Tracing the Impact of Bank Liquidity Shocks

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Abstract

Do shocks to the supply of a bank's liquidity affect its lending? If so, are client firms able to compensate or does the shock decrease their total borrowing? Does this in turn lead to greater firm bankruptcy? Identifying these supply side effects has proven difficult because of problems in separating contemporaneous demand from supply shocks and a lack of micro data linking banks to borrowing firms. Liquidity shocks arising from unanticipated nuclear tests in Pakistan in 1998, and a dataset linking over 18,000 firms to all 145 banks in the economy provides a unique opportunity to answer these questions. First, we isolate the causal impact of the bank lending channel by showing 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 liquidity shock also leads to large declines in the probability of continued lending to old clients, and extending credit to new ones. Second, we find that while firms with multiple banking relationships fully compensate for the liquidity shock by borrowing more from more liquid banks, single relationship firms are unable to do so. As such single relationship firms face substantial and persistent drops in total borrowing. Finally, such firms are also more likely to experience financial distress in terms of greater loan default. Liquidity shocks can thus have significant and persistent distributional impacts on the economy.

Is the ability of banks to intermediate the supply and demand of liquidity affected by shocks to their primary sources of liquidity such as bank deposits? Economists have long been interested in understanding whether supply shocks to the banking sector affect bank lending and in turn, have real impact at the borrower level. While a number of papers argue that supply shocks are responsible for creating or deepening economic recessions,[1] identifying the full impact of a bank liquidity shock has remained a challenge.

To determine whether bank shocks have an impact on borrowing firms three questions need to be answered. First, in the face of a supply shock, are banks able to borrow from other sources or do they have to pass on the shock to the demand side by reducing their lending? In other words, does the Modigliani-Miller (MM) theorem hold at the bank level? This has been referred to as "bank lending channel" in the literature. Second, even if a bank lending channel does exist, does it have an impact on a firm's aggregate borrowing, or is the firm able to compensate by borrowing from other financial sources? Does the MM theorem hold at the firm level (we will refer to this as the "firm borrowing channel")? Third, even if a firm borrowing channel exists, what is its ultimate impact on firm-level outcomes such as financial distress?

Identifying these supply side effects poses yet another challenge. The identification problem stems from the fact that shocks to the supply of bank liquidity are typically accompanied by shocks to the demand for liquidity. For example, liquidity supply in the form of bank deposits may decline in bad times when firms also have lower demand for bank credit. Alternatively, liquidity supply might fall more for "bad banks" known to have more risky loan portfolios.

Given these issues, our paper contributes to the literature by answering the above three questions and also by providing an improved identification of the supply side effects. This is made possible by exploiting a novel loan-level data from Pakistan that links more than 18,000 firms to banks over a seven year period and provides quarterly information on the amount, type, and status of all outstanding loans. The data represents the universe of corporate lending in Pakistan and matches a firm to all its creditors, allowing an examination of both the bank lending and firm borrowing channels.

Identification of the supply shock comes from exploiting cross-sectional variation across banks in liquidity shocks induced by unexpected nuclear tests conducted by Pakistan in 1998.

[1]See for example, Bernanke (1983), Bernanke and Lown (1991), Hoshi and Kashyap (2000), Woo (2003), Agenor, Aizenman, and Hoffmaister (2000) which argue that bank liquidity shocks are important for understanding the Great Depression, the US and Japanese recessions of the 1990s and the more recent Asian crises.

Our ability to provide cleaner estimates comes from two factors. First, in identifying the bank lending channel, we focus on firms that were borrowing from multiple banks at the time of the nuclear tests. This allows us to use firm fixed effects in first-differenced data and test whether the *same* firm borrowing from two different banks experiences a greater loan decline from its bank that has a relatively larger liquidity crunch (as compared to its other bank/s). This methodology controls for unobserved firm-level demand shocks that affect firms contemporaneously. Consequently, unlike previous studies, we need not rely on potentially strong identification assumptions that the unobserved demand shocks are uncorrelated with supply shocks.

Second, we are able to show that in the particular case we examine, the liquidity supply shock to a bank is in fact *negatively* correlated to its liquidity demand shock. This implies that while OLS estimates are biased, they are nevertheless useful since they provide underestimates of the supply shock impact. Therefore, even in cases where it is not possible to use firm fixed effects, we can provide conservative estimates of bank liquidity supply shocks on aggregate firm-level outcomes such as total firm borrowing and firm financial distress.

The negative correlation between supply and demand shocks is generated by the nature of the supply shock. Due to the international financial sanctions that followed the nuclear tests, the Pakistani government forced all banks to stop withdrawal of dollars from dollar-denominated deposits (almost half of all deposits at the time) and only allowed withdrawals in local currency at a disadvantaged exchange rate. The loss of confidence from this partial default on dollar deposits led to a run on banks. The extent of this run was greater for banks with larger dollar-deposit accounts. The negative correlation comes from the fact that while banks with more dollar deposits experienced larger declines in their deposit base, they were in fact better banks and more likely to be lending to better quality and more resilient firms, i.e. those that were likely to face relatively lower demand shocks.

We are able to empirically verify this by showing that banks that experienced greater liquidity supply shocks were better banks in terms of their pre-shock profitability and loan performance. Moreover, comparison of the unbiased firm fixed-effects estimate to the OLS one of the bank lending channel effect, shows that OLS indeed produces an underestimate. This corroborates that supply and demand shocks are negatively correlated.

Our analysis shows the presence of a large bank lending channel. For a firm borrowing from two different banks at the time of the nuclear tests, its borrowing from the bank experiencing a 1% larger liquidity decline, drops by an extra 0.37%. As highlighted above, our strategy controls for unobserved firm-level *changes* in the demand of credit. When we separate the overall bank lending channel effect by quarters we find that the effect is sudden and persists till the end of our sample period i.e. even upto 5 years after the shock. Consistent with a negative correlation between supply and demand shocks, the OLS estimate is smaller (a half) than the FE estimate. There may be a residual concern even in the FE estimate that firms finance different types of projects through different banks and that this choice is correlated with the shocks experienced by banks i.e. that firm fixed effects may not account for the firm's loan level credit demand change. Since we have information on loan types, we can show that this concern is not legitimate by using firm interacted with loan type fixed effects.

The bank lending channel also has a large impact on a bank's extensive margin, i.e. its decision to lend to new clients and to continue lending to existing clients. A 1% fall in bank liquidity reduces the probability of lending to new clients by 0.9% and the probability of continuing lending to existing clients by 1%. Interestingly, the bank lending channel identified in this paper works predominantly through its impact on the quantity of loan supply. We find no evidence that the bank liquidity shocks also impact the price (i.e. interest rate) of loans.

Given the strong bank lending channel, we investigate if a firm borrowing channel also exists. The presence of multiple prior banking relationships is an important indicator for whether a firm can fully hedge its bank specific liquidity shocks. Firms with single banking relationships at the time of nuclear tests are completely unable to hedge the initial supply shocks. In contrast, firms with multiple prior relationships fully compensate for the bank-level liquidity shock by borrowing more from their more liquid banks. The absence of a firm borrowing channel for multiple relationship firms is not driven by other measures of access to credit such as firm size, political connections, or membership in business conglomerates.

Finally, we consider the impact of the bank supply shock on firm financial distress. We find that, consistent with the aggregate borrowing results, only single relationship firms borrowing from liquidity constrained banks are likely to end up in default. The effect on such firms is large: A 1% decline in the supply of bank liquidity leads to an increase in the incidence of default of its borrowing firms by 1.9%. Multiple relationship firms show no such increase in default rates as they are able to hedge against bank specific liquidity shocks. Given our identification strategy described earlier, we argue that the higher default rates are a causal (and conservative) impact of the reduction in bank liquidity.

The question of how banks might transmit liquidity shocks into real shocks has been theoretically examined by papers such as Bernanke and Blinder (1988), Bernanke and Gertler (1989), Holmstrom and Tirole (1997), and Stein (1998). They show that liquidity shocks can be transmitted to firms due to market imperfections at the bank and firm level leading to a failure of the Modigliani Miller hypothesis. While this theoretical work has been accompanied by a large empirical literature, this literature has mostly focused on the first question - the bank lending channel - and has had to rely on relatively strong assumptions to separately identify the supply shock from contemporaneous demand shocks. Our paper adds to this literature on both accounts. First, our micro level data linking firms to banks allows us to answer questions regarding the ability of firms to mitigate the bank lending channel. Moreover, this data enables us to measure the ultimate impact of bank liquidity shocks on firm outcomes such as its financial distress. Second, the empirical strategy described above provides a more robust identification of the supply side shock.

Earlier papers such as Bernanke and Blinder (1992), Bernanke (1983), and Bernanke and James (1991) use time-series correlation between changes in liquidity and changes in loans (or output) to argue that changes in liquidity have real consequences. However, a limitation is that these results can also be attributed to omitted variables such as economy wide productivity shocks that impact both changes in the supply and demand of credit at the same time.

This led to work that uses cross-sectional variation across banks and firms to answer the same question instead of relying on aggregate time-series data. Papers such as Gertler and Gilchrist (1994), Kashyap, Lamont, and Stein (1994), Kashyap, Stein and Wilcox (1993), and Kashyap and Stein (2000) use variation in liquidity supply changes across banks and firms to account for economy wide productivity shocks. These papers show that liquidity changes across banks and firms are correlated with outcomes such as loan supply or firm output. However, a concern remains that cross-sectional variation in changes in loans or output of firms may be driven by omitted firm or bank specific demand shocks.

Other papers attempt to find sources of exogenous variation in the supply of bank liquidity. Peek and Rosengren (1997) show that the decline in the Japanese stock market was associated with reduced lending by Japanese banks in the U.S. through bank capital requirement constraints. In a later paper (2002), they show that the financial difficulties at the bank level were responsible for the decline in number of FDI projects taken up by Japanese firms in the U.S. More recently, Paravisini (2005) instruments for additional bank liquidity under a small business credit expansion program in Argentina by using pre-specified formulas for credit eligibility across banks. While these papers make further headway, there remain concerns regarding the validity of the exogeneity assumptions and instrumentation strategies. Moreover, since the shocks in these papers affect a subset of banks and firms in the economy, they are limited in the extent to which the distributional impact of the shock can be traced.

In what follows, section I describes the data and the institutional background. Section II presents our empirical methodology. Sections III and IV provide results concerning bank lending and firm borrowing channels, and whether these channels have any impact on firm outcomes. Section V concludes.

I Institutional Background and Data

A. The 1998 Liquidity Crunch

The unanticipated nuclear tests by India on the 11th of May 1998 led to retaliatory nuclear tests by Pakistan on the 28th of May. These events led to a large and sudden liquidity shock for banks in Pakistan. The extent of this shock varied across banks depending on their exposure to dollar denominated deposit accounts. We outline the sequence of events that led to these changes.

Dollar Deposit Accounts

By the early 1990s Pakistan had a relatively liberalized banking sector with significant private and foreign bank participation. An important element of the reforms in the early nineties was the introduction of the foreign currency deposit scheme[2] that allowed opening of foreign currency (mostly dollar) deposit accounts in Pakistan. The scheme was aimed at stopping the flight of dollars oversees by allowing citizens to hold such currencies within Pakistan.

An important feature of the dollar accounts was that local banks accepting dollar deposits *could not* keep the dollars but had to surrender them to the central bank in return for rupees at the prevalent exchange rate. When a depositor demanded his dollars (with interest) back,

[2] See State Bank of Pakistan Foreign Exchange Circular # 36, 1991.

the bank obtained dollars from the central bank in exchange for rupees at the *initial* exchange rate. All exchange rate risk between the time of deposit and the time of withdrawal was borne by the central bank. The State Bank of Pakistan's (SBP) official notification (SBP notification #54, June 7, 1992) states:

> [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.

The central bank did not provide this exchange rate insurance for free. It charged banks a 3% annual fee for the insurance. However, the widely held and expost correct belief was that this fee was subsidized. Average depreciation in the preceding 6 years was 8.1% a year. To the extent this was an indication of expected depreciation, a risk adjusted market price should be well above 3%. Actual annual depreciation of the local currency between January 1992 and December 1997 was also higher at 4.3%. In addition, the government turned a blind eye to the source of the foreign currency deposited. In the words of the original notification, *"No question will be asked by any authority in Pakistan about the source of acquisition of such foreign exchange".*

Thus the dollar-deposit accounts were both expected and turned out to be very lucrative for both banks and depositors. As a result by May 1998, in a span of six years, dollar deposits had grown to 43.5% of total deposits in Pakistan. Although comprising almost half of total deposits, banks differed substantially in the extent to which they were able to attract those with dollars to deposit. The percentage of deposits denominated in dollars ranged from 0% to 98% across banks, with a standard deviation of 27%. The cross-bank variation in dollar deposits was clearly not exogenous. It depended on a host of factors such as the customer base of a bank, its marketing strategy, and its perceived outlook, with better and more proactive banks achieving greater success in attracting such accounts. We shall both verify and exploit this feature later in section II.

"Freeze" on Dollar Deposit Accounts

When India and Pakistan tested nuclear devices in May 1998, the international community moved swiftly to impose military and financial sanctions on both countries. These sanctions included a suspension of all bilateral and multilateral financial assistance available to Pakistan for exchange rate support.

In anticipation of the balance of payment problems which were certain to arise, the Prime Minister of Pakistan, along with the announcement of the nuclear tests on May 28th, declared that the foreign currency accounts would be "frozen". This meant that dollar deposit holders could only withdraw their money in rupees at a disadvantaged exchange rate i.e. not the exchange rate at the time of deposit but the lower official exchange rate at the time of withdrawal. The "freeze" amounted to a partial default on dollar deposits by the government.

The loss of confidence as a result of this partial default turned out to have a serious impact on the banking sector. Dollar deposit holders went to banks in droves to withdraw money. Figure I traces the aggregate dollar deposits over time and shows the sudden and precipitous withdrawal from dollar accounts after the nuclear tests with these deposits falling by a half within a year of the freeze.

While part of this liquidity exited the Pakistani banking system (it was converted back into dollars through the black market and invested abroad) the data suggests that a substantial fraction re-entered the system, since several banks actually experienced overall *increases* in their deposit base i.e. the local currency (Rupee) deposit accounts grew more than the drop in the dollar based accounts. This is important for our empirical identification as it allows us to exploit cross-bank variation in changes to their deposit base. In other words, while the aggregate liquidity shock as a result of nuclear testing was negative,[3] our identification does not come from the aggregate shock, but from the cross-sectional redistribution of liquidity across banks induced by the nuclear tests.

The decline in bank liquidity was larger for banks that were more reliant on dollar deposits as their source of liquidity. This is both because such banks were more likely to see their deposits initially withdrawn and because the reconverted rupees were often redeposited in a different bank with greater specialization in rupee accounts. Figure II illustrates this change in liquidity for the forty two commercial banks in Pakistan that issued demandable deposits

[3] The average annual growth in deposit liquidity was 17.2% before the nuclear tests. The corresponding annual growth for the post-shock period is only 5.0%.

in both local and foreign currency. The upper panel of Figure II plots the overall change in liquidity for these banks from December '97 to December '99 against their pre-nuclear test reliance on dollar deposits. The lower panel gives the same plot but each observation is plotted proportional to its bank size in December 1997. Both panels show a negative relationship between dollar deposit exposure and changes in bank liquidity.[4] We shall exploit this feature in our estimation strategy detailed in section II.

B. Data

The primary data in this paper comes from the central information bureau (CIB) of the central bank of Pakistan which supervises and regulates all banking activity in the country. The data has quarterly loan-level information on the entire universe of corporate bank loans outstanding in Pakistan between July 1996 and June 2003. It follows the history of each loan with information on the amount and type of loan outstanding, default amounts and duration. In addition, it also has information on the name, location and ownership of the borrowing firm and its bank. We combine this data with annual balance sheet information on banks.

In terms of data quality, our personal examination of the collection and compilation procedures, as well as consistency checks on the data suggest that it is of very good quality. CIB was part of a large effort by the central bank to setup a reliable information sharing resource that all banks could access. Perhaps the most credible signal of data quality is the fact that all local and foreign banks refer to information in CIB on a daily basis to verify the credit history of prospective borrowers. For example, we checked with one of the largest and most profitable private banks in Pakistan and found that they use CIB information about prospective borrowers explicitly in their internal credit scoring models. We also ran several internal consistency tests on the data such as aggregation checks, and found the data to be of excellent quality. As a random check, we also showed the data from a particular branch of a bank to that branch's loan officer who confirmed the authenticity of the data related to his portfolio.

Although the original data includes 145 financial intermediaries, for most of our analysis we will restrict our sample to the 42 commercial banks that were allowed to open demandable

[4] Notice that changes in the exchange rate cannot artificically induce the cross-bank changes in liquidity observed in Figure II. The nuclear tests led to a depreciation of the local currency which means in local currency more dollar reliant banks deposits now have a higher market value. Moreover, accounting rules only follow the book value of the initial deposits and hence do not fluctuate with exchange rate movements in the short-run.

deposits (including dollar deposits). The remaining financial intermediaries had private or institutional sources of funding and are excluded because we do not have information on their changes in liquidity. The sample restriction however should not be a big concern for two reasons. First, the excluded financial intermediaries only make up 22% of overall lending at the time of nuclear tests. Second, since the excluded institutions were not taking dollar or rupee deposits, they were not seriously affected by the nuclear tests. Therefore, assuming that they only experienced the average change in liquidity in the economy, including them in our sample makes no qualitative difference to the results of this paper. Moreover, we do include all financial intermediaries when we examine aggregate firm outcomes such as overall firm borrowing and default rates.

We use the above data to analyze the impact of credit crunch resulting from the nuclear tests of May 1998. Our starting point is the set of all performing loans at the time of nuclear tests, and we follow these loans and all new ones given out subsequently. This allows us to study how the liquidity crunch impacted both existing loans and disbursement of new loans. For most of the analysis we keep equal pre and post treatment windows and so limit our data to July 1996 and December 1999. This gives us a sample of 61,497 firms spanning 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 the sample. In all, the sample contains 393,579 loan-quarter observations. A number of our tests will be based on loans that exist both before and after the nuclear tests. This subsample consists of 22,083 loans from 18,647 firms. Moreover, for the greater part of the analysis we will be conservative and collapse our quarterly time dimension into a single "pre" and single "post" nuclear test period by taking time-series averages of loans.[5] This time-collapsing of data has the advantage that our standard errors are robust to concerns of autocorrelation (see Bertrand, Duflo and Mullainathan (2004)).

Table I presents basic data characteristics and Table II summarizes basic statistics for both the loan and bank level variables used in our analysis. The loan level summary statistics are presented for collapsed data and at the firm level. All loans in our sample are loans to private firms in the economy. There are some large government owned firms in sectors such as utilities,

[5] The time-series averages are taken after converting all values to real 1995 rupees. Moreover, we exclude the quarter of the nuclear tests from these calculations. Thus pre average covers July 1996 through March 1998 while post average covers July 1998 through December 1999.

airline, and defense in our original data set. However, we exclude loans to such firms as loans to government firms are implicitly backed by government guarantees and thus may confound our analysis. In any event, including the few government owned firms does not change our results.

II Empirical Methodology

The theoretical basis for how a bank liquidity crunch might affect the supply of loans to firms has been well documented. Papers such as Bernanke and Blinder (1988), Holmstrom and Tirole (1997), and Stein (1998) provide leading explanations of this effect. These papers differ in their details but share the same basic idea.

First, when banks face a shortage in the supply of liquidity from their deposit holders, 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 is driven by market imperfections such as informational asymmetries and agency costs. Hence the MM-hypothesis fails at the bank level and banks are forced to cut back lending to their client firms. This happens even if there are no changes in the firms' credit worthiness. Such a reduction in bank loan supply which is unrelated to changes in the firm's demand for loans, is referred to as the bank lending channel.

Second, the market imperfections that prevent banks from raising new liquidity may also prevent the firms affected by a reduction in their loan supply from accessing new sources of financing. This second failure of MM at the firm level means that the bank lending channel also translates into a firm borrowing channel by reducing the aggregate credit available to firms. The reductions in overall borrowing might in turn affect firm outcomes such as productivity and propensity to default. Such arguments have routinely been given to explain large economic collapses ranging from the Great Depression to the recent Asian crises.

The above explanations have not gone unchallenged. Critics such as Romer and Romer (1990) argue that the inability of banks and firms to raise new financing as assumed by the above explanations is not an accurate depiction of the real world. These papers argue that shocks to the supply of bank liquidity have no important real consequences for the economy.

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

A. The traditional identification problem

The following simple framework outlines the main econometric problem. Consider a two period model where banks provide financing to firms each period. For simplicity, we assume that a bank can only lend to one firm while firms can borrow from multiple banks.[6] Let i and j index banks and firms respectively. In period t, bank i and firm j negotiate a loan of size L_{ij}^t. In order to finance this loan bank i has to 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. Since the loan L_{ij}^t is the only asset available to the bank, the following accounting identity must hold for bank i lending to firm j at time t:

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

In the spirit of the theoretical literature on the subject such as Stein (1998), we need two important ingredients in our model: (i) banks are constrained in the amount of liquidity they can raise through deposits, and (ii) raising additional liquidity through external non-deposit funds (i.e. B_i^t) is costly due to market imperfections. For simplicity these elements are introduced as follows. A bank can raise deposits costlessly but only up to a maximum amount $\overline{D}_i^t$. Raising additional financing (B_i^t) is costly with the marginal cost linear in B_i^t and given by $(\alpha_B * B_i^t)$ where $\alpha_B > 0$. The cost function for additional financing implies that the overall credit supply function for a bank (i.e. $D_i^t + B_i^t$) is linear in the cost of funds.

The total amount $(D_i^t + B_i^t)$ raised by a 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 $(\bar{r}_j - \alpha_L L_{ij}^t)$. This functional form captures decreasing marginal returns as the size of the loan increases. 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 (i.e. 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

[6] We want to emphasize here that our purpose is not to build a fully specified model of bank intermediation. We shall deliberately only focus on those features that highlight the fundamental econometric issues.

$t+1$. 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: $\overline{r}_j - \alpha_L L_{ij}^{t+1} + \overline{\eta} + \eta_j$. 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, equilibrium each period is determined by jointly solving the FOC[7] and accounting identity (1) for L_{ij} and B_i. Solutions for the two periods (assuming away corner solutions) can then be combined into a single first-differenced equation:

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

Equation (2) although derived from an admittedly simple model, highlights some important issues. First, it shows the importance of costly external financing. Without this assumption (i.e. $\alpha_B = 0$), banks would 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, equation (2) highlights the identification problem in estimating 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 first-differencing takes out *all* secular time trends in the economy through the constant term. Let β_0 $(= \frac{1}{(\alpha_L+\alpha_B)}[\alpha_B * \overline{\delta} + \overline{\eta}])$ denote this constant. 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 "lending channel" for each incremental unit of deposits lost. The OLS regression typically run to estimate (3) is:

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

where $\Delta D_i = \delta_i$ represents the bank-specific change in deposits. However, the estimate $\hat{\beta}_1^{OLS}$ in (4) will be biased if $Corr(\delta_i, \eta_j) \neq 0$. 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

[7] 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 $t+1$.

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 or alternatively, lower quality banks are both more likely to have weaker depositors and firms that are more sensitive to shocks. Given this positive correlation between δ_i and η_j, equation (4) will lead to an *over-estimate* of β_1 as $\hat{\beta}_1^{OLS} = \beta_1 + \frac{Cov(\delta_i,\eta_j)}{Var(\delta_i)}$.

B. An Unbiased Estimate of β_1: Firm Fixed Effects

An unbiased estimate of β_1 can be obtained by putting in firm fixed effects in equation (4) and comparing changes in loans across banks for the *same* firm. Firm fixed effects absorb the variation driven by changes in the demand of liquidity at the firm level and thus isolate the supply side. Note that since the specification is in a first-difference form the firm fixed-effects absorb all firm-specific *changes* between the pre and post-shock period. This estimation strategy implies that we have to restrict ourselves to firms that borrow from multiple banks at the time of nuclear tests. There are more than 1,800 such firms in our sample. Empirically, the new strategy translates into running the following Fixed-Effects regression:

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

where β_j are firm fixed effects. The β_j subsume all firm specific fixed shocks η_j that were the source of bias for $\hat{\beta}_1^{OLS}$ earlier. $\hat{\beta}_1^{FE}$ in (5) is therefore an unbiased estimate of β_1, but comes at a slight cost that the sample has to be limited to firms that borrowed from multiple banks at the time of nuclear tests.[8]

Although the firm fixed approach addresses a number of concerns in the empirical literature, there may be some residual concerns that we briefly discuss. In particular, one may question the FE approach if one believes that loan demand varies across banks even for the same firm. For example, one bank may specialize in providing short term loans while another might specialize in providing longer term loans. Thus when a macro shock hits, a firm's demand might be

[8] This argument is slightly more subtle. Once we model the fact that a bank lends to multiple firms, equation (3) has to be modified to include idiosyncratic demand shocks experienced by these other "$-j$" firms. The firm fixed effect will only take out firm j's demand shock and the other "$-j$" firms' demand shock components that comove with j's demand shock. However, since these remaining components are, by construction, orthogonal to j's demand shock, β_1, is identified. Put another way, from the perspective of firm j, all one requires is that its bank experiences a *net* (of other firm's demands) liquidity supply shock that is orthogonal to firm j's credit demand.

differentially impacted across the two banks. Note however that this alone is not sufficient to question the FE approach. In order to invalidate the FE identification strategy, one would not only need differential demand across banks for the same firm, but also that this differential demand is positively correlated with the liquidity shock experienced by a bank. Thus one needs quite specialized scenarios to invalidate the FE results. In any event, we will address this concern directly since we know the type of loan a firm takes from a bank. Specifically, we will show our results remain robust to using firm-loan type interacted fixed effects.

There can also be a related concern that a firm may strategically choose to withdraw borrowing from a more affected bank in anticipation of future relationship problems. We shall also address such concerns in detail in the results section.

C. An OLS /"Instrumental" Approach

The FE approach provides an unbiased estimate of β_1 that can be used to understand the bias in the OLS estimate of (4). As discussed earlier, traditionally the OLS estimate is believed to be biased upwards due to a positive correlation between liquidity supply and demand shocks (i.e. $Cov(\delta, \eta_j) > 0$). While this is likely to be the case in general, does the positive correlation also hold in our data?

As briefly discussed in section I, there is good reason to believe that the unique environment in Pakistan that generated the cross-sectional variation in liquidity shocks, produced a *negative* correlation between supply and demand shocks. Recall from section I that the cross-bank variation in liquidity shocks is generated by the banks' differential exposure to dollar deposits. Banks that were more exposed to dollar deposits experienced larger declines in their deposit base. However, the same banks are also more likely to have better loan portfolios in terms of profitability and low default rates. If more profitable firms are better able to adapt to the overall macro shock resulting from nuclear tests, then these firms would experience smaller declines in their loan demand compared to less profitable firms. Consequently, while more dollar reliant banks experience greater reduction in their supply of liquidity they would face relatively larger (smaller declines in) demand for liquidity giving a negative correlation between δ_i and η. In this case the OLS estimate while biased, would still be useful as it provides a conservative estimate (an underestimate) of the true lending channel coefficient. A nice feature of our data is that not only can we test if more dollar reliant banks were lending to more profitable firms, but we can also show that OLS indeed provides an underestimate by comparing the OLS coefficient with the unbiased FE coefficient estimated earlier.

Table III first presents shows the negative correlation between dollar reliance and deposit growth seen in Figures IIa-b, and then presents evidence that dollar reliant had higher pre-nuclear test profitability of loan portfolios. Columns (1) and (2) of Table III regress change in bank liquidity on percentage dollar deposits before nuclear tests and show that more dollar reliant banks experienced larger declines in deposit growth. Column (1) runs an unweighted regression while column (2) weighs each observation by the size of its bank prior to nuclear tests. The weighted regression is economically more meaningful and shows that a 1% increase in the percentage of dollar deposits held by a bank prior to nuclear tests, leads to a 0.55% decline in bank liquidity. The R-sq is also high at 32%.

Columns (3) through (6) of Table III, show that more dollar reliant banks had significantly lower average default rates on their loans (columns (3) and (4)), and significantly higher overall return on assets (columns (5) and (6)). 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 and had lower defaults). Thus more dollar reliant banks had better quality loan portfolios. The rationale for this correlation is that since dollar deposits were very lucrative because of the government subsidized exchange rate insurance program, competition implied that banks that were of better quality and provided better services were more likely to attract dollar deposits.

The evidence in Table III supports the case that supply and demand shocks might be negatively correlated.[9] Further and more direct evidence will come later when we compare the OLS estimate and show that it is indeed smaller that then unbiased FE estimate.

Given the results in Columns (1) and (2) one may be tempted to use an IV strategy to estimate β_1. Specifically, attempt to isolate the supply side variation generated by exposure to dollar deposits by "instrumenting" the change in deposits in the RHS of (4) with a bank's pre-shock percentage dollar deposits i.e. use Columns (1)/(2) as a first stage. However, such

[9] One could argue here that although banks with more dollar deposits were of better quality, they might systematically lend to those firms whose liquidity demand "co-moves" with the bank's supply of liquidity (see Kashyap, Rajan and Stein (2002) for the full theoretical argument). If this were true then more dollar reliant banks would also experience larger liquidity demand shocks. While the argument is valid in general, it is unlikely to apply in our context because of the exchange rate insurance provided by the central bank. The insurance implied that banks did not have an incentive to try to hedge exchange rate fluctuation when making lending decisions.

an IV strategy is unlikely to be reasonable for the same reasons as the OLS specification − the potential instrument is not valid - and such an "IV" estimate is also likely to underestimate β_1. We will see later on that this is indeed the case.

III Results: The Bank Lending Channel

Taking the empirical methodology to data, we start with the collapsed loan level data described in section I, with one pre and one post nuclear test observation for each loan. We divide our analysis of the bank lending channel into two parts, an "intensive margin" referring to a reduction in the amount of lending to existing firms, and an "extensive margin" referring to denial of credit to existing and new firms altogether.

A. The Intensive Margin

There are 22,083 loans to 18,647 firms that appear both before and after the nuclear tests. Using this data, we estimate (4) by first-differencing the data. We regress change in log loan amount as a result of nuclear tests on the change in log bank liquidity. Since the liquidity shock comes at the bank level, changes in loans from the same bank may be correlated. Therefore all our loan level regressions have errors clustered at the bank level.

Column (1) in Table IV shows the OLS results. A 1% decline in bank liquidity leads to 0.31% decline in the amount of loan to firms by the bank. Given the likely negative correlation between liquidity supply and demand shocks in our data, this represents an underestimate of the true causal impact of bank liquidity on firm loan supply. Column (2) repeats the same regression but attempts to instrument change in bank liquidity with percentage of deposits held as dollars prior to the nuclear tests. As discussed earlier, this "IV" is likely to be invalid and suffer from similar endogeneity problems as the OLS. The result shows that our coefficient of interest remains 0.31.

We next turn to the preferred FE estimation strategy in equation (5) that provides an unbiased estimate of the lending channel coefficient. The FE strategy implies that we have to limit ourselves to the set of firms that borrowed from at least two different banks at the time of nuclear tests. There are 1,864 such firms with a total of 5,300 loans. As expected, these tend to be larger firms. For example, more than 80% of the firms in the restricted sample belong to the top three size deciles in the unrestricted sample. Since these firms are different, our FE estimate may also be affected by the sample restriction. We first test for the sample restriction affect by repeating the OLS regression of column (1) on the restricted sample of 5,300 loans. Column (3) shows that sample restriction reduces the lending channel coefficient from 0.31 to 0.19.

The FE specification is then shown in column (4). A 1% decline in bank liquidity leads to 0.37% decline in a firm's loan supply from the bank. Since the FE is an unbiased estimate, the results confirm our earlier claim that OLS provides an underestimate of the true lending channel coefficient. Comparing columns (3) and (4) we can see that the lending channel coefficient moves from 0.19 in the OLS version to 0.37 in the FE specification. In other words, OLS underestimates the true effect by a factor of about 2.

A-1. Robustness to alternative explanations

Although firm fixed effects subsume most firm specific variables such as changes in a firm's aggregate loan demand and other firm level attributes, there may be some remaining concerns that we address here.

First, one may wonder if the lending channel coefficient is driven by any systematic bank level differences. For example there may be a concern that the change in lending due to nuclear tests is simply a continuation of an old trend in the banks' liquidity positions. Similarly, perhaps the estimate is picking up differences across foreign and local banks as foreign banks are more likely to deal in dollar deposits. Therefore, column (5) includes several bank level controls such as pre nuclear test return on assets of a bank, pre-nuclear test deposit growth of a bank, log of bank size, pre-nuclear test capitalization ratio, and dummies for foreign and government banks.[10] The results indicate that the lending channel coefficient is robust to all these bank level controls.

Second, what if firms borrow different "types" of loans from different banks, and loan types are affected differentially by shocks such as the nuclear tests? In this case firm FE will not account for all demand side fluctuations correlated with bank liquidity shocks. For example, our FE estimates will be biased if firms systematically took shorter term loans from banks more

[10] 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.

hit by the liquidity crunch, and these types of loans saw a larger reduction in demand in the aftermath of nuclear tests. However, we can address such concerns since we have information on the type of loan.[11] We do so by interacting the firm fixed effects with loan type to ensure comparison of the *same* loan type and for the *same* firm across banks (this gives us 2,731 fixed effects for the 1,864 firms in the sample of firms with multiple pre-shock banks). The result in column (6) shows no significant change in the lending channel coefficient. It is also worth noting here that since most of the firms belong to traditional sectors such as textile and consumer goods, there are not many "specialized" loans that firms can take in the first place.

Finally, a related concern might be that our FE results represent a "strategic" withdrawal by firms from hard hit banks. For example, a firm may voluntarily cut back lending from a bank facing liquidity problems and switch to more liquid banks for fear that the liquidity constrained bank might become insolvent in the future. This is unlikely since banks hit by the liquidity crunch were historically more profitable (as seen in Table III) and, while they did see profitability decline post-shock, they still remained as profitable as the banks which got positive liquidity shocks. In fact, no bank declared insolvency after the nuclear tests. Moreover, it is worth noting that this is more of an interpretational concern i.e. even if the loan decline is due to such strategic reasons, it would still be induced through the initial supply-side shock i.e. firms choose to borrow less from the banks that were hit by a larger liquidity shock (that is exogenous to the firms' demand).

B. The Extensive Margin

We now investigate if liquidity crunch also impacts the extensive margin of banks by forcing them to either stop lending to firms altogether or reducing the intake of new firms. Although we cannot use firm fixed effects for the extensive margin as most of the firms affected by the extensive margin had single bank relationships, the results in Table IV show that OLS provides conservative estimates of the impact of liquidity shock. This is also likely to hold for the extensive margin.[12]

[11] Loan type is classified as: (i) short term (under 6 months) working capital loans, (ii) longer term fixed loans, and (iii) non-funded loans such as guarantees and letters of credit.

[12] Strictly speaking, our comparison of the OLS and FE estimates was for the sample of firms that had pre-existing multiple bank relationships. For these firms the comparison shows that their credit demand is negatively correlated with their banks' supply shock. Our assumption when we examine exit rates is that the same negative correlation holds for single-bank firms i.e. the better (less affected by the shock) of these firms are more likely

We begin by testing if the "exit rate" of firms is higher in banks harder hit by the liquidity crunch. To do so, we start with the set of all performing loans just before the nuclear tests (there are 24,710 such loans). Then for each loan, we create a variable $EXIT$ which is 1 if the loan is not renewed at some point during the first post-nuclear test year. In other words, $EXIT$ is 1 for a loan if the firm exits the particular banking relationship in the first post test year.[13] Using this variable, we run the following regression to test if firms borrowing from more liquidity crunched banks were more likely to exit from the relationship:

$$EXIT_{ij} = \beta + \beta_1 * \Delta D_i + \varepsilon_{ij} \tag{6}$$

β_1 is the coefficient of interest.[14] Column (1) in Table V shows that differential exit of firms is higher for firms lending from more credit-crunched banks. A 1% reduction in bank liquidity leads to a 21 basis points increase in the probability of exit for a loan (that is about a 1% increase in probability since the mean exit rate for loans was 20.7% during this period).

As shown earlier, since banks with greater liquidity crunch had better quality firms to begin with, our estimated coefficient is likely to be an underestimate. Still to check if any unobserved firm or bank characteristics are driving the results, we include the bank level controls used in Table IV before, on the RHS of (6). We also add firm level controls including dummies for each of the 134 cities/towns the firm is located in and 21 industry dummies. Columns (2) and (3) show that our coefficients of interest are unaffected by the inclusion of this extensive set of controls. There may be a concern given our contention that OLS is likely to be an underestimate, that the coefficient drops slightly when controls are included. However, the difference is not statistically significant, with controls mostly just improving the precision of the estimates. Put another way, these controls are simply not effective in accounting for omitted credit demand factors. This is also borne out in the mutiple-client firm sample in Table IV where including bank and firm controls in the OLS specification in column (3) hardly changes the bank lending channel coefficient (regression not shown).

Similar to exit, we also check if the uptake of new loans (or "entry") after the nuclear tests

to have been borrowing from the (initially more profitable) banks that faced a larger liquidity crunch. This is likely to be true since such banks also had lower (pre-shock) default rates on loans to single-relationship firms.

[13] We will examine exit rates separately for each quarter following the shock later on in the paper. At this stage we focus on exit during the first year to capture the immediate impact of the liquidty shocks.

[14] Using a non-linear probit model gives the same results as our linear specification.

is systematically different across banks facing differential supply shocks. To run this test, we start with all loans given out in the first post nuclear test year. There are 35,921 such loans. We then create a new variable $ENTRY$, which is 1 if the loan did not exist in the pre-nuclear test period and 0 otherwise. Using $ENTRY$ as the LHS variable, we rerun equation (6). Column (4) shows that liquidity crunch significantly impacts a bank's ability to issue new loans. A 1% reduction in bank liquidity reduces its probability of making a new loan by 34 basis point (the mean entry rate in the data was 38.5%). Columns (5) and (6) show that the effect remains with bank and firm level controls as well.

Another way to understand the magnitude of the exit and entry results is to note 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 30% and entry rates of new firms goes down by 26.5%.

In summary, the results in Tables IV and V show that shocks to a bank's supply of liquidity have large impacts on the lending behavior of banks. As section II explained through the use of firm fixed effects, our results are not readily attributed to correlated changes in credit demand. The results therefore indicate that the MM hypothesis breaks down at bank level, and shocks to the banking sector are transmitted to the loan-level through changes in the banks' lending patterns.

C. Bank Level Results

In addition to examining the bank-lending channel at the firm level, we can conduct a similar analysis at the bank level by examining how a bank's overall lending is affected by its liquidity shock. This allows us to both compare the relative importance of the intensive and extensive margins and address any concerns that our previous results may be driven by small loans that are not very significant from an economic standpoint.

Column (1) in Table VI shows the relationship between overall bank lending and liquidity shocks to the bank, while column (2) controls for all of our bank level controls. The results show a strong relationship between deposit shocks and lending. Columns (3)-(4) and (5)-(6) then separate this overall affect along the intensive and extensive margins respectively. The intensive margin is calculated as the change in log of total bank lending to firms that existed prior to the nuclear tests. The extensive margin is calculated as the difference in log of total bank lending to new firms that start borrowing after nuclear tests and log of total bank lending prior to nuclear tests. The results show that the magnitude of the intensive margin is very similar to the results in Table IV. Interestingly, Columns (5)-(6) shows that the extensive margin is even larger in magnitude than the intensive one. Liquidity shocks have an even larger effect on the ability of banks to make new relationships.

D. Do Liquidity shocks impact the price of loans?

We saw earlier that the presence of a large bank lending channel forces banks to restrict the availability of loans when faced with a negative shock to their supply of deposits. We now test if besides quantity, bank liquidity shocks also affect the price of loans (i.e. the interest rate charged). Our loan level CIB data set does not contain information on the interest rate charged. However, another data source from the central bank records the average interest rate charged by a given bank at a point in time. Using this data we compute the change in interest rates from December 1997 to December 1999 for each bank and regress this variable on change in log of bank liquidity as before.[15] The results in Columns (7) to (8) in Table VI show that banks experiencing larger declines in liquidity supply did not have significantly different changes in average interest rates charged on their loan rates.[16] In other words, while the bank lending channel affects the quantity of loan supply, it does not affect the average price charged by banks.

There could be a number of explanations for this result. For example, even if a bank raises its interest rate on loans that it continues to make in the face of a liquidity shortage, this may not increase the average bank interest rate if the marginal loan now denied by the bank used to have a high interest rate. If a bank is more likely to cut lending to relatively lower quality firms, then the marginal loan declined by the bank will have higher interest rate prior to nuclear tests. Another explanation for our result could be that the bank does not want to raise interest rates because of inter-bank loan competition, or because of the fear of increasing moral hazard concerns. Our interest rate results are similar in spirit to the result in Peterson and Rajan (1994) who find that closer ties between the firm and its creditor increases the availability of credit but does not lower the price of credit. This suggests that quantity rather than price is

[15] Out of the forty two commercial banks used in our analysis, interest rate information is available for thirty nine of these banks.

[16] We also instrumented change in bank liquidity with pre-shock exposure to dollar deposits and got similar results.

the more relevant margin in firm-bank relationships.

E. Short and Medium Run Liquidity Impact

So far the time-series data had been collapsed before and after the liquidity shock to get at the "average" time effect. Moreover, we had deliberately cut off our data at December 1999 to ensure that we average over the same length of time before and after the nuclear tests. Since we can extend the data till June 2003, and can also exploit quarterly variation, we now look at the quarter by quarter impact of credit crunch in the short and medium run on both the intensive and extensive margins. To do so we go back to our original data and instead of running loan-level regressions in first differences as before, we run the following regression using the quarterly loan level data:

$$Y_{ijt} = \beta_{ij} + \beta_t + \beta_{1t} * \Delta D_i + \varepsilon_{ij} \tag{7}$$

where Y_{ijt} represents either the logarithm of L_{ijt}, the loan amount from bank i to firm j in quarter t, or $EXIT_{ijt}/ENTRY_{ijt}$. $EXIT_{ijt}$ is an indicator variable which is 0 when firm i is borrowing from bank j and 1 when it stops borrowing. $ENTRY_{ijt}$ is an indicator variable which is 1 when firm i starts a new relationship with bank j during our sample period, and 0 otherwise. Our coefficients of interest are the quarter-wise bank lending channel coefficients β_{1t}. β_{ij} are bank-firm (i.e. loan) level fixed effects. For illustrative convenience we plot these coefficients in Figs III-V.

Figure III plots the quarter-wise bank lending channel coefficients for the intensive margin. It shows that the impact of the liquidity shock is sudden and persistent i.e. it continues till the end of our sample period as indicated by the lending channel coefficients till June 2003. All of the post-nuclear tests coefficients after the first quarter are statistically significant at the 5% level. The figure also shows that the lending channel measured earlier is really being driven by the liquidity shock resulting from the nuclear tests and not some incidental "trend" in the data since there is no systematic difference in the amount of loans given out by dollar dependent banks (i.e. those that experienced a large liquidity drop due to the nuclear shock) relative to other banks before the nuclear shock.

Figure III also shows periodic peaks in the lending channel coefficient every four quarters.

These peaks (which are statistically significantly above the overall trend) occur in the last quarter of every year and correspond to the seasonal high demand by the textile (cotton) industry. The peaks suggest that liquidity has an even larger effect in times of high loan demand.

Figures IV and V plot the same quarter-wise bank lending channel coefficients for the extensive exit and entry margins respectively and bear out similar patterns as the intensive margin. For both exit and entry rates we see that the shock leads to a sudden and persistent effect. Moreover, there is no such consistent relationship in the pre-shock quarters.

IV Results: Firm Level Impact

A. Can Firms Hedge Bank Specific Liquidity Shocks?

We have seen that shocks to the supply of a bank's liquidity translate into a drop in its client firms' loans. As section II highlighted, this reflects the inability of the bank to access external financing when faced with a credit crunch. However, even if market imperfections at the bank level force them to cut back their lending, this may not have an impact on the borrowing firms if they can compensate by borrowing from elsewhere. For example, if firms could switch to new banks and form borrowing relationships with relative ease, then the loan level impact of liquidity crunch identified earlier will be mitigated. This is particularly pertinent given our context - while many banks suffered declines in liquidity, others actually experienced significant increases.

To test for the extent of substitution to more liquid banks, one needs detailed data linking firms to all possible financial institutions that they can borrow from. This data requirement has so far made it difficult to answer the substitution question. However, we can address it since our dataset includes all loans that a firm has taken from any of the 145 bank and non-bank financial intermediaries in the country.

Recall that in the analysis so far, we restricted our attention to commercial banks that used demandable deposits as their source of liquidity. However, when looking at the question of substitutability across banks, one ought to consider *all* possible financial intermediaries in the economy. For this reason we now include all of the 145 financial intermediaries in our analysis, and construct the aggregate loan amount borrowed by each firm from all of these intermediaries before and after the nuclear tests.

We then compute the aggregate liquidity shock faced by each firm by constructing a loan-size weighted average of the change in deposits for each of the commercial banks that the firm borrowed from before the nuclear tests. Since the deposit data is available only for commercial banks, we assume non-commercial banks experience the economy wide change in liquidity. Since the non-commercial banks only make up 22% of the market share this particular assumption is not crucial for our results. For example, assuming instead that non-commercial banks experience no change in liquidity does not affect our results. We use OLS to estimate:

$$\Delta L_j = \beta_0 + \beta_1 * \Delta \overline{D}_j + \varepsilon_j \tag{8}$$

where the data is aggregated at the firm level and $\Delta \overline{D}_j$ is the loan-size weighted liquidity shock described above. β_1 is the coefficient of interest and captures the firm borrowing effect. If there is no substitution then β_1 in (8) should be the same as that in (4) i.e. the same as the bank-lending channel effect. At the other extreme, if there is full substitution all firms will have equal access to lenders regardless of whom they borrowed from initially. A given bank's liquidity crunch will therefore have no impact on its firm's aggregate borrowing and β_1 will be zero since all firms will only respond to the aggregate liquidity shock (captured by β_0). More generally, the greater the substitution, the closer $\beta_1$will be to zero.

Columns (1) and (2) in Table VII shows the result of estimating (8) using OLS. For the same reasons as before (i.e. liquidity supply and demand shocks are negatively correlated), OLS is expected to provide underestimates of the true effect. The estimated coefficients are statistically similar to the bank lending channel coefficients suggesting little evidence of substitution. Firms are unable to avoid the adverse liquidity shock by going to other lenders in the market.[17]

Column (3) however, shows that there is a subset of firms for which the substitution effect fully compensates for the bank-lending channel. This is the set of firms that already have multiple banking relationships at the time of the nuclear tests. These are the same 1,864 firms that were used in the FE estimation in column (4) of Table IV . While such firms did experience relatively larger drops in loans from their banks that experienced a greater fall in liquidity,

[17] We still cluster observations at the bank level in Table VI. However since observations across banks are aggregated at the firm level, for multiple-relationship firms we use the largest lender of a firm as the unit of clustering. Similarly, for multiple relationship firms, "bank controls" are constructed by value-weighing bank data for each of the banks a firm borrows from.

column (3) in Table VII shows that this drop is fully compensated by greater lending from their other banks: The change in aggregate firm borrowing for these firms is not statistically different from zero (0.34-0.46). The result suggests that firms with prior relationships with multiple banks are able to hedge loan level reductions in liquidity supply by increasing borrowing from more liquid banks. Interestingly, this result is not driven by such firms forming new banking relationships but by being able to compensate from one of their pre-existing banks.[18] Regressions (not shown) of the change in number of creditors (or an indicator for forming a new banking relationship) on changes in bank liquidity show that multiple relationship firms that face greater bank liquidity shocks are no more likely to form new banking relationships.

In contrast, column (3) shows that firms which do not have prior relationships with more liquid banks are unable to substitute. The result thus highlights the importance of relationships, and the presence of significant short term frictions in forming new relationships.

We should point out that we remain agnostic as to why multiple-relationships matter. While we can control for firms attributes such as firm size that may be correlated with being a multiple-relationship firm, our results may be picking up unobserved firm quality, with higher quality firms both having multiple creditors and being better at hedging against lending shocks. Nevertheless, column (4) shows the multiple-relationship hedging effect is robust to a firm's size, whether it is politically connected, and its membership in business conglomerates. We measure a firm's political connectedness with a variable that equals one if any of the directors of the firm participated in a national election. Politically connected firms might be in a better position to protect themselves from liquidity shocks due to their influence. Our measure of conglomerate is the size of the group a firm belongs to. Firms in larger groups might be better able to cope with liquidity shocks if they have better access to financial markets.[19] The results indicate that none of the three additional variables are significant in explaining the result of column (3). Our coefficient of interest (the firm borrowing effect for multiple relationship firms) remains stable when these controls and their interactions with change in bank liquidity are included.[20]

As an aside, note that the coefficients on a firm's political status, group size, and multiple

[18] As it turns out the overwhelming majority (around 95%) of these firms had a pre-existing banking relationship with at least one lending institution that did not experience a negative liquidity shock i.e. those lenders that either did not have demand deposits or saw an increase in their deposits.

[19] See Khwaja and Mian (2005) for details on the construction of the political connectedness and conglomerate membership measures.

[20] The result also holds if we introduce firm size controls non-parametrically by including a dummy for each firm size decile and its interaction with change in bank liquidity.

relationship status are all positive and significant. This suggests that such firms experienced larger than average increases in their use of external credit. Column (5) shows the results remain robust to also including firm and bank level controls.

Figure VI plots the firm-level equivalent of equation (7), where we aggregate all loans across banks at the firm level and then run the regression at the firm-quarter level. The results look very much like Figure III, showing the inability of single-relationship firms in general to hedge against the shock by borrowing from new banks.[21] The liquidity shocks leads to an immediate and persistent decline in overall borrowing by such firms.

B. Firm Financial Outcomes

Our results have shown that although all firms experience a relatively greater fall in loans from their banks facing a greater liquidity crunch, multiple relationship firms are able to compensate for this by borrowing more from more liquid banks. This suggests that while multiple relationship firms should experience no change in their observed outcomes such as default propensity, single relationship firms might be adversely affected if their bank happens to have a negative liquidity shock. However, even single relationship firms may not be adversely affected if they can compensate for the lower aggregate external borrowing, by tapping into internal cash reserves or other forms of informal financing such as trade credit and family loans. If these internal and informal means of financing are sufficient, then a reduction in aggregate external financing will have no impact on a firm's real outcomes.

While we do not have firm level output data, we do have default rates on a firm's loans. To the extent that such default captures a firm's financial distress, we can examine whether the liquidity shock also translates into a real impact at the firm level. We run our main regression specification (4) with a firm's default rate as the LHS variable. Since cross-default clauses make it unlikely a firm can default on one bank but not the other, we aggregate the data at the firm level.

Column (1) in Table VIII shows that firms that on average experience a reduction in their banks' liquidity, experience higher default rates. In particular, a 1% reduction in liquidity of a bank increases the probability of default of its firm by about 13.2 basis points (on a mean post nuclear test default rate of 6.9 percentage points, this is a 1.9% increase in probability).

[21] As before, the multiple relationship firms are able to perfectly hedge.

Recall that our identification strategy suggests that the increase in default rate of firms more exposed to a liquidity crunch cannot be attributed to unobserved negative productivity shocks experienced by such firms and that, if anything, this bias leads to an underestimate. In the absence of a liquidity shock to their banks, these firms are unlikely to have had differentially higher default rates. Thus not only does a liquidity 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 such as drawing on internal capital or borrowing from sister/family firms.

If higher default rates for firms borrowing from more credit-crunched banks is due to reduced loans to the firms, we should see the same relationship between change in default rates and change in a firm's loans. In general, change in loan supply is endogenous to changes in a firm's demand conditions. A potential instrument for change in a firm's loan supply is the firm's bank's liquidity.[22] Column (2) instruments the change in a firm's loans by the change in its bank's liquidity and shows an even larger effect on a firm's default rate of a reduction in its loan supply. Columns (3) and (4) present the OLS and IV estimates including the main bank and firm-level controls used previously and shows that the result remains robust to these controls.

Recall that Table VII showed that firms with multiple relationships prior to nuclear tests did not experience any reduction in aggregate borrowing due to their ability to hedge the bank specific shocks. If default rates increase due to the credit constraints faced by firms, one would expect this to hold for only the single relationship firms. This is confirmed in column (5). The results show that multiple relationship firms experience no increase in their default rates when borrowing from liquidity constrained banks. In fact, multiple-relationship firms borrowing from more credit-constrained banks actually experience a relative decrease in their default rates compared to similar firms borrowing from less credit-constrained banks. This is in line with our earlier observation that firms borrowing from more (post nuclear tests) credit constrained banks are actually better quality firms. Column (6) shows that this result is robust to bank and firm level controls. Note that we cannot run IV in columns (5) and (6) because as Table VII showed, the first stage does not hold for multiple relationship firms.

[22] The first stage for this instrument is given in Table IV. To the extent that bank's experiencing greater liquidity shocks only affect their client firm's financial condition through the amount lent, the exclusion restriction for the instrument is also likely to be satisfied.

V Concluding Remarks

Our study traces how liquidity supply shocks to the banking sector are transmitted to the economy. We find that there is a large bank lending channel. Banks experiencing greater liquidity shocks are unable to borrow and as a result, decrease lending to otherwise profitable firms. This suggests that even for institutions like banks, credit markets in emerging markets do not work well.

In addition, we find that firms that do not have multiple banking relationships are unable to hedge against their bank's liquidity shocks and experience both a fall in aggregate borrowing and a greater likelihood of financial distress. In comparison, multiple relationship firms are able to successfully hedge against bank level shocks. This suggests that there are important frictions in forming new banking relationships. Moreover, given the persistence of our results, such frictions do not seem to be readily overcome. Despite having banks in the economy that experience liquidity gains, firms that were initially only clients of an adversely affected bank, are simply unable to access alternate sources of finance.

Our results suggest that liquidity shocks can have significant aggregate and distributional consequences. At the aggregate level, they lead to drops in credit extended and increased financial distress. In fact we can use our micro-level estimates and benchmarks from the Pakistani economy to provide a sense of the magnitude of these effects.

Consider an economy experiencing an aggregate drop in liquidity of 1%. How much will this liquidity shock cause aggregate lending to drop relative to what it should have been? Our results suggest that such shocks will only affect aggregate lending to single-relationship firms. These firms will face drops in lending both due to a decreased level of borrowing (the intensive margin) and greater exit and less entry of such firms (the extensive margin). Using both our estimates from Table VII (column (3)) and Table V (columns (3) and (6)), and the fact that single-relationship firms received 39% of lending prior to the shock, we impute that a 1% drop in liquidity leads to a 0.28% drop in aggregate lending in the economy ($= 0.39 * 0.34 + 0.39 * 0.17 + 0.39 * 0.21$ - the terms are respectively the intensive margin, increased exit, and reduced entry effects)[23]. The same 1% drop in liquidity also leads to a

[23] Strictly speaking, we should use coefficient estimates that are weighted by firm borrowing size and, in the case of Table V, for single-entry firms only. We choose not to do so for the sake of simplicity and because these estimates are similar and do not change our calculation in any significant way.

13.9 basis points increase in the likelihood of default for single relationship firms. Therefore in addition to aggregate affects liquidity shocks are also likely to have distributional consequences in the economy.

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TABLE I
PRIMARY DATA CHARACTERISTICS

Time Series Dimension	Frequency	Quarterly
	Range	3rd Quarter 1996 to 2nd Quarter 2003
	Number of quarters	28
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 firms with multiple bank relationships prior to nuclear tests	1,864
	Number of firms with single bank relationships prior to nuclear tests	16,783
	Number of banks	42

The data comes from central information bureau (CIB) maintained by the central bank of Pakistan. It contains loan-level financial information on all corporate loans given out by the banking sector in Pakistan. For most of our analysis, data is restricted to banks that: (i) take retail (commercial) deposits (78% of all formal formal financing), (ii) loans that were *not* in default in the first quarter of 1998 (i.e. just before the nuclear tests), and (iii) that appear both before and after the nuclear tests.

TABLE II
SUMMARY STATISTICS

PANEL A: LOAN LEVEL

Variable	N	Mean	SD	Min	25th Percentile	50th Percentile	75th Percentile	Max
Pre-nuclear Test Total Lending ('000)	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
Post-nuclear Test Default Rate	22,083	6.85	20.22	0.00	0.00	0.00	0.00	100.00

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
Average Loan Interest Rate	39	15.33	1.47	13.67	14.11	14.83	16.19	19.06
Growth in Deposits (Dec '97 to Dec '99)	42	0.05	0.30	-0.82	-0.15	0.07	0.22	0.56

The loan level data comprises all performing loans given out by the forty two commercial banks at the time of nuclear test that continued to be serviced. The pre and post data is averaged over June 1996 to March 1998, and June 1998 to December 1999 respectively. Note that since we only include performing pre-nuclear loans, default rate just prior to nuclear tests is zero by construction.

TABLE III

BANK LEVEL CORRELATIONS WITH PRE-SHOCK DOLLAR DEPOSIT EXPOSURE

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	-0.33	-0.55	-0.27	-0.31	0.044	0.061
	(0.17)	(0.13)	(0.06)	(0.06)	(0.014)	(0.016)
Constant	0.25	0.33	0.25	0.28	-0.013	-0.022
	(0.11)	(0.07)	(0.04)	(0.04)	(0.009)	(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 regressions are run on the forty two commercial banks that were allowed to open dollar deposits and hence were direclty affected by the "dollar freeze" as a result of the nuclear tests in May 1998. Average Pre-nuclear test default rate is the loan-size weighted default rate of loans from a given bank over July 1996 to March 1998. The bank level default rate is defined here as a fraction between 0 to 1. Average pre-nulcear-test 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

BANK LENDING CHANNEL COEFFICIENT - INTENSIVE MARGIN

Dependent Variable	Δ Log Loan Size					
	OLS	"IV"	OLS	FE	FE	FE
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Log Bank Liquidity	0.31	0.31	0.19	0.37	0.36	0.34
	(0.07)	(0.10)	(0.11)	(0.08)	(0.09)	(0.10)
Lag Δ Log Bank Liquidity					0.03	
					(0.10)	
Pre Avg Bank ROA					4.24	
					(1.34)	
Log Bank Size					0.02	
					(0.02)	
Pre Bank Capitalization					-2.28	
					(0.89)	
Gov. Bank Dummy					0.09	
					(0.05)	
Foreign Bank Dummy					-0.05	
					(0.06)	
Fixed Effects				Firm	Firm	Firm X Loan-Type
Constant	-0.19	-0.19	-0.12	--	--	--
	(0.02)	(0.02)	(0.03)			
No of Obs	22,083	22,083	5,300	5,300	5,300	5,300
R-sq	0.01	0.01	0	0.36	0.37	0.54

All quarterly data for a given loan is collapsed over pre and post nuclear test period. The nuclear test occurred in the 2nd Quarter of 1998, so all observation from Quarter 3 1996 to Quarter 1 1998 for a given loan are time-averaged into one. Similarly, all observation from 3rd Quarter 1998 to 4th Quarter 1999 are time-averaged into one. Standard Errors in parantheses are clusterd at the bank level (42 banks in total). Data is restricted to banks that: (i) take retail (commercial) deposits (78% of all formal formal financing), (ii) loans that were not in default in the first quarter of 1998 (i.e. just before the nuclear tests), and (iii) that appear both before and after the nuclear tests.

TABLE V

BANK LENDING CHANNEL COEFFICIENT - EXTENSIVE MARGINS

Dependent Variable	Exit?			Entry?		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Log Bank Liquidity	-0.21	-0.19	-0.17	0.34	0.24	0.21
	(0.03)	(0.02)	(0.02)	(0.21)	(0.07)	(0.04)
Constant	0.22	--	--	0.35	--	--
	(0.01)			(0.02)		
Bank Level Controls		Yes	Yes		Yes	Yes
Firm Level Controls			Yes			Yes
No of Obs	24,710	24,710	24,710	35,921	35,921	35,921
R-sq	0.02	0.02	0.05	0.03	0.08	0.13

The data in columns (1) through (3) includes all loans that were outstanding (and not in default) at the time of the nuclear tests. For a given loan, "exit" is classified as 1 if the loan is not renewed and the firm exits its banking relationship by the first post-shock year. The data in columns (4) through (6) includes all loans given out during and after the nuclear tests quarter (2nd quarter of 1998). For a given loan, "entry" is classified as 1 if the loan entered for the first time in the first post-shock year. Bank level controls include lag change in bank liquidity, pre-shock bank ROA, pre-shock log bank size, and pre-shock bank capitalization, while firm level controls include dummies for each of the 134 cities/towns the firm is located in and 21 industry dummies. Standard Errors in parantheses are clustered at the bank level (42 banks in total).

TABLE VI

AGGREGATE LENDING CHANNELS AT BANK LEVEL

Dependent Variable	Δ Log Total Bank Lending		Δ Log Intensive Bank Lending		Δ Log Extensive Bank Lending		Δ Average Lending Interest Rate	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ Log Bank Liquidity	0.55	0.60	0.37	0.39	1.20	1.47	0.14	0.06
	(0.15)	(0.15)	(0.11)	(0.10)	(0.52)	(0.55)	(0.45)	(0.53)
Lag Δ Log Bank Liquidity		0.06		0.02		0.17		0.51
		(0.16)		(0.10)		(0.46)		(0.30)
Pre Avg Bank ROA		2.35		2.15		9.10		-3.79
		(2.27)		(0.93)		(8.12)		(6.51)
Log Bank Size		-0.04		0.00		-0.09		0.13
		(0.04)		(0.02)		(0.13)		(0.13)
Pre Bank Capitalization		-1.86		-1.93		-4.27		-5.51
		(1.59)		(0.55)		(4.98)		(3.19)
Gov. Bank Dummy		0.16		0.14		0.34		-0.12
		(0.11)		(0.09)		(0.41)		(0.54)
Foreign Bank Dummy		0.15		0.07		0.50		0.00
		(0.11)		(0.08)		(0.39)		(0.30)
Constant	0.00	0.56	-0.27	-0.16	-1.63	-0.45	-0.42	-2.05
	(0.04)	(0.76)	(0.03)	(0.39)	(0.13)	(2.41)	(0.16)	(2.14)
No of Obs	42	42	42	42	42	42	39	39
R-sq	0.28	0.36	0.22	0.4	0.16	0.26	0	0.21

The regressions are run on the forty two commercial banks that were allowed to open dollar deposits and hence were direclty affected by the "dollar freeze" as a result of the nuclear tests in May 1998. Δ Log Intensive Bank Lending is the change in log of bank lending to firms that were borrowing from the bank prior to the nuclear tests. Δ Log Extensive Bank Lending is calculated as the log of bank lending to firms that start borrowing after the nuclear tests minus log of overall bank lending prior to nuclear tests. Δ Average Lending Interest Rate is the change in average interest rates charged by the banks aftr the shock. Interest rate data is available for 39 of the 42 banks. Robust standard errors in parentheses.

TABLE VII

FIRM BORROWING CHANNEL COEFFICIENT

Dependent Variable					
	Δ Log Aggregate Loan Size				
	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)
Δ Log Bank Liquidity	0.33	0.26	0.34	0.83	0.67
	(0.07)	(0.06)	(0.06)	(0.45)	(0.46)
Multiple Relationship Firms			0.19	0.39	0.38
			(0.02)	(0.04)	(0.04)
Δ Log Bank Liquidity * Multiple Relationship Firms			-0.46	-0.45	-0.44
			(0.11)	(0.15)	(0.15)
Conglomerate Firm?				0.22	0.20
				(0.03)	(0.03)
Δ Log Bank Liquidity * Conglomerate Firm				0.03	0.01
				(0.14)	(0.15)
Political Firm?				0.11	0.09
				(0.02)	(0.03)
Δ Log Bank Liquidity * Political Firm				-0.05	-0.07
				(0.11)	(0.11)
Log Firm Size				-0.11	-0.12
				(0.02)	(0.02)
Δ Log Bank Liquidity * Log Firm Size				-0.06	-0.04
				(0.06)	(0.06)
Constant	-0.19	--	-0.21	0.60	--
	(0.02)		(0.02)	(0.11)	
Controls		Bank and Firm Level			Bank and Firm Level
No of Obs	18,647	18,647	18,647	18,647	18,647
R-sq	0.01	0.02	0.01	0.04	0.06

All bank loans at a point in time (from any of the 145 banks) for a given firm are summed to compute the aggregate firm level loan size. Quarterly data for a given firm is then collapsed over pre and post nuclear test period. The nuclear test occurred in the 2nd Quarter of 1998, so all observation from Quarter 3 1996 to Quarter 1 1998 for a given firm are time-averaged into one. Similarly, all observation from 3rd Quarter 1998 to 4th Quarter 1999 are time-averaged into one. Data is restricted to (i) firms that were not in default in the first quarter of 1998 (i.e. just before the nuclear tests), and (ii) that appear both before and after the nuclear tests. Bank level controls include lag change in bank liquidity, pre-shock bank ROA, pre-shock log bank size, and pre-shock bank capitalization, while firm level controls include dummies for each of the 134 cities/towns the firm is located in and 21 industry dummies. Standard Errors in parantheses are clustered at the bank level, i.e. the largest lender for a firm.

TABLE VIII

FIRM BORROWING CHANNEL IMPACT ON FIRM FINANCIAL DISTRESS

Dependent Variable	Δ Firm Default Rate					
	OLS	IV	OLS	IV	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Log Bank Liquidity	-13.22		-12.59		-13.94	-13.54
	(7.15)		(5.07)		(6.78)	(4.74)
Δ Log Firm Loan		-40.38		-48.23		
		(14.21)		(14.80)		
Multiple Relationship (MR) Firm					-5.27	-2.37
					(1.38)	(1.09)
Δ Log Bank Liquidity * MR Firm					19.71	10.01
					(5.90)	(3.80)
Constant	8.24	0.50	--	--	8.67	--
	(1.32)	(2.27)			(1.32)	
Controls			Bank and Firm Level	Bank and Firm Level		Bank and Firm Level
No of Obs	18,647	18,647	18,647	18,647	18,647	18,647
R-sq	0.01		0.04		0.01	0.05

All bank loans at a point in time (from any of the 145 banks) for a given firm are aggregated at the firm level to compute firm default rate, loan size etc. Quarterly data for a given firm is then collapsed over pre and post nuclear test period. The nuclear test occurred in the 2nd Quarter of 1998, so all observation from Quarter 3 1996 to Quarter 1 1998 for a given firm are time-averaged into one. Similarly, all observation from 3rd Quarter 1998 to 4th Quarter 1999 are time-averaged into one. Data is restricted to (i) firms that were not in default in the first quarter of 1998 (i.e. just before the nuclear tests), and (ii) that appear both before and after the nuclear tests. Bank level controls include lag change in bank liquidity, pre-shock bank ROA, pre-shock log bank size, and pre-shock bank capitalization, while firm level controls include dummies for each of the 134 cities/towns the firm is located in and 21 industry dummies. Standard Errors in parantheses are clustered at the bank level, i.e. the largest lender for a firm.

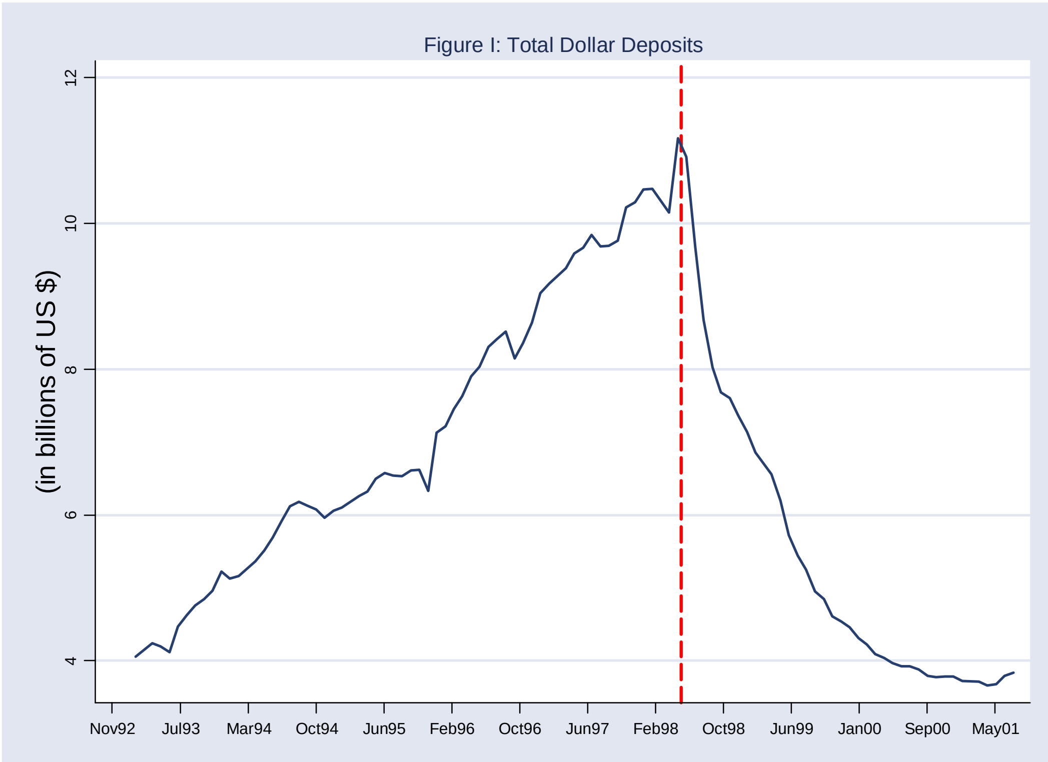
Figure I: Total Dollar Deposits
(in billions of US $)
12
10
8
6
4
Nov92
Jul93
Mar94
Oct94
Jun95
Feb96
Oct96
Jun97
Feb98
Oct98
Jun99
Jan00
Sep00
May01

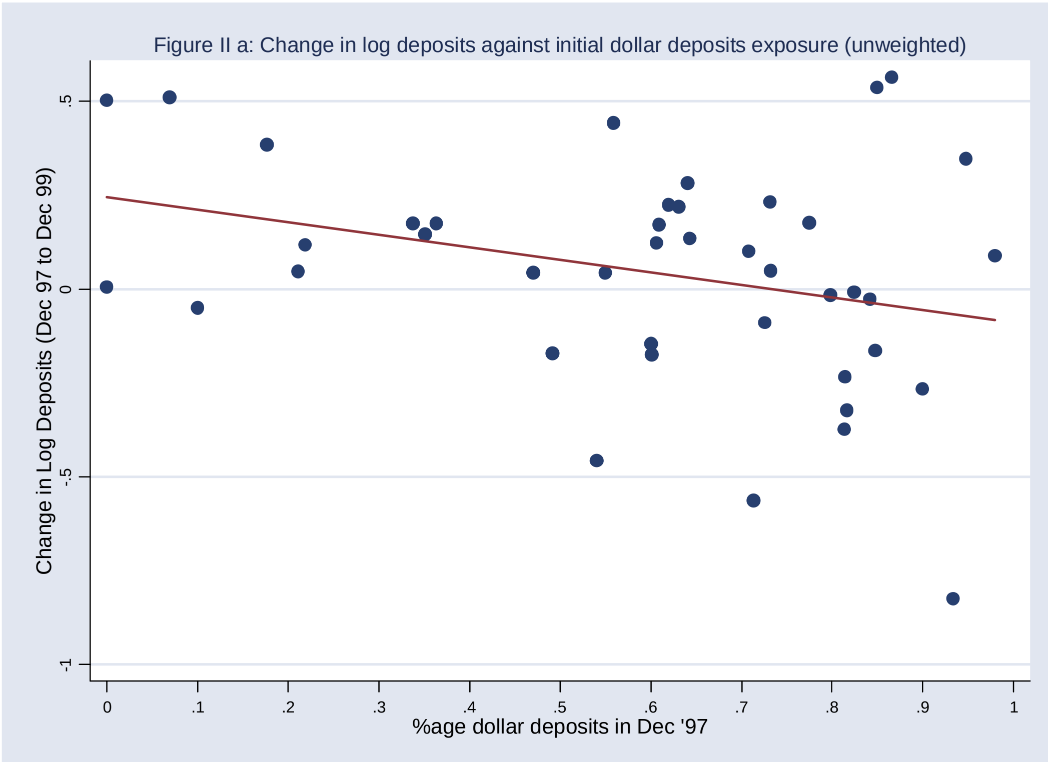
Figure II a: Change in log deposits against initial dollar deposits exposure (unweighted)
Change in Log Deposits (Dec 97 to Dec 99)
.5
0
-.5
-1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
%age dollar deposits in Dec '97

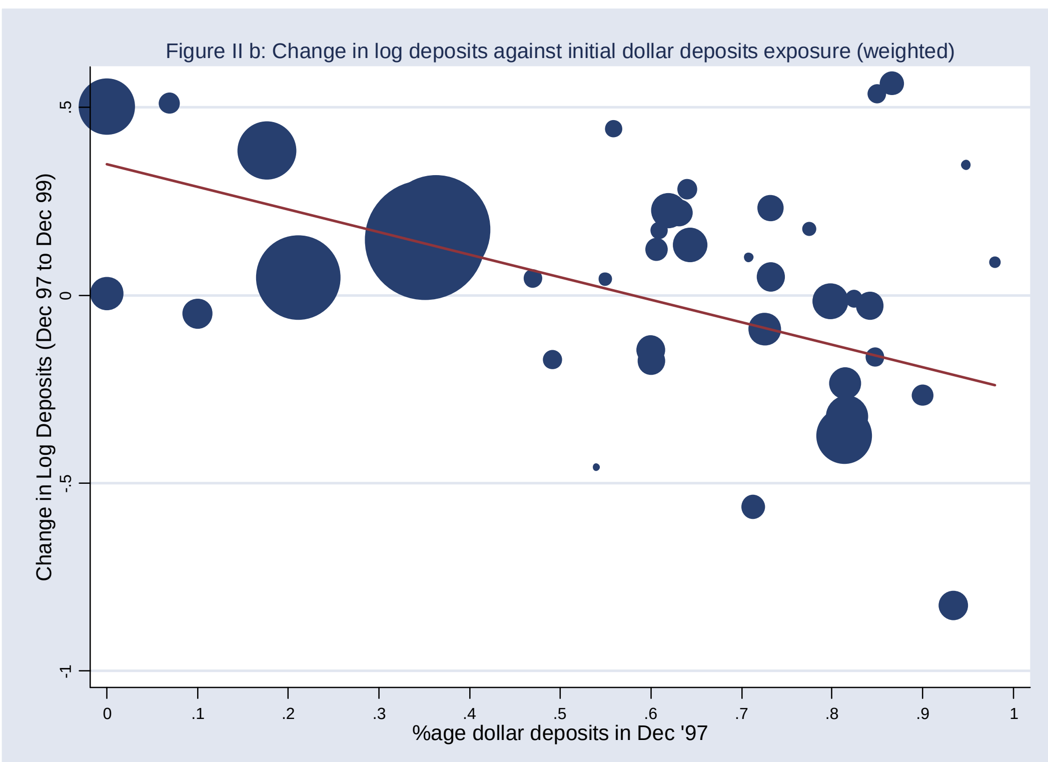
Figure II b: Change in log deposits against initial dollar deposits exposure (weighted)
Change in Log Deposits (Dec 97 to Dec 99)
.5
0
-.5
-1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
%age dollar deposits in Dec '97

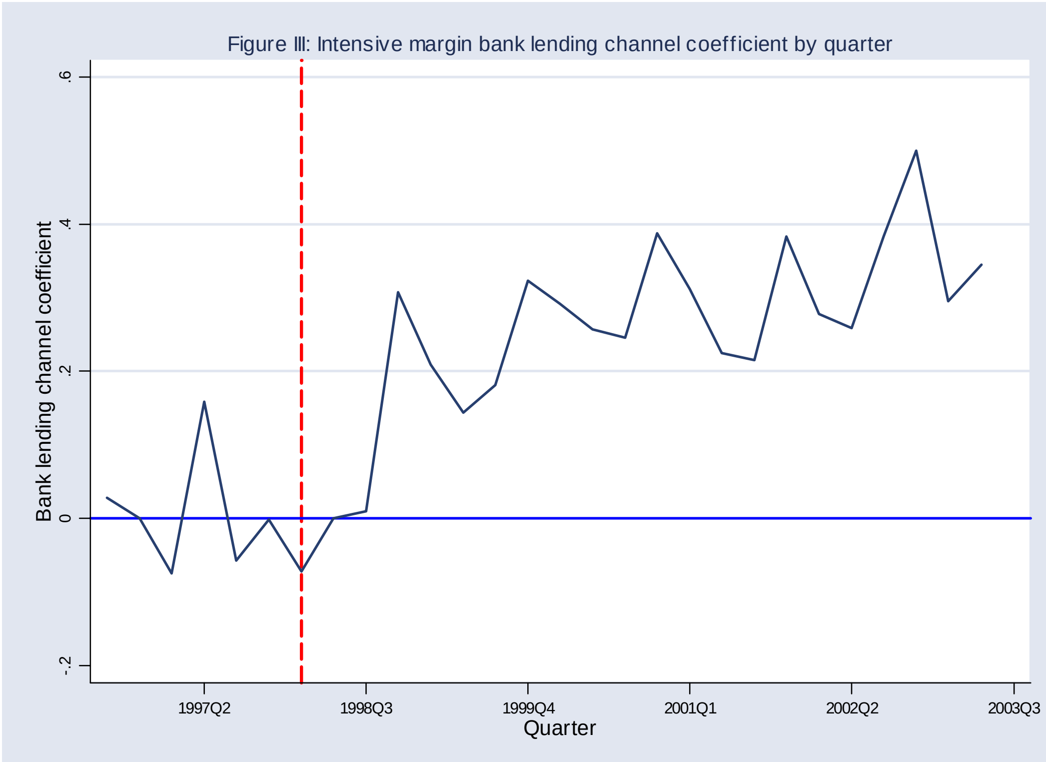
Figure III: Intensive margin bank lending channel coefficient by quarter
Bank lending channel coefficient
-.2
0
.2
.4
.6
1997Q2
1998Q3
1999Q4
2001Q1
2002Q2
2003Q3
Quarter

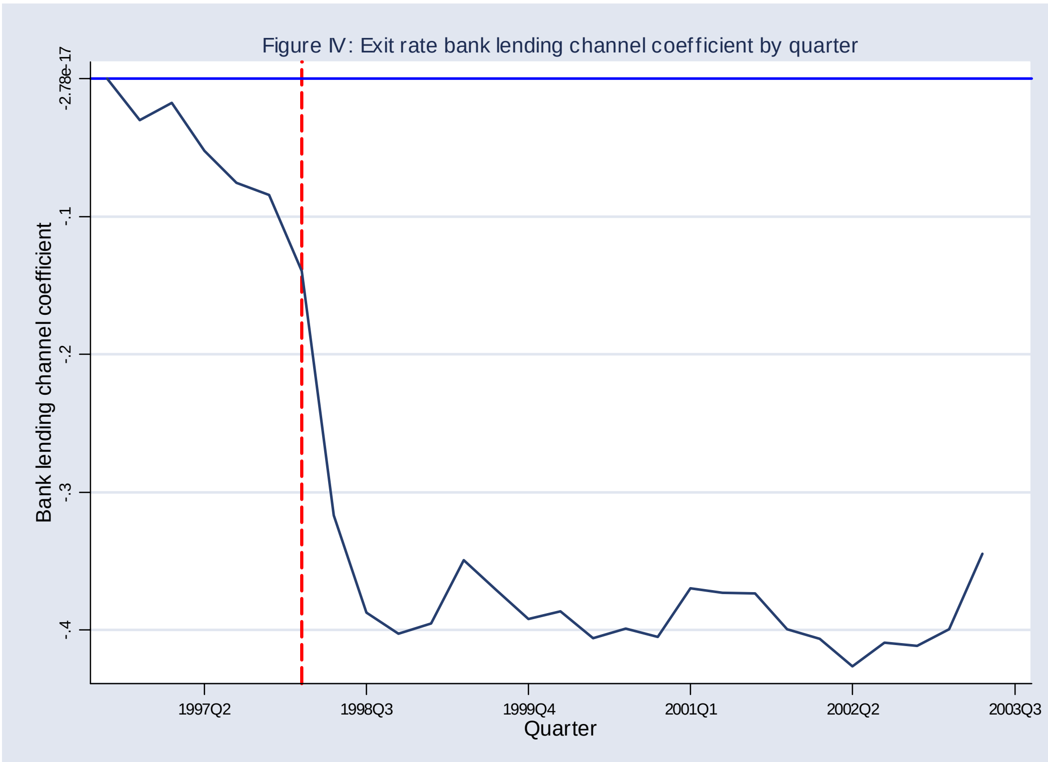
Figure IV: Exit rate bank lending channel coefficient by quarter
Bank lending channel coefficient
-2.78e-17
-.1
-.2
-.3
-.4
1997Q2
1998Q3
1999Q4
2001Q1
2002Q2
2003Q3
Quarter

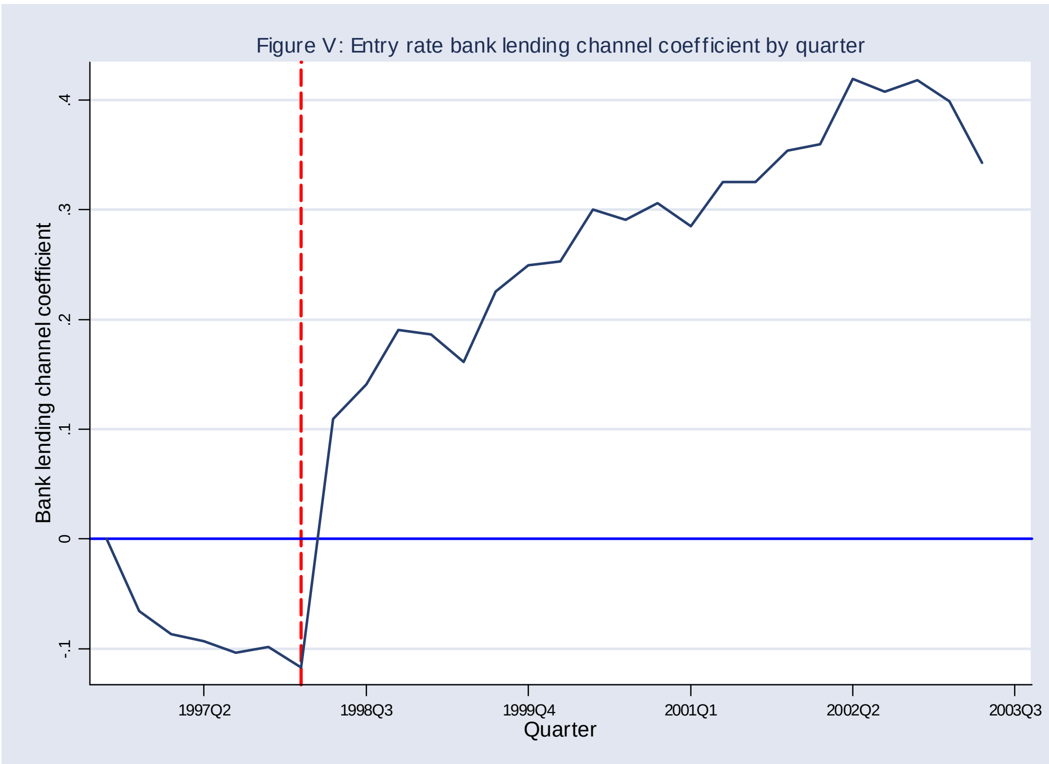
Figure V: Entry rate bank lending channel coefficient by quarter
Bank lending channel coefficient
.4
.3
.2
.1
0
-.1
1997Q2
1998Q3
1999Q4
2001Q1
2002Q2
2003Q3
Quarter

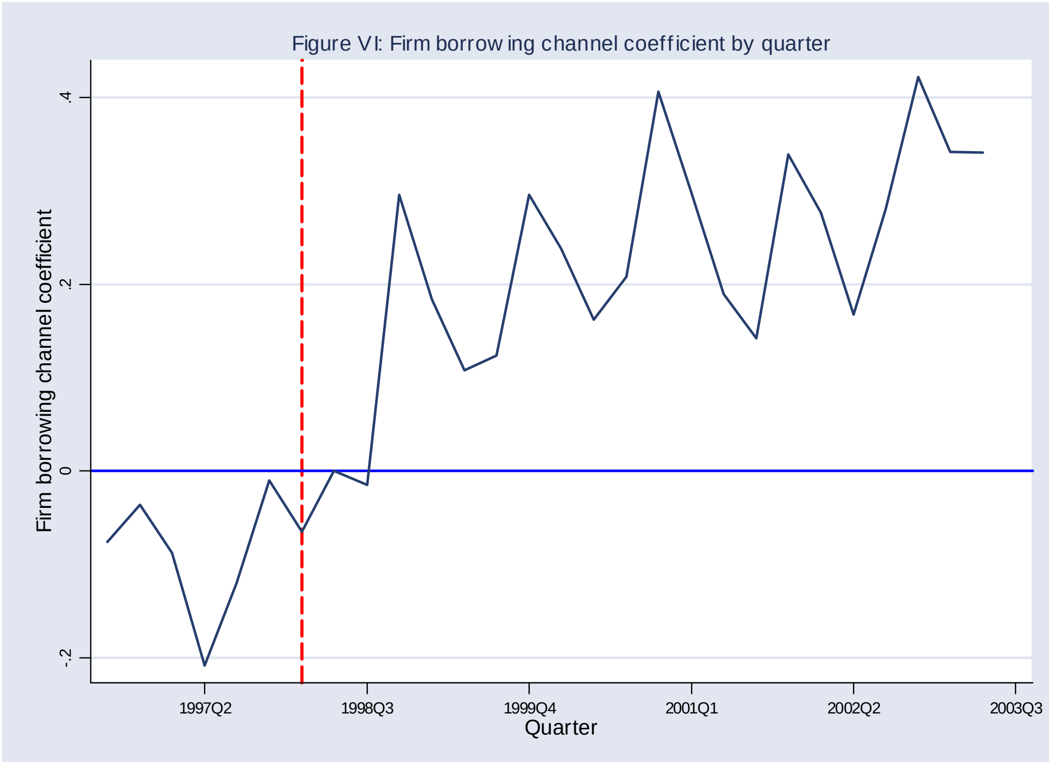
Figure VI: Firm borrowing channel coefficient by quarter
Firm borrowing channel coefficient
.4
.2
0
-.2
1997Q2
1998Q3
1999Q4
2001Q1
2002Q2
2003Q3
Quarter