we would like to draw the reader's attention to the following features of the figures in Table 2. First, on average small banks have less core deposits relative to total assets than large and medium banks. Core deposits are deposits for which banks do not pay any interest. Table 2 shows that small banks hold 3.5 times less core deposits than large and medium banks. Second, on average, funding cost is negatively related to size. Funding cost is defined as the monthly average interest rate on all liabilities. The large difference in core deposits is certainly part of the explanation for the difference in funding cost. Third, on average small banks have a higher ratio of equity to total assets than large and medium

[23] Note that this in turn implies that small banks have relatively less loans.

[24] Kashyap and Stein (1998) divide banks into six categories instead of three, and again the holdings of cash and securities relative to total assets decreases with size.

banks. Finally, on average large banks are more profitable than small and medium banks. For profitability, we use the ratio interest expense over interest income.[25]

3.2 Empirical tests for the buffer-building period

In this section we test some of the predictions stated in Section 2.6, using the data from January 1997 to February 1998. We focus on Predictions 3, 6, 8, and 10. We do not have enough information to test the other predictions. For Predictions 2, 4, 5, and 7, we would need to know the banks' expectations about future liquidity shocks. For Prediction 1, we would need the expected return on loans and securities. We comment on Prediction 9 at the end of the section.

Thus, we want to analyze whether demand deposits, refinancing cost, capital, and size are significant predictors of liquid assets. We use three different measures for liquid assets: securities, cash, and the sum of them (that we call liquid assets). We construct a cross-section and time-series panel, with indices i and t representing bank and date, respectively. With 32 banks and 14 months, we have 442 observations.[26]

We make three separate regressions: one for securities SECU_{it}, one for cash (this measure includes overnight interbank loans) CASH_{it}, and one for liquid assets (the sum of securities and cash) LA_{it}, as a fraction of total assets.[27] For deposits, we distinguish between demand deposits DEPO_{it} (which depositors may withdraw at any time) and time deposits TDEPO_{it} (which have a fixed maturity). Although we only want to test for effects of demand deposits, we include TDEPO_{it} to control for other effects. The variable TDEPO_{it} includes certificates of deposits (CDs) and all other interest bearing deposits. For size, we use the bank's market share (assets of the bank as a fraction of total assets of the system).[28] We use funding cost FC_{it} as a proxy for refinancing cost for lack of a better measure. Letting K_{it} stand for capital, we regress the three equations below. To allow for differences between banks that

[25] Interest expense is the sum of interest paid on all interest-bearing liabilities, and interest income is the sum of interest and fees earned on all the bank assets.

[26] 6 observations are missing.

[27] All other variables are also scaled by total assets.

[28] We also ran the regressions using the logarithm of assets for size, and obtained similar results.

are not captured in the model (i.e., individual differences due to variables outside the model, like for instance degree of risk aversion, or managerial idiosynchracies), we include individual effects α_i.

$$\mathrm{LA}_{it} = \alpha_i + \beta_1 \mathrm{DEPO}_{it} + \beta_2 \mathrm{TDEPO}_{it} + \beta_3 \mathrm{K}_{it} + \beta_4 \mathrm{SIZE}_{it} + \beta_5 \mathrm{FC} + \epsilon_{it} \tag{3.1}$$

$$\mathrm{SECU}_{it} = \alpha_i + \beta_1 \mathrm{DEPO}_{it} + \beta_2 \mathrm{TDEPO}_{it} + \beta_3 \mathrm{K}_{it} + \beta_4 \mathrm{SIZE}_{it} + \beta_5 \mathrm{FC} + \epsilon_{it} \tag{3.2}$$

$$\mathrm{CASH}_{it} = \alpha_i + \beta_1 \mathrm{DEPO}_{it} + \beta_2 \mathrm{TDEPO}_{it} + \beta_3 \mathrm{K}_{it} + \beta_4 \mathrm{SIZE}_{it} + \beta_5 \mathrm{FC} + \epsilon_{it} \tag{3.3}$$

We run both random and fixed effects regressions.[29] The results are summarized in Table 3.

• Test of Prediction 3: Looking first at the random effects estimates (columns 1,3, and 5 in Table 3), we find that demand deposits have a significant negative effect on securities and liquid assets, whereas they have no significant effect on cash. This result contradicts the theory (Prediction 3) suggested by Kashyap et al. (1998). Since there is a risk that the random effects estimates are biased (see footnote 29, we next look at the fixed effects estimates (columns 2,4, and 6). They show the same pattern as the random effects estimates. Moreover, the Hausman test results formally confirm that we cannot reject the hypothesis that the random and fixed effects estimates are different. We therefore conclude that we may have established a causal relation between demand deposits and securities (and also between demand deposits and liquid assets, as implied by the relation between deposits and securities, and the fact that the coefficient for cash is very close to zero).[30]

[29] Fixed effects amounts to viewing each α_i as an unknown parameter to be estimated. In contrast, with random effects regressions, the individual effects are viewed as random (and captured by an individual error term u_i), and thus the following model is actually regressed (using the first equation as an example): $\mathrm{LA}_{it} = \alpha + \beta_1 \mathrm{DEPO}_{it} + \beta_2 \mathrm{TDEPO}_{it} + \beta_3 \mathrm{K}_{it} + \beta_4 \mathrm{SIZE}_{it} + \beta_5 \mathrm{FC} + u_i + \epsilon_{it}$. Whereas the random effects estimators are more efficient than the fixed effects estimators, the random effects model suffers from a drawback, namely, that it assumes that the individual error term u_i is uncorrelated with the other regressors (the β's). If that assumption is violated, the estimators are biased. The fixed effects model does not rely on such an assumption, and is thus more robust, albeit less efficient (since the estimation of the α_i's amount to a loss of a large number of degrees of freedom).

[30] From Table 2, we know that banks with high ratios of demand deposits to total assets tend to be large. It might therefore be tempting to conclude that our result could be explained by invoking that large banks (those with relatively more demand deposits) have easier access to liability markets because they are too big to fail, and thus need less liquid assets. However, that would be wrong. Indeed, in the regressions we

How do we explain this result? The theory relies on the assumption that the volatility of demand deposit withdrawals increases as demand deposits increase. The empirical result suggests that this assumption may be unrealistic. There are two alternative assumptions that would better fit our result. First, it may be that the variance of withdrawals decreases as the depositor population of a bank becomes more diverse, which is typically the case for large banks. Since in our data set higher ratios of demand deposits to total assets are observed for large banks, such an assumption would be compatible with the empirical result. A second possibility is that banks actually consider demand deposits to be very stable liabilities, i.e., which are not a source of large, unpredictable liquidity shocks. Thus, given an increase in demand deposits, banks might tend to invest more in loans than in liquid assets.

Although Prediction 3 was mainly stated for demand deposits, we think it might carry over to time deposits. Time deposits have a fixed maturity, implying that the bank knows in advance when it will have to be reimbursed. However, time deposits made by large investors are often rolled over. As a result, the bank faces uncertainty concerning the fraction of investors who will roll over their time deposits at maturity. Since time deposits typically represent a larger fraction of total assets than demand deposits,[31] it could be argued that time deposits in fact would be a more important source for liquidity shocks than demand deposits. Prediction 3 would therefore imply that the coefficient for time deposits (β_2) be positive. The estimates in Table 3 show that it is not significant for liquid assets nor for securities. However, it is significant and positive (but small) for cash. This does not lend full support to Prediction 3, but it does suggest that banks invest demand and time deposits differently. We conclude this discussion by noting that further empirical research would be valuable to shed more light on the assumptions to be used in theoretical models concerning the most significant sources of liquidity shocks.

• Test of Prediction 6: Our results suggest that when funding cost increases there is a significant shift in the composition of liquid assets (cash decreases and securities increases), whereas the overall effect on liquid assets is not significant.

control for size and for individual effects such as reputation on the interbank market.

[31] For large, medium, and small banks in our data set, the fractions were on average 50%, 47%, and 42%, respectively, from January 1997-February 1998 (see Table 2).

Recall that our measure of cash includes overnight interbank loans. The composition shift can be explained by a substitution of both cash and interbank loans for securities. First, it seems reasonable to believe that an increase in the funding cost is correlated with an increase in returns on securities (reflecting an overall increase in market interest rates). The opportunity cost of holding cash having increased, it is intuitive that cash drop and securities increase. Second, the theory proposed by Alger (1999) suggests that an increase in funding cost could lead to a decrease the interbank market activity (due to credit rationing), and as a result, securities should increase.

• Test of Prediction 8: Capital has a significant positive effect on securities and liquid assets as a whole, in line with the prediction.

As intuition suggests, when more capital is at stake, the bank will invest more in liquid assets for precautionary motives.

• Test of Prediction 10: We find no significant effect of the variable SIZE_{it} on any of the measure we use for liquid assets.

This seemingly lends support to the prediction that liquid assets and size are unrelated. However, the figures in Table 2, and the intuition developed above, do seem to suggest that size matters. To further investigate this, we first plot liquid assets against size (see Figure 1). We see that there are three clusters of banks, corresponding to small, medium and large banks. The variance for large banks is small, whereas it is larger for medium banks, and huge for small banks. This large variance may explain why no linear relationship is found. Notice however that only small banks have very large holdings of liquid assets, giving partial support to our intuition that small banks must rely more on liquid assets and less on liabilities to meet liquidity needs, or to the intuition that small banks are more averse to risk.

• Prediction 9: The theory behind the prediction that liquid assets signal a high asset quality was suggested by Lucas and McDonald (1992), who also provide an empirical test of their theory, using U.S. annual data from 1985-1989. The hypothesis they test is that holdings of liquid assets is a predictor for future loan performance. They regress the ratio of non-performing loans to total loans on the lagged ratio of the sum of cash and securities to total assets, and on another set of potentially relevant variables. The data gives support

to their hypothesis that banks with a higher asset quality have relatively more liquid assets. Letting NP_{it} stand for the ratio of non-performing loans to total loans as the proxy for asset quality, we make a similar regression:

$$NP_{it} = \alpha_i + \beta_1 (LA_{it})_{-1} + \beta_2 (K_{it})_{-1} + \epsilon_{it} \tag{3.4}$$

$(\mathrm{LA}_{it})_{-1}$ is the lag of liquid assets (securities + cash) and $(\mathrm{K}_{it})_{-1}$ is the lag of equity (both being scaled as a proportion of total assets). The results are summarized in Table 4. We find that the relation is not significant for Mexican banks. We would like to interpret that result with caution, however, due to a possible distortion of the data.[32]

3.3 Evidence on effects of a liquidity shock

As mentioned previously, a few facts led us to believe that the period March 1998-March 1999 was characterized by an aggregate and prolonged negative liquidity shock on the Mexican banking system. To give formal support to this belief, we run regressions (3.1), (3.2), and (3.3) using the whole dataset, and adding a dummy for each of the 27 months to control for differences in the constant term across months, in each regression. The coefficients for the dummies, plotted in Figure 2, suggest a structural change occurring in the thirteenth month (i.e., March 1998, as expected). We therefore use the period March 1998-March 1999 to analyze which banks (if any) use their liquid assets to meet their liquidity needs.

Unfortunately, the theory we reviewed in Section 2 does not give many hints as to which types of banks (if any) will use their liquid assets more than others in case of an aggregate liquidity shock. We will therefore base our discussion below on the following intuitions. Banks who use their liquid assets to meet liquidity needs relatively more than others, are those banks that must pay the highest interest rates, or who simply cannot find liquidity on the liability side.[33] A bank may be in that situation if it is known to have a bad asset quality,

[32] After the 1994 crisis the government bought much of existing bad loans, making bad banks look better in our data.

[33] In Mexico, banks cannot sell loans.

or, as suggested by the intuition developed above, if it is small and relatively unknown to other banks and investors.

We begin the analysis of the data by running regressions to analyze whether banks changed their behavior significantly during the period March 1998-March 1999 (labeled A, as in after the liquidity shock) as compared to the period January 1997-February 1998 (labeled B). We modify (3.1)-(3.3) to test if a structural change occurred. We run the regressions, using the whole dataset, allowing for different coefficients for the variables during the two different periods (see Table 5). The Chow tests reveal that coefficients jointly are significantly different between the two periods. Hence, we can conclude that banks' strategy with respect to liquid assets changed, possibly as a result of the aggregate liquidity shock.

To further anlayze the difference, we regress equations (3.1), (3.2), and (3.3) using the data from March 1998-March 1999 (see Table 7). Comparing Table 3 and 7 yields interesting insights. First, we notice that all coefficients become smaller (in absolute value) during the second period, and that there are even sign changes. Next, we study in detail some of the changes.

For demand deposits, the fixed effects coefficient estimate changes from -.65 to .51 for securities, from .019 to -.36 for cash, and from -.71 to -.13 (not significant) for the sum of cash and securities. Regarding securities, there are two possible explanations: first, banks may decide to invest more of demand deposits in securities than before. This can be a result of banks expecting an increase in the volatility of liquidity (due to the tightening of monetary policy and the worsening economic conditions in Mexico). Another explanation is that banks ration credit, due to the overall increase in interest rates. Second, it may be that there is simply a strong positive correlation betweem demand deposits and securities (i.e., they both increase or decrease over the period). To help us analyze this, we plot the average ratios of demand deposits, liquid assets, securities, and cash for small, medium, and large banks over time (see Figure 3).[34] We see that demand deposits decrease over the second period (albeit not very strongly), while securities decrease dramatically for small banks, and slightly for large banks (for medium banks, they increase). Thus, the second explanation could be the right one.

[34]See also Tables 2 and 6 for the descriptive statistics.

The fact that demand deposits decrease over the second period may also explain the negative coefficient for cash mentioned above. Indeed, Figure 3 shows that all banks increase their cash holdings quite dramatically. This is probably explained by an increase in interbank market activity (due to the liquidity shortage, interbank market rates should have gone up, making interbank lending an interesting investment): indeed, the overall increase in cash is very close to the shortage of liquidity sustained by the Mexican central bank during this period.

For capital, the estimated random effects coefficient changes from .27% to -.19% for securities. Figure 4, which plots average capital and the three different measures for liquid assets, indicates that medium banks decrease their capital while their securities holdings increase, the pattern being the opposite for small and large banks.

Finally, we can use Figure 3 to determine whether there is a difference between large, medium, and small banks. A striking pattern emerges: whereas large and medium banks actually increase their holdings of liquid assets (from 18.2% to 19.1% for large banks, and from 20.8% to 29.4% for medium banks), it decreases for small banks (from 42.9% to 32.8%). Small banks seem to have been particularly affected by the crisis starting in the Summer of 1998 and culminating in the Fall (months 22 and 23). Table 6 and Figure 3 further reveal that the increase in liquid assets is due to an increase in cash only for large banks, and partly cash, partly securities for medium banks. Small banks decrease their securities dramatically, and not their cash holdings (which actually increased on average). Thus, small banks were the only ones who sold off a significant part of their securities, lending support to our intuition. In contrast, medium banks increased their holdings, whereas large banks decreased it slightly. In other words, large and medium banks did not seem to have been really affected by the aggregate liquidity squeeze.

4 Conclusion

The objective of this paper was to provide an overview of theoretical results concerning the determinants of liquid asset holdings by banks, to test some of the theoretical predictions using Mexican data, and to try and identify banks that rely more heavily on liquid assets to withstand liquidity needs during a large, and prolonged liquidity squeeze on the banking

system. We would like to emphasize three of our results, focusing on their implications for future research.

First, we find that banks seem to treat cash (including interbank loans) and securities rather differently. In the main regression (see Table 3), often the coefficients on cash and securities are of opposing sign. This is quite a striking result, that suggests that we can probably not view cash and securities as close substitutes. This contrasts with existing theory, which does not distinguish between cash and securities.

Second, surprisingly our data suggests that there is strong evidence that banks having more demand deposits (relative to total assets), have less liquid assets (relative to total assets). This contrasts with the theoretical prediction, and with previous empirical results on U.S. banks. We explain our finding by noting that the banks having relatively more demand deposits are large banks. Intuition suggests that large banks differ from small ones on two crucial matters. First, they typically have a more diversified depositor population. Hence, we question the assumption underlying the theoretical prediction, namely, that liquidity shocks are proportional to demand deposits. Second, intuitively large banks have better access to liabilities to meet liquidity needs: they are better known, and creditors have better incentives to monitor large banks; they may also be considered as too big to fail, further diminishing the risk perceived by investors. As a result, large banks should not need to rely on liquid assets to meet liquidity needs as much as smaller banks. The positive correlation between size and the ratio of demand deposits to total assets could thus be an explanation to our empirical finding.

The third major result of our analysis gives support to the above developed intuition: indeed, analyzing data from a period characterized by a prolonged aggregate liquidity squeeze on the Mexican banking system, we find that only small banks reduce their holdings of liquid assets substantially, whereas medium and large banks actually increase their holdings.

These two conclusions suggest that more research (both theoretical and empirical) could be done on the differences between small and large banks. Finding more support for significant differences in their behavior could indeed have important implications for the regulation of banks.

Appendix

The following table shows a simplified bank balance sheet.

Assets (uses of funds)	**Liabilities (sources of funds)**
Cash	Demand deposits
Securities	Time deposits (CDs)
Repos to resell	Repos to repurchase
Interbank lending	Interbank borrowing
Loans	Capital

- Securities: debt and money market instruments with different maturities.

- Securities sold under agreement to repurchase are fully collateralized loans. The bank sells securities, and the buyer agrees to repurchase them at a certain price on a certain date. The maturity is usually very short, often overnight. The difference between the sale and repurchase prices yields an implicit interest rate for the funds borrowed.

- Certificates of deposit, or CD's are deposits with a fixed maturity, which may be very short. Large investors may contribute to increasing the bank's liquidity on short notice through CD's. CD's may or may not be negotiable, i.e., they may or may not be sold further on a secondary market.

- Interbank loans are made on a short-term basis, mostly overnight or even intraday. The terms are set over the phone, over electronic networks linking the banks, or through brokers. The loans are unsecured, and they may not be sold. They include loans from the central bank. The interest rate is fixed by the central bank, which also determines borrowing eligibility rules.

Table 1: Descriptive Statistics, Panel January-97 to February-98 (first table), and Panel March 1998-1999 (second table).[35]

	N. obs	Mean	Sdev	Percentiles		
				25%	50%	75%
January 1997-February 1998:						
Liquid Assets	448	0.3512	0.2176	0.1700	0.3100	0.5100
Securities	448	0.2256	0.2115	0.0771	0.1366	0.3288
Cash	448	0.1254	0.1358	0.0355	0.0744	0.1701
Deposits	442	0.0954	0.1034	0.0036	0.0503	0.1826
Time Deposits	442	0.4382	0.1979	0.3134	0.4603	0.5625
Capital	448	0.2492	0.2171	0.0859	0.1919	0.3396
Funding Cost	435	0.1843	0.0535	0.1663	0.1913	0.2147
Size	448	0.0268	0.0514	0.0007	0.0016	0.0265
March 1998-March 1999:						
Liquid Assets	416	0.3066	0.1820	0.1800	0.2600	0.4100
Securities	416	0.1413	0.1412	0.0398	0.1016	0.1787
Cash	416	0.1654	0.1381	0.0657	0.1250	0.2322
Deposits	416	0.0995	0.0998	0.2784	0.4657	0.5874
Time Deposits	414	0.4296	0.2015	0.2784	0.4657	0.5874
Capital	416	0.2115	0.1843	0.0753	0.1538	0.2986
Funding Cost	414	0.2240	0.0872	0.1806	0.2106	0.2923
Size	416	0.0273	0.0505	0.0009	0.0016	0.0277

[35]Source: National Banking and Securities Commission CNBV, Mexico. http://www.cnbv.org.mx.

Table 2: Descriptive Statistics, Large Medium and Small Banks January 1997 to February 1998.[36]

	No. obs	Mean	Stdev.	Min	Max
3 Large Banks					
Liquid Assets	42	0.1829	0.0467	0.1100	0.3400
Securities	42	0.1316	0.0311	0.0760	0.2182
Cash	42	0.0512	0.0222	0.0181	0.1230
Deposits	42	0.1881	0.0375	0.1070	0.2392
Time Deposits	42	0.5006	0.0657	0.4090	0.6279
Capital	42	0.0775	0.0209	0.0451	0.1092
Funding Cost	42	0.1517	0.0289	0.1161	0.2339
Size	42	0.1729	0.0294	0.1262	0.2208
Profit	42	0.8078	0.0730	0.6626	0.9576
Loans	42	0.7577	0.0419	0.6056	0.8135
8 Medium Banks					
Liquid Assets	112	0.2085	0.1268	0.0300	0.6000
Securities	112	0.0968	0.0571	0.0001	0.3806
Cash	112	0.1117	0.1041	0.0042	0.4932
Deposits	112	0.1912	0.1046	0.0085	0.3959
Time Deposits	112	0.4677	0.1171	0.2811	0.7106
Capital	112	0.1080	0.1084	0.0162	0.4597
Funding Cost	112	0.1727	0.0346	0.0999	0.2532
Size	112	0.0389	0.0195	0.0088	0.0757
Profit	112	0.8806	0.2019	0.5094	1.2643
Loans	112	0.7724	0.0978	0.4664	1.0089
21 Small Banks					
Liquid Assets	294	0.4297	0.2187	0.0100	0.9000
Securities	294	0.2881	0.2352	0.0018	0.8911
Cash	294	0.1413	0.1511	0.0002	0.6939
Deposits	288	0.0446	0.0676	0.0003	0.2739
Time Deposits	288	0.4176	0.2300	0.0022	0.8894
Capital	294	0.3275	0.2222	0.0458	0.9460
Funding Cost	281	0.1938	0.0595	0.0394	0.2830
Size	294	0.0014	0.0016	0.0001	0.0077
Profit	288	0.7468	0.2273	0.0913	1.6051
Loans	288	0.5084	0.2165	0.0077	0.9810

[36]The market share to total assets is 0.51, 0.43, and 0.044 respectively. Source: CNBV (Mexico).

Table 3: regression results, January 1997-February 1998. *** Significant at 10% confidence level; ** Significant at 5% confidence level; * Significant at 1% confidence level. Standard errors in parentheses. The Hausman test tests the null hypothesis that $\hat{\beta}_{RE} = \hat{\beta}_{FE}$, where $\hat{\beta}_{RE}$ and $\hat{\beta}_{FE}$ are the vectors of coefficient estimates using, respectively, the random effects and the fixed effects regression model.

	LA	**LA(fe)**	**SECU**	**SECU(fe)**	**CASH**	**CASH(fe)**
Deposits	-0.7193*	-0.6268**	-0.6502*	-0.6517*	-0.0646	0.0192
	(0.1989)	(0.2633)	(0.2016)	(0.2597)	(0.1469)	(0.2326)
Time Deposits	0.0832	0.0826	-0.0547	-0.0629	0.1277*	0.1440*
	(0.0563)	(0.0579)	(0.0557)	(0.0572)	(0.0483)	(0.0512)
Capital	0.1943**	0.1872***	0.2750*	0.3078*	-0.0487	-0.1203
	(0.0892)	(0.1034)	(0.0896)	(0.1020)	(0.0695)	(0.0913)
Funding Cost	-0.1046	-0.0829	0.2800***	0.2633	-0.4028*	-0.3457**
	(0.1583)	(0.1661)	(0.1569)	(0.1638)	(0.1351)	(0.1467)
Size	-0.2010	1.7391	0.2675	0.8882	-0.4957	0.8630
	(0.5560)	(1.6073)	(0.5879)	(1.5856)	(0.3426)	(1.4201)
No. obs	480	480	480	480	480	480
R-sq: overall	0.27	0.024	0.219	0.189	0.038	0.004
Hausman test	1.9		1.11		3.54	
p-values	0.8633		0.9532		0.6172	

Table 4: Fixed-effects estimates for equation (3.4) January 1997 - March 1999. Standard errors in parentheses.

	Nonperforming loans			
Liquid Assets$_{-1}$	-0.0148	**R-sq:**	within	0.001
	(0.0364)		between	0.011
			overall	0.009
Capital$_{-1}$	-0.0371			
	(0.0803)			
No. obs	484			

Table 5: Regression results (random effects), January 1997-March 1999. Standard errors in parentheses.

	LA	**Securities**	**Cash**
Deposits (B)	-0.5402	-0.4494	-0.1267
	(0.1645)	(0.1567)	(0.1245)
Deposits (A)	-0.3216	-0.2885	-0.0694
	(0.1688)	(0.1606)	(0.1278)
Time deposits (B)	0.0600	-0.0207	0.0797
	(0.0569)	(0.0555)	(0.0422)
Time deposits (A)	0.0406	0.0648	-0.0256
	(0.0505)	(0.0492)	(0.0375)
Capital (B)	0.3753	0.2344	0.1456
	(0.0739)	(0.0717)	(0.0551)
Capital (A)	-0.0806	-0.0896	0.0145
	(0.0729)	(0.0706)	(0.0544)
Funding Cost (B)	-0.4940	-0.2759	-0.2021
	(0.1952)	(0.1903)	(0.1447)
Funding Cost (A)	-0.1104	0.1007	-0.2108
	(0.1223)	(0.1190)	(0.0908)
Size (B)	0.4864	0.4446	-0.0614
	(0.4538)	(0.4137)	(0.3587)
Size (A)	0.4598	0.5701	-0.2240
	(0.4677)	(0.4260)	(0.3698)
No. obs	847	847	847
R-sq	0.13	0.19	0.058
Chow Test (test of equality of coefficients in A and B):			
F-statistic	113.77	90.86	10.98
p-values	0	0	0.0518

Table 6: Descriptive statistics, for large, medium and small banks, March 1998 to March 1999.[37]

	No. obs	Mean	Stdev.	Min	Max
3 Large Banks					
Liquid Assets	39	0.1908	0.0452	0.1000	0.2900
Securities	39	0.1045	0.0281	0.0489	0.1661
Cash	39	0.0856	0.0377	0.0268	0.1465
Deposits	39	0.1995	0.0310	0.1429	0.2512
Time Deposits	39	0.4919	0.0685	0.3828	0.6241
Capital	39	0.0793	0.0202	0.0527	0.1144
Funding Cost	39	0.1817	0.0485	0.1202	0.2864
Size	39	0.1679	0.0333	0.1198	0.2055
Profit	39	0.7782	0.0720	0.6642	0.9489
Loans	39	0.7313	0.0401	0.6598	0.8093
8 Medium Banks					
Liquid Assets	104	0.2939	0.1664	0.0600	0.6400
Securities	104	0.1109	0.1033	0.0001	0.4823
Cash	104	0.1830	0.1577	0.0227	0.6078
Deposits	104	0.1922	0.1052	0.0054	0.3911
Time Deposits	104	0.5014	0.1188	0.2440	0.6581
Capital	104	0.1009	0.0972	0.0323	0.4325
Funding Cost	102	0.2212	0.0647	0.1063	0.3543
Size	104	0.0424	0.0192	0.0141	0.0802
Profit	104	0.8529	0.2127	0.5226	1.3996
Loans	104	0.6823	0.1187	0.3676	0.9542
21 Small Banks					
Liquid Assets	273	0.3280	0.1932	0.0100	0.9000
Securities	273	0.1581	0.1595	0.0001	0.7439
Cash	273	0.1701	0.1357	0.0019	0.7174
Deposits	273	0.0499	0.0607	0.0001	0.2266
Time Deposits	271	0.3931	0.2284	0.0004	0.8849
Capital	273	0.2725	0.1931	0.0270	0.9617
Funding Cost	273	0.2310	0.0967	0.0789	0.4126
Size	273	0.0015	0.0017	0.0001	0.0096
Profit	271	0.8173	0.1879	0.0528	1.5602
Loans	273	0.6006	0.2144	0.0069	0.9240

[37]The market share to total assets is 0.50, 0.45, and 0.05 respectively. Source: CNBV (Mexico).

Table 7: Regression results, March 1998 to March 1999. Standard errors in parentheses.

	LA	**LA(fe)**	**SECU**	**SECU(fe)**	**CASH**	**CASH(fe)**
Deposits	-0.1308	0.1484	-0.0572	0.5165	-0.2489	-0.3671
	(0.2008)	(0.2301)	(0.1697)	(0.2211)	(0.1455)	(0.1694)
Time Deposits	0.0473	0.0401	0.1343	0.1247	-0.0875	-0.0882
	(0.0557)	(0.0559)	(0.0523)	(0.0537)	(0.0399)	(0.0412)
Capital	-0.2803	-0.3107	-0.1916	-0.2843	-0.0346	-0.0257
	(0.0810)	(0.0833)	(0.0744)	(0.0800)	(0.0581)	(0.0613)
Funding Cost	0.1453	0.1256	-0.0733	-0.1007	0.2223	0.2242
	(0.0785)	(0.0775)	(0.0754)	(0.0745)	(0.0561)	(0.0571)
Size	0.2707	6.6671	-0.1414	6.2378	0.0939	0.3377
	(0.5912)	(1.4033)	(0.4167)	(1.3484)	(0.4421)	(1.0332)
No. obs	412	412	412	412	412	412
R-sq	0.07	0.12	0.08	0.16	0.06	0.07
Hausman test	35.63		50.14		3.46	
p-values	0		0		0.6293	

Figure 1: Liquid Assets and Size, January 1997-March 1999.

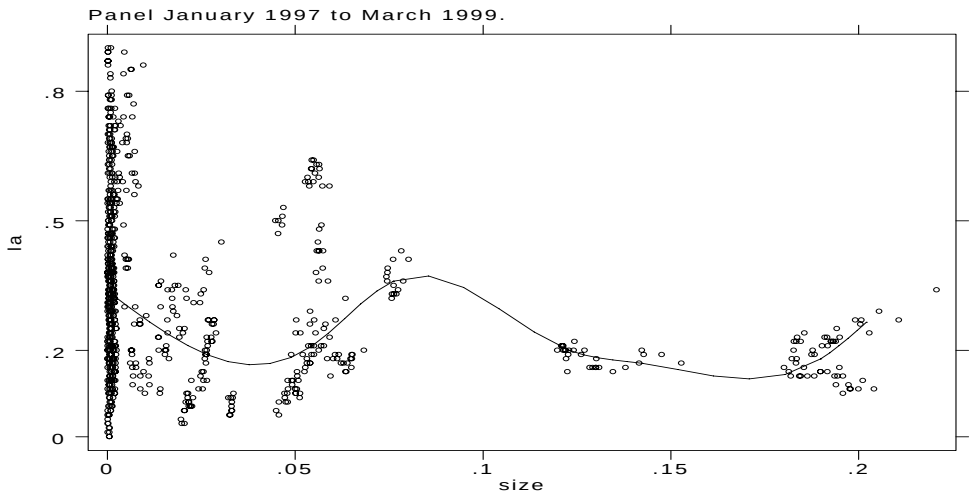


Figure 2: Coefficients of monthly dummy variables (for liquid assets, securities, and cash, respectively), January 1997-March 1999.

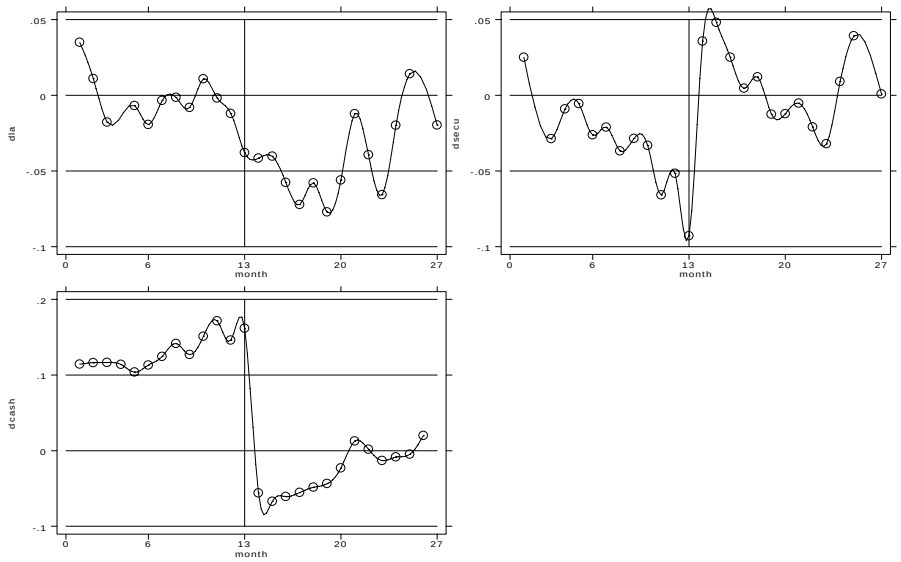


Figure 3. Average demand deposits, liquid assets, cash, and securities by bank group.

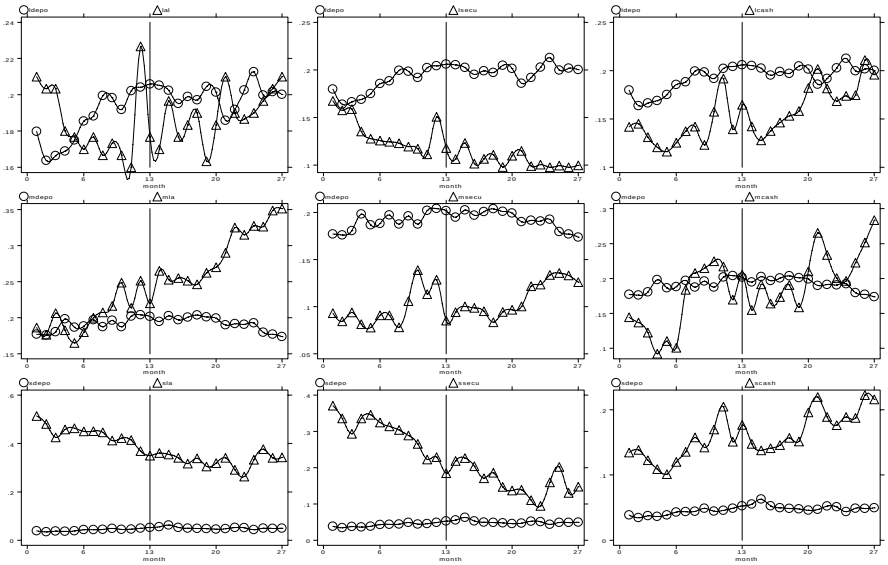
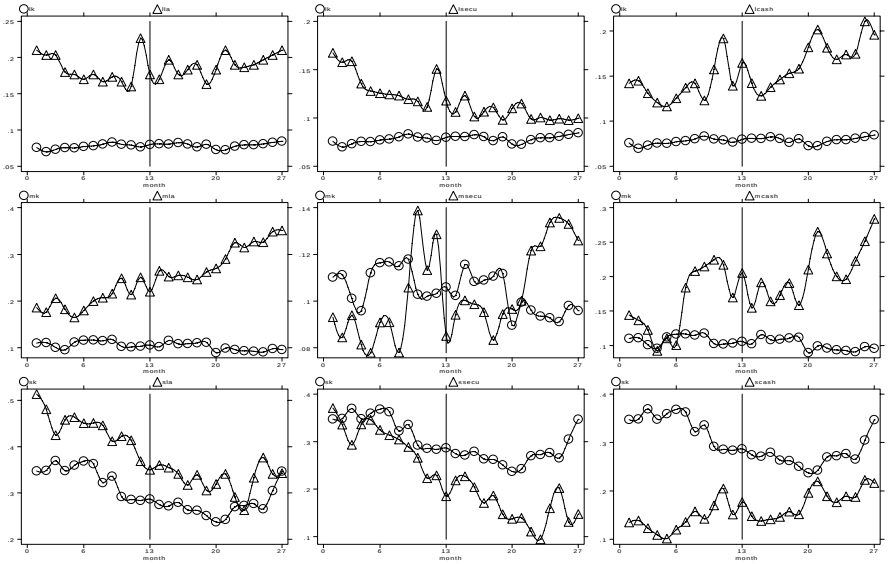


Figure 4. Average capital, liquid assets, cash, and securities by bank group.



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