Tracing the Financial and Real Impact of a Credit Crunch

[PRELIMINARY ... PLEASE DO NOT CITE]

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Abstract

From the great depression to recent recessions in Asia and the US, shocks to the *supply* of liquidity in the banking sector have often been blamed for creating and prolonging economic downturns. However separating the *causal* impact of such a "credit crunch" from contemporaneous demand and productivity shocks hitting the economy has proven difficult. In this paper we isolate this causal impact by using firm fixed effects and variation in the supply of liquidity across banks induced by their exposure to dollar deposits prior to nuclear tests by India and Pakistan. Using a data that links more than $61,000$ firms with banks in Pakistan, we show that for the *same* firm borrowing from two different banks, its loan from the bank experiencing a 1% larger decline in liquidity drops by an additional 0.37%. The effect is even stronger for smaller firms. Liquidity crunches to the bank also reduce the probability that it lends to a new client and that it continues to lend to an existing client. Tracing the impact of this liquidity shock further we find that firms are unable to hedge these shocks through other banks in the market as a firm's *total* borrowing from the financial sector falls by 0.33% for every 1% drop in its pre-shock banks' deposits. These liquidity shocks also have real effects as they lead to an increase in the incidence of firm's default by 1.2% for every 1% drop in the liquidity of its bank.

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How effective are banks in isolating their client firms from credit supply shocks unrelated to the firms' future net worth? Banks often get adverse shocks to their supply of liquidity for a number of reasons including a poorly timed tightening of the monetary policy, random bank runs or "mob psychology" as in Kindleberger (1978) and Diamond and Dybvig (1983), and asymmetric information between banks and their depositors. Shocks to the supply of bank liquidity have been frequently blamed for creating or deepening a number of recessions in the past including the great depression, the US and Japanese recessions of the 90s, and the recent Asian crises (e.g. Bernanke (1983), Bernanke and Lown (1991), Hoshi and Kashyap (2000), Woo (2003), Agenor, Aizenman, and Hoffmaister (2000)).

However, despite the question's historical and economic importance, resolving it empirically has proven to be a difficult task. The difficulty stems from two basic hurdles. First, the literature has had a hard time separating adverse shocks to the supply of liquidity from contemporaneous or resultant negative shocks that impact the demand for liquidity. Such unobserved shocks include those to firm productivity and aggregate demand shocks. Second, there has been a lack of micro-level data linking banks to *individual* firms borrowing from them.

This paper addresses these two fundamental problems as follows. First to identify the impact of a fall in the *supply* of liquidity, we use firm fixed effects to compare lending growth for the *same* firm across different banks that experience varying liquidity shocks induced by the unexpected nuclear tests in India and Pakistan. The firm fixed effects absorb *all* firm specific and economy-wide demand shocks including the ones mentioned above and thus allow us to identify the *causal* impact of an adverse shock to the supply of bank liquidity. The identification strategy can be better understood through a simple example. Consider a firm borrowing from two different banks A and B. Bank A relies on dollar deposits as its source of liquidity and hence experiences a sharp reduction in liquidity relative to bank B when Pakistan tests its nuclear devices.[1] If the firm experiences a sudden reduction in its loan from bank A relative to bank B, then the additional reduction in loan supply from bank A can only be attributed to the reduction in bank $A's$ liquidity supply and not to any change in the firm's demand for loans.

Second, the paper uses a novel data set that links more than $61,000$ firms to banks over a three year period and comprises the *universe* of corporate lending in the country. Not only

[1] We will explain the precise mechanism for this reduction in liquidity in the following section.

do we know the identity of each bank and firm, we also know the total amount that is lent through the financial markets to each firm. The data contains quarterly loan level information on each of the more than $71,000$ loans taken by these firms from all lending institutions. The information includes loan amount, default rate, and recovery/litigation in case of default and also has firm-level information such as a firm's location, industry, and group affiliation, and bank-level financial data. The scope and depth of the data set helps us address a number of important questions. For example, not only can we identify whether a liquidity supply shock reduces bank lending to a firm, but we can also test if the firm compensates for this loss by going to other institutions in the financial market. This is an important issue because even if liquidity shocks are passed on at the *bank-level*, they may not matter for the overall economy if firms can borrow from other sources in the financial market. While this still leaves open the possibility that firms compensate by borrowing from non-formal financial sources (internal, group, family etc. funds), we can also indirectly check for this by seeing whether the firm experiences real consequences of the liquidity crunch in terms of higher default rates.

Using the identification strategy outlined above, we show that a 1% decline in the supply of bank liquidity causes a reduction of 0.37% in the loan given to a firm by the bank. Moreover, the shock to a bank's liquidity also impacts both its willingness to lend to new clients and to continue to lend to existing clients: A 1% fall in bank liquidity reduces the probability of lending to a new client by 0.83% and the probability of continuing to lend to an existing client by 0.16%. These effects are even stronger for smaller firms suggesting that banks prefer to shrink lending to smaller firms first. Thus smaller firms appear particularly vulnerable to changes in the supply of liquidity in an economy.

Tracing the impact of our liquidity shock further, we find that firms are unable to hedge the reduction in loans from their pre-shock banks by going to other institutions in the financial market, including non-bank financial intermediaries, that do not experience a similar reduction in liquidity. A 1% decrease in the average liquidity of the banks a firm was borrowing from prior to the shock, results in a 0.33% fall in the firm's total borrowing from all (formal) financial intermediaries after the shock. There is evidence to suggest that these financial shocks to the firms are not compensated through informal means either as firms experience losses in real outcomes. Specifically, we find that a 1% decline in the supply of bank liquidity leads to an increase in the incidence of firm-level default by 1.2%. There are thus substantial real consequences of the credit crunch.

Given the importance of the question, it is not surprising that there exists a large body of literature looking at the impact of liquidity shocks on banks. Theoretically, papers such as Bernanke and Blinder (1988), Holmstrom and Tirole (1997), and Stein 1998 have shown how a credit supply shock to banks is transmitted to their firms due to market imperfections that lead to a failure of the Modigliani Miller hypothesis at the bank level. To provide empirical support, initially papers such as Bernanke and Blinder (1992), Bernanke (1983), and Bernanke and James (1991) used time-series correlation between changes in monetary policy or deposits, and changes in loans or output to argue for a causal link between supply of credit and lending. However, the papers suffer from a concern that omitted variables like economy wide productivity shocks may be correlated with both changes in the supply and demand of credit, hence making any causal inference impossible. This led to work that used cross-sectional variation (either across banks or firms) in lending *changes* to account for any economy wide omitted demand shocks. Papers in this line of research include Gertler and Gilchrist (1994), Kashyap, Lamont, and Stein (1994), Oliner and Rudebusch (1994), and Kashyap and Stein (2000). However, these papers suffer from a related concern that cross-sectional variation in changes in loans or output of firms may be driven by omitted firm or bank specific demand shocks. More promising and recent attempts to deal with these issues attempt to find sources of exogenous variation in the supply of bank liquidity. Parvisini (2004) exploits a government credit market program for small and medium firms in Argentina. While the uptake of this extra liquidity was a choice for banks and therefore subject to similar endogeneity concerns arising from demand considerations, the paper instruments for the availability of this additional liquidity using pre-specified formulas that determined how much credit each bank was eligible for based on its average loan size and proportion of lending in poor areas.

The empirical methodology used in this paper also exploits a natural experiment, the liquidity shock caused by nuclear tests conducted by Pakistan in response to India's tests, but in addition, uses firm fixed effects to account for all firm and economy wide credit demand changes, thereby providing much cleaner estimates of the liquidity shock. Moreover, this methodology allows us to empirical verify the bias that arises in OLS specifications or even those that attempt to instrument for the liquidity shock. Interestingly, we find that these biased specifications produce underestimates of the true effect as opposed to the over-estimates that one is typically concerned with (since usually both the credit supply and demand changes move in the same direction). This arises because the liquidity shock induced by the nuclear tests affects higher quality banks more which in turn are likely to have clients that are better able to withstand the shock and show a smaller impact on their credit demand. The fact that these specifications produce underestimates also allows us to present conservative estimates even in cases where the fixed effect specification cannot be employed, such as the impact on a firms' total borrowing from all financial institutions. We shall discuss this in more detail in section II.

In what follows, section I describes the data and the institutional background necessary to understand our empirical methodology. Section II then describes our empirical methodology and how it addresses the traditional empirical problems. Section III estimates the liquidity impact, section IV tests how the effect varies across firms and over time. Section V then traces the real impact of the liquidity shock by testing if firms can hedge the bank-specific shocks and whether liquidity impact leads to higher default rate by firms. Section VI concludes.

I Data and Institutional Background

We start by describing the data used in our analysis. In order to understand the context of the liquidity shock and how it leads to differential shocks across banks, we also discuss how this shock arose in response to Pakistan's nuclear tests. In doing so we highlight the role that foreign currency deposit accounts in banks prior to the nuclear tests played in creating shock heterogeneity across banks.

A. Data

The primary data used in this paper is unique both in terms of its coverage and detail. We have quarterly information on *the entire universe* of corporate bank loans outstanding in Pakistan from July 1996 to December 1999. The data was provided by the central bank of Pakistan which supervises and regulates all banking activity in the country and as such, accurately captures this universe. The data is at the level of the bank, borrowing firm and quarter and traces the history of lending with information on the amount of the loan (principal and interest) outstanding by different loan types (fixed, working capital, etc.), default amounts and duration, and any litigation, write-offs or recoveries on these loans. In addition, we have information on the name, location and directorship of the borrowing firms and banks allowing us to construct various borrower and bank level attributes.

Although the original data includes 145 financial intermediaries, we restrict our sample to the 42 commercial banks which were allowed to open demand deposits (including dollar deposits). In other words, these banks were involved in the intermediation of liquidity and since the paper investigates a liquidity shock we limit ourselves to them. However, when we consider changes in total amount borrowed by a firm, we do include borrowing from all financial intermediaries. The 42 banks included in our sample make up 78% of total loans (by value) in the original data.[2]

Since we are interested in how firm lending changes in response to the liquidity shock, we exclude loans that were in default prior to the shock from our analysis. This gives us a sample of $61,497$ unique firms over 14 quarters (July 1996 to December 1999). The cross-sectional unit of observation in the data is a *loan* defined as a bank-firm pair. Since a firm can borrow from more than one bank, there are a total of $71,969$ loans in this sample. In addition, in our primary specification, since identification comes from exploiting differences in lending changes across banks to a firm, we generally further restrict the data to loans that existed both before and after the nuclear tests. This restriction gives a panel data set of 42 banks lending to 18,647 unique firms and a total of 22,083 loans. In all, the sample contains 393,579 loan-quarter observation. Table I summarizes these basic data characteristics, and Table II summarizes the basic statistics of the variables used in our analysis.

Unless otherwise stated, we collapse the quarterly panel data by taking time-series averages before and after the May 1998 nuclear shocks.[3] We do so to avoid issues of serial correlation in the data and thus get conservative standard errors (see Bertrand, Duflo, and Mullainathan (2004)).

All loans in our sample are loans to private firms in the economy. There are some large government owned firms in traditional government-run sectors such as utilities, airline, and defense. However, we exclude loans to government firms as including government firms which are backed by government guarantees, may confound the analysis. In any event, including the

[2] One could have included the remaining 103 banks under the assumption that since these banks did not have demand deposits, they were not impacted by the liquidity shock. Doing so does not change any of our results significantly.

[3] We exclude the quarter during which the nuclear shock occured in these calculations. Before taking time-series averages, we converted all values into real 1995 rupees (Rs.)

few government owned firms does not change our results significantly.

B. The Banking Sector in Pakistan

After starting off in the 1950s with a liberalized banking sector followed by a wave of nationalization in the 1970s, Pakistan underwent a series of broad financial reforms in 1991. By the start of our data period Pakistan had a relatively open banking sector with significant private and foreign bank presence, regulation of all lending institutions by an autonomous Central Bank (the State Bank of Pakistan), and prudential regulations that brought supervision guidelines in-line with international banking practices (Basel accord). Two features of interest to this paper in these reforms were the setting up of a centralized credit information bureau (CIB) to track loan-level default and other information, and allowing local residents to hold foreign currency (mostly dollars) deposits in Pakistan. The former is the primary source for the extensive data used in this paper and the latter resulted in differential liquidity shocks to banks after Pakistan's nuclear tests and helps in our empirical methodology.

Foreign Currency Accounts:

As part of the financial reforms, the State Bank of Pakistan (SBP) allowed private citizens to open foreign currency deposit accounts within Pakistan in 1991 (SBP FE circular #36). The move was aimed at stopping the "flight" of capital oversees as citizens, concerned by large devaluations of the local currency, had dollar-denominated assets in off-shore bank accounts through the black market. Since almost all of the foreign currency accounts introduced were denominated in dollars, we shall henceforth refer to them as "dollar accounts".

Although the dollar accounts were opened with local private, government and foreign banks, the banks could not keep the dollars and instead had to surrender them to the SBP in return for equivalent rupees. When a depositor demanded his dollars (with interest) back from the bank, the latter would obtain these dollars from SBP by paying it rupees at the exchange rate *at the time the deposit had been made*. All the exchange rate risk (for principal as well as interest) during this time was borne by the SBP:

> [foreign currency deposits are] required to be surrendered to the State Bank. In return the State Bank gives to the institution surrendering the foreign exchange, equivalent Pakistan Rupees at the rate prevailing on the date of surrender. The concerned institutions are entitled to receive back from the State Bank the amount

> of foreign exchange surrendered at the same rate at which it was surrendered to the State Bank. In other words, the State Bank assumes the exchange fluctuation risk. (SBP notification #54, June 7, 1992)

The SBP charged a 3% fee to the banks for foreign currency accounts, and given that actual depreciation of the local currency from January 1992 to December 1997 was 4.3%., this fee was subsidized.

Foreign currency accounts turned out to be extremely popular for a couple of reasons. First, since the general view was that the local currency would depreciate significantly, most were able to foresee the subsidy provided by the SBP and take advantage of it. Second, the government also turned a blind eye to the source of the foreign currency. While most were informal remittances from abroad, dollars could also be readily bought off the black market, and therefore provided a means of "legitimizing" money accrued through suspect means. In the words of the original notification that allowed such accounts, *"No question will be asked by any authority in Pakistan about the source of acquisition of such foreign exchange".*

As a result, by May 1998, dollar accounts had become a dominant source of liquidity for Pakistan's commercial banks, with 43.5% of total deposits in the country denominated in dollars. More importantly, from the point of view of this paper, there was significant variation across banks in their exposure to dollar deposits. Percentage of deposits denominated in dollars ranged from 0% to 98%, with a standard deviation of 27% (see Table II). This was partly a matter of the existing customer base of these banks, partly a reflection of how individuals viewed each bank (i.e. foreign banks such as Citibank were regarded as a more "natural choice" to open a dollar account), and also a result of the marketing strategies of each bank. Since dollar deposits were regarded as attractive by the banks, more pro-active ones tended to open more of these accounts.

C. Nuclear Tests, Account Freezes and Liquidity Shocks

On 11^{th} May, 1998 India unexpectedly tested its nuclear weapons. Despite international pressure and threat of sanctions to act otherwise, Pakistan, under domestic pressure to retaliate, tested its own nuclear devices on the 28^{th} of May 1998. These events led to a sudden imposition of international sanctions on both India and Pakistan. Since the external accounts position was much weaker for Pakistan than India, the international sanctions had an immediate negative impact on the balance of payments position of Pakistan. For example, the country could no longer rely on international assistance from the IMF and others for short-term "bail-outs".

In anticipation of these balance of payment problems which were certain to arise, the Prime Minister of Pakistan along with the announcement of the nuclear tests, declared that the foreign currency accounts would be "frozen". This meant that depositors could no longer take their money out in the form of dollars and only do so in rupees. Moreover, the SBP reneged on its earlier agreement to convert these dollars at the exchange rate at the time of deposit, and instead offered to do so at the current official rate which was below the black market rate and significantly lower than most depositors' time of deposit rate, given the depreciation over the prior years. Thus the "freeze" essentially amounted to a partial default on dollar deposits by the government.

Dollar Accounts Leading to a Liquidity Shock

The unanticipated political events of May 1998 in India and Pakistan had a serious impact on dollar deposits. In anticipation of further local currency depreciation (see Figure I for how these expectations were indeed upheld), most dollar deposit holders rushed to take their money out in local currency. Figure II plots the aggregate dollar deposits over time and shows this sudden withdrawal from dollar accounts after the nuclear tests.

Not surprisingly, the dollar deposit exodus lead to a large shock to the supply of liquidity for those banks that were reliant on dollar deposits. This is starkly illustrated in Figure III which plots the overall change in liquidity for banks from December '97 to December '99 against their pre-nuclear shock reliance on dollar deposits. Similarly, Column (1) of Table III regresses change in liquidity against percentage dollar deposits before nuclear tests and shows a large and significant negative relationship between the two. Column (2) repeats the regression in column (1), but weighs each observation by the size of its bank. The weighted regression is economically more meaningful and shows an even stronger negative relationships between change in liquidity and exposure to dollar deposits. A 1% increase in the percentage of dollar deposits held by the bank before the nuclear tests, led to a 0.55% decline in liquidity of the bank. The R-sq of this regression is also very high at 32%.

The negative impact on dollar reliant banks was also noted by the main business press in the country:

> With the run for encashment of dollars they *(dollar dependent banks)* faced

> serious liquidity problems. (Pakistan Economist, June 28, 1999)

The greater liquidity shock to dollar deposit reliant banks should not come as a surprise. To the extent that depositors converted their dollars to rupees at a lower rate, this implied that the actual rupee value of a bank's deposits fell (i.e. the same dollar account was suddenly worth a lot less in rupees). However, these banks and in fact the banking system as a whole, suffered from an additional and perhaps even more serious loss of depositor confidence. As a result, a significant fraction of the dollar depositors simply exited the Pakistani financial markets either by transferring their money abroad as dollars through the black market or investing in alternate assets such as real estate.

> An immediate and telling manifestation of this loss of confidence has been the process of financial disintermediation precipitated by the freeze on FCAs. (Economy Watch , ABN Amro Bank Pakistan, August 1998).

The loss of confidence may have been even larger for dollar-reliant banks compared to those with lower dollar deposits since, as shown in Figure III, some of the latter actually experienced a gain in their rupee deposits, despite the overall liquidity shock to the economy.

Thus the primary cause of the liquidity shock was the freeze of dollar accounts by the government and the ensuing loss of reputation in the public's eyes. Given that India's Nuclear tests, which set the whole process going, were not expected by anyone particularly in Pakistan, we can treat this as an entirely unexpected shock to the economy and exploit this in our analysis.[4]

II Empirical Methodology

The theoretical basis for how an adverse shock to the supply of liquidity of a bank (i.e. a credit crunch) might restrict the supply of loans to firms has been well studied. Papers such as Bernanke and Blinder (1988), Holmstrom and Tirole (1997), and Stein 1998 provide some of the leading explanations of this effect. These papers differ in their details, but share the same basic idea. When banks face a shortage in the supply of liquidity from their deposit holders,

[4] Note that this does not mean that the change in depoits can be treated as a exogenous liquidity *supply* shock since there can also be accompanying demand shocks. What it does imply though is that lending changes after the shock were not anticipated before the shock, but were an outcome of it.

they are unable to fully compensate for the deficit through alternative sources such as bonds, equity and private debt markets. The inability to access alternative sources could be driven by a number of market imperfections including informational asymmetries and agency concerns. This failure of the Modigliani Miller theorem at the bank level means that banks are forced to cut back lending to their client firms even if there has been no change in these firms' credit worthiness. If the firms cannot find new sources of financing either, then the reduction in their bank loans leads to lower output and productivity in the overall economy. As discussed in the introduction, such arguments have been routinely put forward to explain large economic collapses ranging from the Great Depression to the recent Asian crises.

The above hypotheses however have not gone unchallenged. Critics such as Romer and Romer (1990) argue that the inability of banks to raise new financing as assumed by the above explanations is not an accurate depiction of the real world. Such papers argue that shocks to the supply of bank liquidity have no important real consequences. Instead large economic crises can be better explained by real productivity shocks or some other alternative explanation.

Although there has been a large empirical literature aimed at discriminating between the two competing explanations, the literature has struggled with properly identifying the causal impact of an adverse liquidity shock to the banks. In this section we first highlight the basic identification problem that the literature has struggled with and then outline our methodology for resolving this problem.

A. The Basic Problem of Identifying a Liquidity Shock

To outline the basic econometric issue, consider a simple two period model in which banks lend to firms to finance their projects. For simplicity, we assume that a bank can only lend to a single firm.[5] Let i and j index banks and firms respectively. In period t, bank i and firm j come together and negotiate a loan of size L_{ij}^t. In order to finance this loan bank i can raise financing through two sources, (i) demandable deposits D_i^t, and (ii) alternate forms of financing (equity, bonds etc.) denoted by B_i^t. The loan L_{ij}^t is the only asset available to the bank. In other words, at any time t, the following accounting identity holds for each bank i lending to firm j:

[5] We want to emphasize here that out purpose is not to build a full fledged model of bank intermediation. We shall deliberately only focus on those ideas that we feel are important in explaining the fundamental econometric issues.

$$D_i^t + B_i^t \equiv L_{ij}^t \tag{1}$$

In light of the theoretical literature cited above we make the important assumption that raising non-deposit funds (i.e. B_i^t) is costly. For simplicity this assumption is introduced as follows. A bank can raise deposits costlessly but only up to a maximum amount $\overline{D}_i^t$. However, raising equity and bonds (B_i^t) is costly with the marginal cost linear in B and given by: ($\alpha_B * B_i^t$). The assumptions of costless (but limited) supply of deposits and the functional form of the cost function are only for tractability. What is important is that external financing (B_i^t) be costlier than raising deposits D_i^t (i.e. $\alpha_B > 0$ in the model). The cost function for additional financing implies that the overall credit supply function for a bank ($D_i^t + B_i^t$) is linear.

The total amount ($D_i^t + B_i^t$) raised by the bank is lent to its firm in the form of a loan L_{ij}^t. The marginal return on this loan L_{ij}^t is also linear and is given by ($\overline{r}_j - \alpha_L L_{ij}^t$). This functional form captures decreasing marginal returns as the size of the loan increases. We thus get a linear credit demand function for bank i. Given the linear supply and demand curves, the equilibrium amounts of B_i^t and L_{ij}^t are given by the intersection of these curves in each period.

At the end of time t, the economy (banks and firms) receives two types of shocks. The first, a "credit supply" shock, determines the level of deposits available to each bank in period $t+1$. In particular, the supply of deposits for bank i in $t+1$ is given by $\overline{D}_i^{t+1} = \overline{D}_i^t + \overline{\delta} + \delta_i$, where $\overline{\delta}$ and δ_i are economy wide and bank-specific shocks respectively. The second shock is a "credit demand" shock that firm j experiences in the form of a shock to its productivity. In particular, the marginal return on its loan L_{ij}^{t+1} next period is now given by: $\overline{r}_j + \overline{\eta} + \eta_j - \alpha_L L_{ij}^{t+1}$. The productivity shock ($\overline{\eta} + \eta_j$) reflects an economy wide and a firm-specific component respectively.

Given the linear set up of our model, the equilibrium each period can be easily determined by jointly solving the FOC[6] and the accounting identity (1) for L_{ij} and B_i. Since both equations are linear, we can write the solutions in terms of changes from last period. The solution for our main variable of interest i.e. L_{ij} is given by:

$$\Delta L_{ij} = \frac{\alpha_B}{(\alpha_L + \alpha_B)}(\overline{\delta} + \delta_i) + \frac{1}{(\alpha_L + \alpha_B)}(\overline{\eta} + \eta_j) \tag{2}$$

Equation (2) although derived from an admittedly simple model, highlights some important

[6] The FOC is $\alpha_B B_i^t = \overline{r} - \alpha_L L_{ij}^t$ in period t, and $\alpha_B B_i^{t+1} = \overline{r} + \overline{\eta} + \eta_j - \alpha_L L_{ij}^{t+1}$ in period $t+1$.

requirements for properly identifying a credit supply shock. First, it shows the importance of costly external financing, or $\alpha_B > 0$. Without this assumption, banks will be in a Modigliani-Miller world and shocks to deposits or "liquidity shock" (δ) would have no impact on equilibrium loan amounts. Second, and more importantly for this section, it highlights the identification problem in trying to the estimate the causal impact of a liquidity shock on loans. To see this, let us first re-write (2) as:

$$\Delta L_{ij} = \frac{1}{(\alpha_L + \alpha_B)}(\alpha_B * \overline{\delta} + \overline{\eta}) + \frac{\alpha_B}{(\alpha_L + \alpha_B)}\delta_i + \frac{1}{(\alpha_L + \alpha_B)}\eta_j \tag{3}$$

The first term on the RHS of (3) is just a constant reflecting economy wide shocks. Thus time-differencing has the advantage of taking out *all* secular time trends in the economy by absorbing them in the constant term. Let β_0 $(= \frac{1}{(\alpha_L+\alpha_B)}[\alpha_B * \overline{\delta} + \overline{\eta}])$ denote this constant term. The second term on the RHS contains the main coefficient of interest. Let $\beta_1 = \frac{\alpha_B}{(\alpha_L+\alpha_B)}$, then β_1 captures the "liquidity impact" on loans for each incremental unit of deposits lost (δ_i). For an econometrician, the closest OLS regression he can run to estimate (3) is given by:

$$\Delta L_{ij} = \beta_0 + \beta_1 * \Delta D_i + \varepsilon_{ij} \tag{4}$$

However notice that the estimate $\hat{\beta}_1^{OLS}$ in (4) will be biased as long as $Corr(\delta_i, \eta_j) \neq 0$. This isolates the fundamental problem: In reality δ_i and η_j are very likely to be *positively* correlated. For example, "liquidity shocks" such as bank runs are more likely to occur in banks that receive some bad news about the quality or productivity of the firms they lend to. Given this positive correlation between δ_i and η_j, β_1 is extremely hard to estimate, and any estimation similar to (4) will lead to an over-estimate as $\hat{\beta}_1^{OLS} = \beta_1 + \frac{Cov(\delta_i,\eta_j)}{Var(\delta_i)}$..

B. Our Approach To Identifying the Liquidity Shock

In this section we outline our methodology for identifying the "liquidity impact" coefficient β_1 above. Our primary identification strategy will rely on using firm fixed effects.

First note that we do not rely on endogenous liquidity shocks such as those created by some "bad news" about a bank's financial health. Instead we use variation in liquidity shocks across banks induced by the unexpected nuclear tests. As outlined in Section I above, this liquidity shock to the bank is related to its proportion of deposits held in dollar accounts and the government's decision to "freeze" such accounts and is *not* due to a larger decline in the quality of its loan portfolio. *However*, we should caution that this by itself does not imply that the proportion of dollar deposits held by the bank will be a valid instrument for identifying β_1 and in fact, as we will show, it is not. The issue is that such exposure may be related to differences across banks and their client firms which could create identification issues due to differing credit demand shocks across banks. Thus we will not rely on instrumentation as our main identification strategy. Nevertheless, we will make use of such estimates since we can show that they are in fact *underestimates* of the true effect.

Firm Fixed-Effects

A unique feature of our data provides us with the novel opportunity to estimate the true β_1 for a subset of firms without relying on any special identifying assumptions.

The idea behind the new estimation strategy is to restrict to only those firms that borrow from multiple banks in the data and then augment by putting in firm fixed effects. There are more than 1,800 firms in our sample that borrow from multiple banks. Firm fixed effects can thus isolate the credit supply shock by testing if for the *same* firm, a bank with a larger liquidity shock restricts lending more than a bank lending to the same firm but facing a smaller liquidity shock. Empirically, our new strategy translates into running the following OLS regression:

$$\Delta L_{ij} = \beta_j + \beta_1 * \Delta D_i + \varepsilon_{ij} \tag{5}$$

where β_j are firm fixed effects. Notice that β_j subsume *all* possible firm level shocks η_j, and thus $\hat{\beta}_1^{FE}$ in (5) is an unbiased estimate of the true β_1. In order words, since we are only comparing how different banks change their lending to the *same* firm, we are assured that these relative changes cannot be driven by a change in the firm's demand for credit as that would have affected lending from all banks similarly (and is therefore absorbed by the firm fixed effect) but indeed reflects the relative shocks to the *supply* of liquidity across the banks.

Although (5) provides an unbiased estimate of β_1, it comes at the slight cost that the sample has to be limited to firms that borrow from multiple banks. However, we can examine whether this matters by comparing OLS estimates in this restricted sample with those obtained in the larger sample of all firms.

Establishing the Direction of Bias in OLS/"IV"

While our preferred identification strategy makes use of firm fixed effects, we will not always be able to make use of this methodology. For example, when examining how a firm's overall borrowing changes in response to the shock (to check whether it is able to substitute towards other lending sources) it is no longer possible to use firm fixed effects since the LHS variable does not vary for a given firm. Similar issues arise when we examine what impact the liquidity shocks have on a bank's willingness to lend to new clients or continue lending to older clients.

However, even in this case, our paper is able to make a significant empirical contribution since we are not only able to theoretically argue that our OLS/"IV"[7] estimates will be underestimates, but can in fact empirically verify that this is the case. To understand why this is an important contribution, recall that most studies suffer from their findings being overestimates of the supply of liquidity impact. The reason is that negative supply shocks to a bank's liquidity are typically associated with negative shocks to their client firms' demand for liquidity (i.e. the two are positively correlated). In contrast, we will first argue and then show that the opposite holds in our case.

Apriori one would expect that banks that experienced greater liquidity crunches after the nuclear tests i.e. those with a higher fraction of dollar deposits - were generally of better quality. The reason is, as we argued in section I, dollar deposits were regarded as highly attractive both by banks and depositors and therefore more pro-active banks, those with a better depositor base (wealthier, foreign etc.) and better reputation for being safer/higher quality etc. were more likely to have accumulated such accounts. Columns (3)-(6) in Table III go a step further by providing empirical support for this claim. They show that dollar reliant banks indeed are of better quality both in terms of the average default rate on their loans and their ROA. Similar results are obtained if we replace percentage dollar deposits with actual deposit change on the RHS (i.e. banks that experienced larger declines in deposits were more profitable with lower defaults).

Thus, while the *presence* of dollar deposits in a bank is unlikely to have influenced its lending decisions,[8] the above shows that dollar reliant banks were of better quality than other

[7] We purposely use quotation marks when referring to the "IV" estimation since, as we will show, the obvious potential instrument to use, fraction of dollar deposits, is not valid. We nevertheless discuss this potential instrument because it helps in explaining why both the OLS and the attempted IV estimates are underestimates.

[8] The exchange rate insurance provided by the central bank meant that banks did not have to hedge changes in

banks. To the extent that such banks are more likely to lend to better firms in the economy (and the lower default rates in Table III may reflect this), then both the OLS estimates and the potential "IV" estimates (using fraction of dollar deposits as an instrument for deposit changes) will produce underestimates, since better firms are less affected by the shock and hence experience smaller changes in their credit demand i.e. the change in deposits (fraction of dollar deposit) is negatively (positively) correlated with the error term in (4).

While we have argued that our OLS and potential "IV" will lead to underestimates, we will also verify that this is the case in the next section. We are able to do so by comparing our preferred unbiased estimate from the firm fixed effect specification (5), to either a simple OLS or attempted "IV". As we will describe later, doing so gives us lower estimates for β_1 compared to when firm fixed effects are used. Thus we have direct empirical support for our claim.

C. Tracing the Credit Crunch Downstream

The scope and depth of our data set and identification strategies also enables us to answer a number of related empirical questions apart from the impact on bank specific firm borrowing. Since we show that OLS/"IV" leads to underestimates, to the extent that a similar bias is present in related specifications where firm fixed effects cannot be used, we will provide the biased OLS coefficients as they present a useful lower bound for the liquidity supply impact.

There are a variety of related outcomes we consider. First, as mentioned above, we test if firms can substitute out of the credit supply shock through other banks in the financial market. Second, besides measuring the average magnitude of the credit crunch effect, we consider if certain types of firms such as small firms and firms more likely to be credit constrained are hit harder. Third, we can explore the time series to compare the immediate versus medium run impact of the shock. Finally, we can measure real impacts of the credit crunch by estimating its impact on a firm's default probability. These tests and their results will be discussed in later sections.

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supply of liquidity due to exchange rate fluctuations. One way to do so could have been by lending to firms whose liquidity needs "co-move" with exchange rate fluctuations. However, insurance from liquidity shocks caused by exchange rate fluctuations meant that dollar-dependent banks did not systematically target any special set of firms in order to reduce exchange rate risk.

III Estimating the Liquidity Impact of a Credit Crunch

In general when a bank is hit with a liquidity shock, it can respond in one of two ways: (i) reduce lending to existing borrowers (the intensive margin), and (ii) stop lending to old and new potential clients altogether (the extensive margin). We explore both of these margins separately below.

Since our empirical methodology uses changes in variables as a result of the nuclear tests, we use the collapsed version of our data where quarterly observations for a given loan are averaged into a single observation before and after the nuclear tests. Changes in specific variables are then computed as differences between the pre and post collapsed observations. As discussed earlier, the averaging of pre and post variables is done to ensure that the standard errors are not biased downwards because of auto-correlation.

A. The Intensive Margin

To test for the liquidity impact at the *intensive* margin, we restrict data to loans that appear both before and after the nuclear tests.

As discussed in section II, the OLS and potential "IV" coefficients may be an under-estimate of the true effect. Therefore we start with our preferred estimation strategy that uses firm fixed effects. Column (1) In Table IV present the results of estimating (5): It regresses the percentage change (log differences) in loan amount borrowed by firm j from bank i against the percentage change in liquidity of bank i. The results show that every 1% reduction in the liquidity (deposits) of a bank leads to a large 0.37% reduction in the loan of a firm borrowing from that bank. We shall henceforth refer to this coefficient as the "liquidity impact" coefficient. Since putting in firm fixed effects only exploits variation within firms across banks, this estimate in not biased by the usual credit demand side considerations and shows that there is indeed a large an important liquidity impact in bank lending.

Column (2) includes several earlier bank level controls such as pre-98 (i.e. pre-shock) profitability (ROA) of a bank, pre-98 deposit growth of a bank, log of bank size, and pre-98 capitalization ratio[9] and shows the robustness of the result to these variables.

We should point out that all loan or firm level regressions run in this paper use clustered

[9] Pre-98 ROA, bank size, and capitalization rate are averages over fiscal years 1996 and 1997 (fiscal years end in december). pre-98 deposit growth is calculated as growth in deposits from dec 1996 to dec 1997.

standard errors with the each of the 42 banks being a unit of cluster. In other words, we allow for cross-correlation among loans from the same bank. Since collapsing the time dimension of data already took care of any auto-correlation concerns, the standard errors reported in this paper should be conservative.

OLS/"IV" Underestimates:

We had argued in section II that OLS or "IV"estimates, using pre-shock dollar deposit fraction as instrument, were both likely to lead to underestimates. Columns (3) and (4) show that this in indeed the case. Estimating either OLS or "IV" in the same sample of multiple-bank firms we see that the estimated coefficient indeed drops to 0.192 or 0.052 respectively. Not surprisingly the IV is also much less precisely estimated[10] and so we should not infer too much in comparing the relative coefficients of the OLS and "IV" - just that they are both smaller than the correct firm fixed effects one.

Sample Biases:

A concern in the fixed-effect estimate is that since we can only run this in the sample of firms that borrow from multiple banks, to the extent that such firms are different (for e.g., bigger) our estimate may not be the same as that for the average firm. While we cannot address this question directly, we can provide a sense of it by running the same OLS or "IV" regression in Columns (3) and (4) but this time in the full sample of firms. Columns (5) and (6) do so and show that it is likely that this sample restriction has an impact. However, the OLS/"IV" coefficients in the full sample are larger, suggesting that if anything, running the firm fixed specification in the full sample of firms would have lead to an even bigger estimate. Since firms that do not borrow from multiple banks are smaller firms on average, this suggests that the liquidity impact may be even larger for such firms i.e. banks that face a liquidity shock pass more of it to their smaller clients. We will explore this more directly later.

B. The Extensive Margin

The results in Table IV show that firms that continued borrowing after the nuclear tests (i.e. the intensive margin), received substantially smaller loans if their bank was more exposed to

[10] Note that $Var(\hat{\beta}_1^{IV}) = \frac{Var(\hat{\beta}_1^{OLS})}{r^2_{Z\Delta D}}$, where $r^2_{Z\Delta D}$ is the sample correlation between Z_i^t and ΔD_i. Hence the variance of IV estimate is always higher than the variance of the OLS estimate, with the difference between the two inversely proportional to the strength of the first stage.

the liquidity shock. The firm fixed effects specification confirmed that our results cannot be attributed to any unobservable firm characteristic such as a spurious loan demand shock. We now explore whether the credit crunch also impacted the extensive margin by forcing banks to either stop lending to firms altogether, or reduce the intake of new firms after the shock. As argued in section II, while we cannot readily use our preferred firm fixed effects specification here, we can still present the OLS/"IV" estimates since we know that they will be underestimates and present a lower bound to the true effect.

To test if the "exit rate" of firms is higher in banks harder hit by the credit crunch, we select all non-defaulted loans of banks in the quarter before the May 1998 shock. There are $23,684$ such loans. For each loan, we create a variable $EXIT$ which is 1 if the loan is not renewed after the 1998 shock. Column (1) in Table V shows the result of regressing $EXIT$ on bank liquidity shock using a simple OLS specification. The results show that similar to our intensive margin results, the nuclear test shock induced credit crunch also increased the exit rate of firms. A 1% higher credit crunch leads to a 0.16% higher probability of exit for a loan (the mean exit rate for loans is 19.6%). Column (2) shows a somewhat larger effect in the "IV" specification.

Similarly, columns (3) and (4) test for the "entry rate" of new loans in banks after May 1998. To run this test, we start with all loans that appear at some point after the shock quarter in the data. There are 54,375 such loans. We then create a new variable $ENTRY$, which is 1 if the loan did not exist prior to the shock quarter and 0 otherwise. Column (3) shows that liquidity shocks to a bank's credit supply significantly impact its ability to issue new loans. A 1% reduction in liquidity of a bank reduces the probability of making a new loan by 0.59% (the mean entry rate in the data was 59.4%). Column (4) shows the slightly larger "IV" estimate.

Another way to understand the magnitude of the exit and entry results is to see that the standard deviation of bank liquidity shock from Table II is 30%. Thus for every one standard deviation decline in liquidity, exit rate for firms goes up by 4.8% (0.16*30) where the mean exit rate is 19.6%. Similarly, for a one SD decline, the entry rate of new firms goes down by 17.7% (0.59*30) where the mean entry rate was 59.4%. Moreover, knowing that these numbers are underestimates, suggests that there may indeed be significantly large liquidity effects.

The results in Tables IV and V reveal that shocks to a bank's supply of liquidity have a strong impact on the lending behavior of banks. As section II explained, the fixed-effects specification shows that the effect is a causal impact of changes in the supply of bank liquidity.

Our results thus cannot be attributed to unobserved shocks to the demand of loans by firms. The results show that Modigliani Miller hypothesis breaks down at the bank level, and hence shocks to the banking sector can easily propagate to the rest of the economy through changes in the banks' lending patterns.

IV Cross-Sectional and Time Series Effects of Credit Crunch

We have seen the *average* effect of a credit crunch on loan dispersal in the section above. We now explore if this effect differs across firms of different types, and also test in more detail how the effect evolves over time.

A. What firms are hit the hardest by a credit crunch?

Faced with a liquidity shock, what kind of firms will banks want to cut back on the most? Some of the theoretical work cited earlier argues that since maintaining long term relationships and reputation with borrowing firms is very important for banks, they would prefer to cut back on firms with the least long term cost. Similarly they may want to cut back on firms with the least bargaining power relative to the bank in future. To the extent that firm size serves as a useful proxy for overall value for the bank, as well as a firm's bargaining power, one would expect the credit crunch effect to be larger for smaller firms.

To test this we firm classify firms into 10 equal groups by their size decile as determined by overall firm borrowing, and then run the OLS version of the credit crunch test on each decile (regressions not shown). Figure IV plots the coefficient on change in bank liquidity for each of the 10 deciles. The figure shows a strong relationship between firm size and the credit crunch effect. In particular, smaller firms are hit much harder by the credit crunch than larger firms, with the liquidity impact as large as 0.8 for the smallest decile.

B. The Time Series Evolution of Credit Crunch

So far the time-series data had been collapsed before and after the liquidity shock to get at the "average" time effect. However, since the actual data varies by quarter, we can see the evolution of the initial credit crunch impact over time. To do so we go back to our original data and instead of running regressions in first differences as before, we run the following regression:

$$L_{ijt} = \beta_{ij} + \beta_t + \beta_{1t} * \Delta D_i + \varepsilon_{ij} \tag{6}$$

Figure V plots the quarter-wise coefficients β_{1t} (regression not shown), where the quarter of May 1998 is the omitted quarter. The figure illustrates a couple of important facts. First, there was no significant relative trend in the loans given out by dollar dependent banks before the nuclear shock. However, one quarter after the nuclear shock, we see a sharp decline in the relative loans given out by the dollar dependent banks. This shows that the liquidity impact measured earlier is really being driven by the liquidity shock resulting from the nuclear tests and not some incidental "trend" in the data. Second, we can see that this impact is not short-lived since it persists for the next several quarters.

V Tracing the Real Impact of Credit Crunch

So far we have seen that a reduction in the supply of liquidity to a bank leads to a sudden and sharp reduction in the loans provided by banks. As section II explained, this is due to the inability of banks to access alternative source of financing when faced with a liquidity shock. In other words, MM theorem fails at the bank level and banks pass the liquidity shock on to their firms.

This raises a second very important question: does the reduction in a firm's loan by the bank have an effect on the firm's real performance? It is possible that there is no effect if a firm is able to compensate the lost loan by going to other financial institutions in the economy. In such a case although the credit crunch would impact a bank's supply of loans, it will not have any real effect on the economy, as firms will be able to substitute away the shock through other lenders. On the other hand, if there are imperfections in the market that make it difficult for firms to access credit from new sources, then the reduction in loan supply from one bank might lead to overall lower financing for the firm and hence lower output as well. In this section we test if the reduction in loan due to the credit crunch identified earlier affects real outcomes for a firm.

A. How Far Can Firms Substitute Towards More Liquid Banks?

In order to answer this question properly, one needs detailed data that links a firm to all possible financial institutions in the country that the firm can borrow from. Due to this difficult data requirement, the literature so far has been unable to answer this question. Fortunately, our dataset does include a firm's borrowing from all financial institutions. If firms are limited in accessing alternative financial sources when faced with a liquidity shock from their bank, it underscores the importance of *bilateral relationships* between firms and banks. For example, if firms can relatively easily go to a new bank when their original bank faces an adverse shock, then bilateral relationships are not that valuable. Otherwise such financial relationships are very important and shocks to individual banks can be transmitted and propagated to the entire economy.

Recall that in the analysis so far, we have restricted our attention to commercial banks that used demandable deposits as their source of liquidity. However, when looking at the question of substitutability of loans, one ought to consider *all* possible financial intermediaries in the economy that a firm can turn to for financing. For this reason, we now include all of the 145 financial intermediaries in our analysis.

To test if a firm is able to substitute towards a different bank when one of its banks is hit with a liquidity shock, we adopt the following strategy. First for each firm we sum its loans across all banks in the economy at a point in time to compute the firm's aggregate borrowing. We then compute the aggregate liquidity shock faced by each firm by computing a *weighted average* of the change in deposits for each of the banks that the firm borrows from before the nuclear tests.

To understand how the test works, suppose there is no substitution at all and firms are stuck with the banks they have. Then running the aggregated regression should give us the same results as the loan-level regression. On the other extreme, if there is full substitution, then running the aggregated regression should give us a coefficient of zero. The reason is that all firms have equal access to lenders regardless of whether they were borrowing from them prior to the nuclear tests or not. Thus, even if prior to the nuclear test, a firm borrowed from a bank that experienced a large credit crunch, the firm will be able to compensate for that by borrowing from other banks that did not experience as large a liquidity shock. In other words, aggregate firm borrowing will not be correlated with the type of bank the firm was affiliated with before the nuclear tests. More generally, the greater the impact of substitution, the closer the aggregate liquidity impact coefficient will be towards zero relative to the loan-level estimate in Table IV.

Columns (1) through (3) in Table VI shows the result of running the aggregated regressions as a simple OLS, and then OLS with bank and firm controls. It can be seen that the estimated liquidity impact coefficients are always statistically similar to their loan-level liquidity impact coefficients. There is thus no evidence of substitution in our overall data: Firms are unable to avoid the adverse liquidity shock by going to other lenders in the market that may be more liquid than their initial banks.

B. Does Credit Crunch Lead to Higher Default Rates On Loans?

If a credit crunch results in a loss of aggregate loan supply for a firm, does that translate into lower productivity for the firm? Since our data contains information on firm repayment history as well, we can answer this question by testing if lower loan supply identified above leads to higher default rates.

Columns (4) through (6) do so by running our usual regressions using change in default rate as a result of nuclear tests as the dependent variable. The results show that on average firms that experience a reduction in liquidity of their bank, experience higher default rates. A 1% reduction in liquidity of a bank increases the probability of default of its firm by about 8 basis points (on a mean post nuclear test default rate of 6.9 percentage points, that is a 1.2% increase in probability).

It is worth emphasizing here that because of our identification strategy explained earlier, the increase in default rate of firms more exposed to a credit crunch cannot be attributed to unobserved *negative* productivity shocks experienced by such firms and that if anything, this bias leads to an underestimate. Thus. in the absence of a liquidity shock to their banks, these firms would not have had differentially higher default rates. We think of this as evidence that not only does a credit crunch reduce overall lending to firms, but it also makes it more likely for the affected firms to enter financial distress. This is particularly important since it suggests that firms cannot compensate their loss of formal credit through informal channels either such as drawing on internal capital or borrowing from sister/family firms.

VI Concluding Remarks

From the great depression to recent recessions in Asia and the US, shocks to the *supply* of liquidity in the banking sector have often been blamed for creating and prolonging economic downturns. However, separating the *causal* impact of such a "credit crunch" from contemporaneous demand and productivity shocks hitting the economy has proven difficult. In this paper we isolate this causal impact by exploiting the "natural" cross-bank variation in the supply of liquidity induced by exposure to dollar deposits prior to nuclear tests by India and Pakistan. Using firm fixed effects, and a dataset that links more than 61,000 firms with banks, we show that for the *same* firm borrowing from two different banks, its loan from the bank experiencing a 1% larger decline in liquidity drops by an extra 0.37%. The effect is even stronger for smaller firms. Tracing the impact of this liquidity shock further, we find that firms are unable to hedge these shocks through other banks in the market. Consequently liquidity shocks lead to an increase in the incidence of firm's default by 1.2% for every 1% drop in the liquidity of its bank.

These results suggest that liquidity shocks indeed can have large real consequences on the economy and therefore play a significant contributing role in economic downturns. Moreover, since our results show that particular actors, such as smaller firms or new entrants, are more affected by the liquidity shock, this suggests that the impact of these shocks may have substantial distributional consequences as well.

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TABLE I
DATA CHARACTERISTICS

Time Series Dimension	Frequency	Quarterly
	Range	3rd Quarter 1996 to 4th Quarter 1999
	Number of quarter	14
Cross-Sectional Dimension	Unit	Loan (Bank-Firm pair)
	Number of loans that appear both before and after the nuclear test	22,083
	Number of firms that appear both before and after the nuclear test	18,647
	Number of banks	42

Data restricted to banks that take retail (commercial) deposits (78% of all formal formal financing), and loans of these banks that were *not* in default in the first quarter of 1998 (i.e. just before the shock), and that appear both before and after the shock.

TABLE II

SUMMARY STATISTICS

PANEL A: LOAN LEVEL

Variable	N	Mean	SD	Min	25th Percentile	50th Percentile	75th Percentile	Max
Pre Nuclear Shock Total Lending	22,083	17562	76782	500	1195	2682	9626	231263
Change in Log Lending	22,083	-0.17	0.90	-3.34	-0.49	-0.09	0.23	1.95
Change in Log Lending (weighted)	22,083	-0.47	1.48					
Post Nuclear Shock Default Rate [1]	22,083	6.85	20.22	0.00	0.00	0.00	0.00	100.00
Post Nuclear Shock Default Rate (weighted)	22,083	5.35	15.88					

PANEL B: BANK LEVEL

Variable	N	Mean	SD	Min	25th Percentile	50th Percentile	75th Percentile	Max
Bank Assets Dec '97	42	33886	63885	511	6115	13225	22779	310599
Average ROA (96 & 97)	42	0.01	0.03	-0.10	0.01	0.02	0.03	0.04
Capitalization Rate (96 & 97)	42	0.08	0.05	-0.09	0.06	0.08	0.10	0.22
Percentage of Dollar Deposits (Dec '97)	42	0.60	0.27	0.00	0.47	0.64	0.81	0.98
Growth in Deposits (Dec '97 to Dec '99)	42	0.05	0.30	-0.82	-0.15	0.07	0.22	0.56

[1] By Construction default rate prior to the shock is 0 (since we excldude all pre-shock loans in default)

TABLE III
PERCENTAGE OF DOLLAR DEPOSITS

Dependent Variable	Change in Log of Bank Deposits (Dec '99 - Dec '97)		Average Pre-Nuclear Test Default Rate		Average Pre-Nuclear Test Bank ROA	
	(1)	(2)	(3)	(4)	(5)	(6)
Percentage of Deposits in Dollars in Dec '97	-0.334 (0.165)	-0.547 (0.127)	-0.274 (0.061)	-0.309 (0.062)	0.044 (0.014)	0.061 (0.016)
Constant	0.245 (0.108)	0.329 (0.071)	0.249 (0.040)	0.277 (0.035)	-0.013 (0.009)	-0.022 (0.009)
Bank-Size Weighted	No	Yes	No	Yes	No	Yes
Observations	42	42	42	42	42	42
R-squared	0.09	0.32	0.33	0.38	0.2	0.26

The average pre-shock bank ROA is the average ROA of a bank over fiscal years 1996 and 1997 (years end in december)
Robust Standard Errors in Parentheses

TABLE IV

ESTIMATING THE LIQUIDITY IMPACT OF A CREDIT CRUNCH - INTENSIVE MARGIN

Dependent Variable	Δ Log Loan Size					
	FE	FE	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Log Bank Liquidity	0.367	0.397	0.192	0.052	0.306	0.313
	(0.082)	(0.078)	(0.106)	(0.280)	(0.070)	(0.103)
Lag Δ Log Bank Liquidity		-0.023				
		(0.101)				
Pre Avg Bank ROA		3.192				
		(1.121)				
Log Bank Size		0.035				
		(0.022)				
Pre Bank Capitalization		-1.979				
		(0.845)				
Constant	--	--	-0.12	-0.112	-0.191	-0.191
			(0.029)	(0.033)	(0.017)	(0.019)
Firm Attribute FE						
Firm FE	Yes	Yes				
No of Obs	5,300	5,300	5,300	5,300	22,083	22,083
R-sq	0.36	0.37	0	0	0.01	0.01

All quarterly data for a given loan is collapsed at pre and post nuclear shock level for consistent standard error computation. The nuclear shock occurred in 2nd Quarter of 1998, so all observation from Quarter 3 1996 to Quarter 1 1998 for a given loan are collapsed into one. Similarly, all observation from 3rd Quarter 1998 to 4th Quarter 1999 are collapsed into one.

Data restricted to banks that take retails (commercial) deposits (78% of all formal formal financing), and loans of these banks that were *not* in default in the first quarter of 1998 (i.e. just before the shock), and appear both before and after the shock.

Standard Errors in parantheses are clusterd at the bank level (42 banks in total)

TABLE V

ESTIMATING THE LIQUIDITY IMPACT OF A CREDIT CRUNCH - EXTENSIVE MARGIN

Dependent Variable	Exit?[1]		Entry?[2]	
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
Δ Log Bank Liquidity	-0.162	-0.331	0.593	0.832
	(0.033)	(0.130)	(0.215)	(0.240)
Constant	0.202	0.209	0.499	0.46
	(0.011)	(0.019)	(0.027)	(0.048)
No of Obs	23,684	23,684	54,375	54,375
R-sq	0.01		0.11	0.09

All quarterly data for a given loan is collapsed at pre and post nuclear shock level for consistent standard error computation. The nuclear shock occurred in 2nd Quarter of 1998, so all observation from Quarter 3 1996 to Quarter 1 1998 for a given loan are collapsed into one. Similarly, all observation from 3rd Quarter 1998 to 4th Quarter 1999 are collapsed into one.

Data restricted to banks that take retails (commercial) deposits (78% of all formal formal financing), and loans of these banks that were *not* in default in the first quarter of 1998 (i.e. just before the shock), and appear both before and after the shock.

Standard Errors in parantheses are clusterd at the bank level (42 banks in total)

[1] The sample includes all non-default loans in the first quarter of 1998. The dependent variable is 1 if the loan is not given at all post nuclear shock, and 0 otherwise.

[2] The sample includes all loans that appear post nuclear shock, *including* those that *only* appear post shock. The dependent variable is 1 for a loan that only appears post shock.

TABLE VI
TRACING THE REAL IMPACT OF THE LIQUIDITY CRUNCH

Dependent Variable	Δ Log Aggregate Loan Size			Δ Default Rate		
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)
Δ Log Bank Liquidity	0.327 (0.072)	0.325 (0.068)	0.163 (0.051)	-9.54 (6.560)	-10.87 (5.640)	-8.05 (3.771)
Lag Δ Log Bank Liquidity		-0.157 (0.080)	-0.108 (0.080)		7.25 (4.200)	6.268 (3.241)
Pre Avg Bank ROA		0.656 (0.753)	-0.016 (0.954)		-118.96 (43.660)	-94.52 (34.724)
Log Bank Size		-0.017 (0.019)	-0.015 (0.025)		2.704 (0.878)	1.862 (0.642)
Pre Bank Capitalization		-0.15 (0.698)	0.19 (0.863)		88.49 (34.814)	69.904 (28.845)
Constant	-0.191 (0.017)	0.128 (0.339)	--		-42.13 (15.936)	--
Firm Attribute FE			Yes			Yes
No of Obs	18,647	18,647	18,647	22,083	22,083	22,083
R-sq	0.01	0.01	0.05	0.01	0.01	0.06

All quarterly data for a given loan is collapsed at pre and post nuclear shock level for consistent standard error computation. The nuclear shock occurred in 2nd Quarter of 1998, so all observation from Quarter 3 1996 to Quarter 1 1998 for a given loan are collapsed into one. Similarly, all observation from 3rd Quarter 1998 to 4th Quarter 1999 are collapsed into one.

Data restricted to banks that take retails (commercial) deposits (78% of all formal formal financing), and loans of these banks that were *not* in default in the first quarter of 1998 (i.e. just before the shock), and appear both before and after the shock.

Standard Errors in parantheses are clusterd at the bank level (42 banks in total). Δ Default Rate is in percentages.

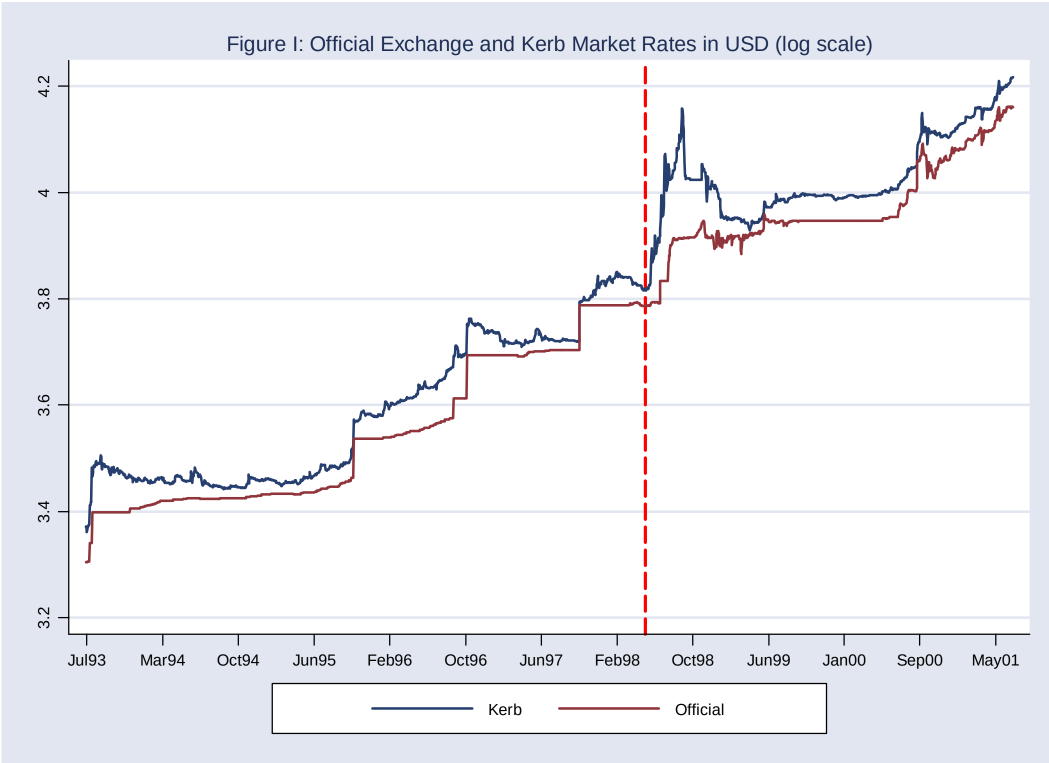

Figure I: Official Exchange and Kerb Market Rates in USD (log scale)
3.2
3.4
3.6
3.8
4
4.2
Jul93
Mar94
Oct94
Jun95
Feb96
Oct96
Jun97
Feb98
Oct98
Jun99
Jan00
Sep00
May01
Kerb
Official

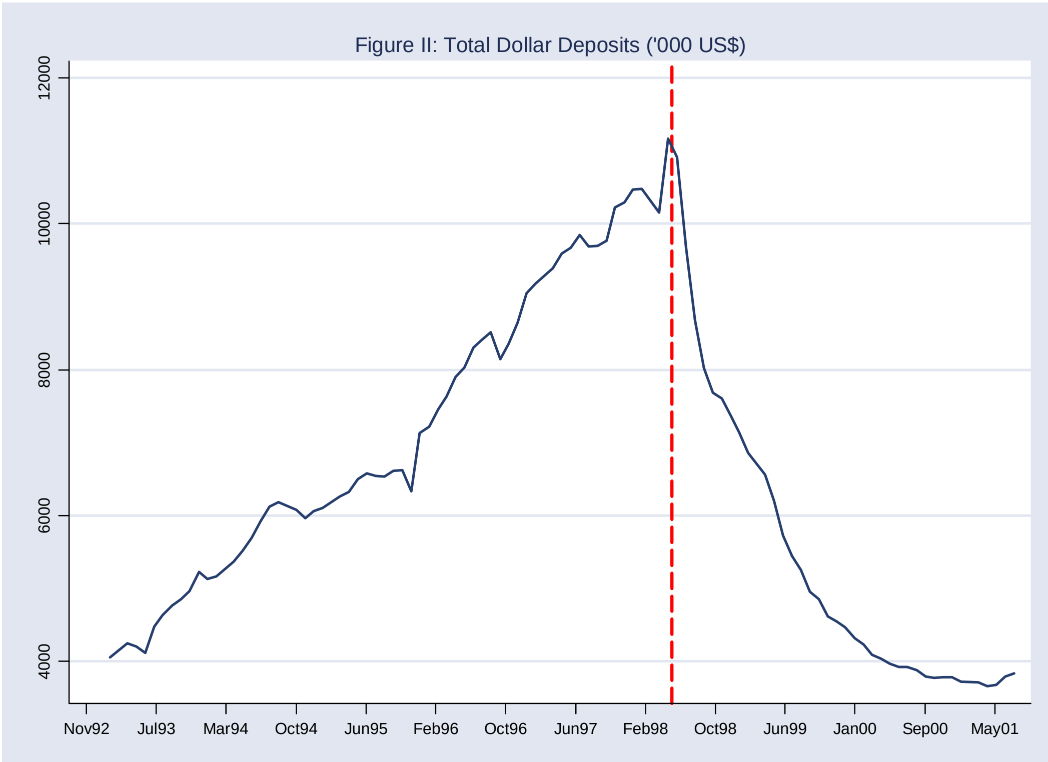

Figure II: Total Dollar Deposits ('000 US$)
12000
10000
8000
6000
4000
Nov92
Jul93
Mar94
Oct94
Jun95
Feb96
Oct96
Jun97
Feb98
Oct98
Jun99
Jan00
Sep00
May01

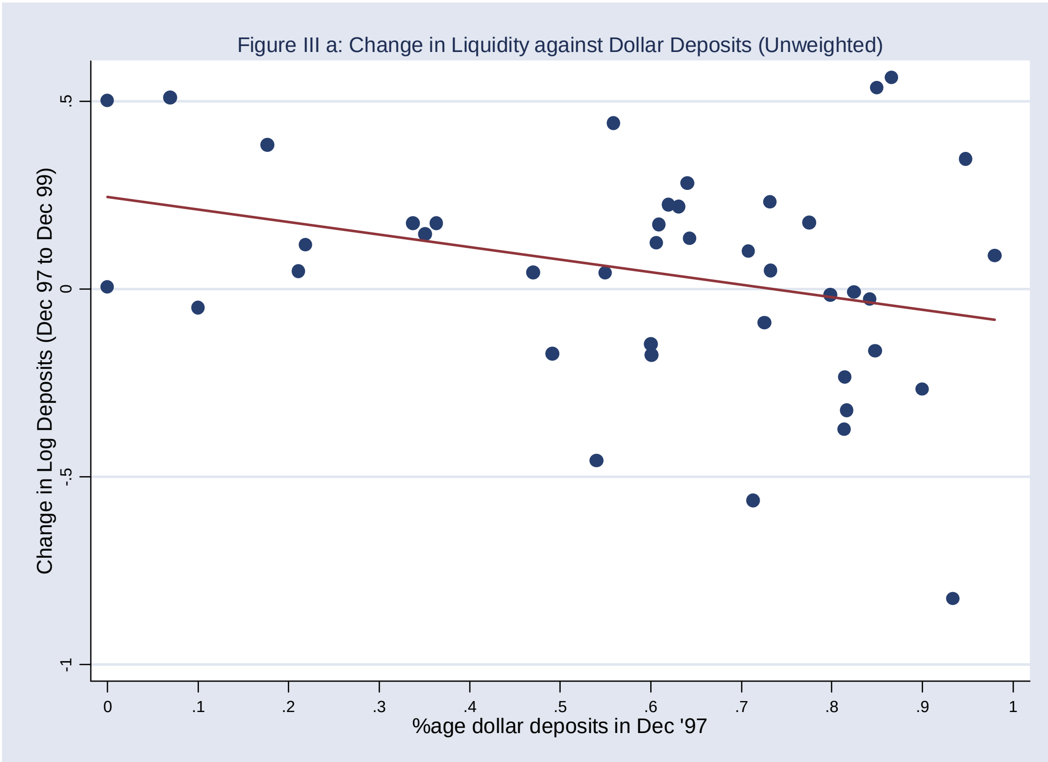
Figure III a: Change in Liquidity against Dollar Deposits (Unweighted)
Change in Log Deposits (Dec 97 to Dec 99)
.5
0
-.5
-1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
%age dollar deposits in Dec '97

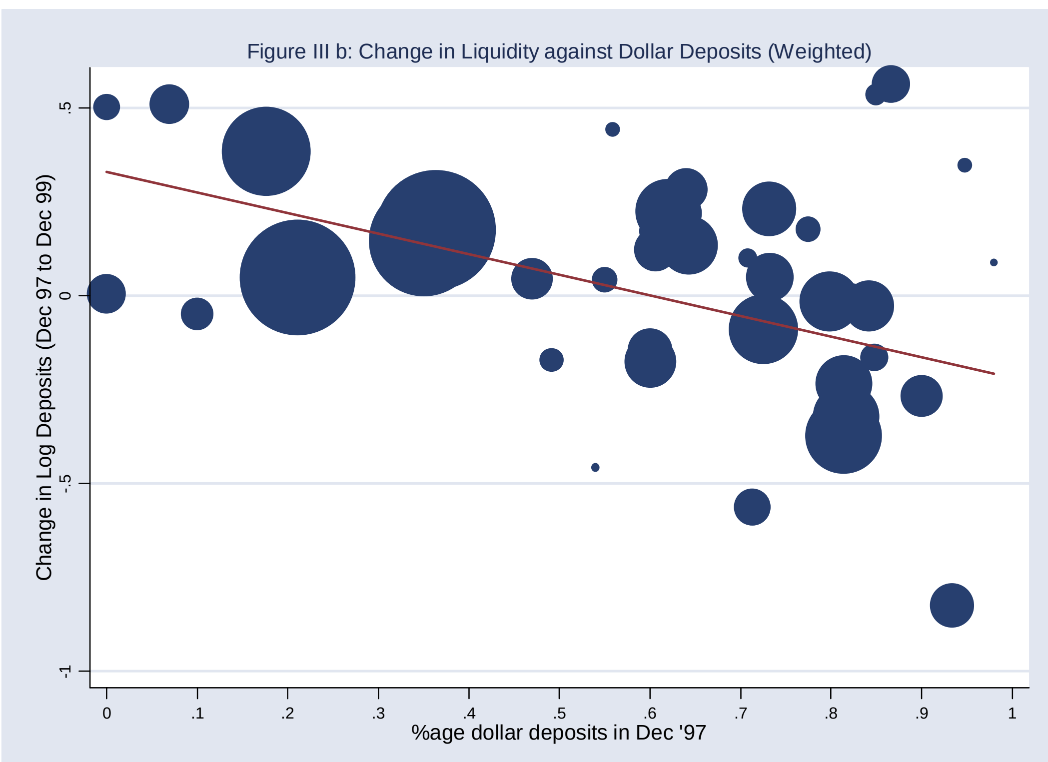
Figure III b: Change in Liquidity against Dollar Deposits (Weighted)
Change in Log Deposits (Dec 97 to Dec 99)
.5
0
-.5
-1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
%age dollar deposits in Dec '97

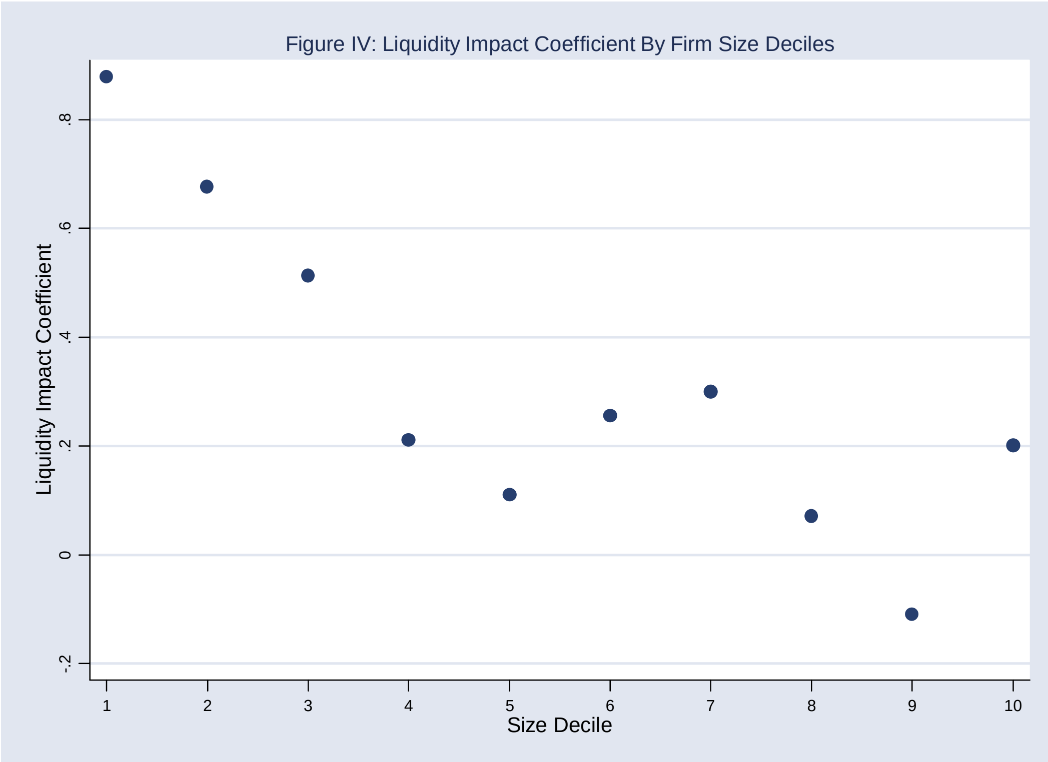
Figure IV: Liquidity Impact Coefficient By Firm Size Deciles
Liquidity Impact Coefficient
-.2
0
.2
.4
.6
.8
1
2
3
4
5
6
7
8
9
10
Size Decile

Figure V: Liquidity Impact Coefficient By Quarter