Understanding Bank Runs: Do Depositors Monitor Banks?

Rajkamal Iyer, Manju Puri and Nicolas Ryan*

(Preliminary and incomplete: please do not circulate)

Abstract

We use unique, depositor-level data for a bank that faced a run and was placed in receivership to study whether depositors monitor banks. Depositors with uninsured balances, depositors with loan linkages and staff of the bank are far more likely to withdraw in response to the shock. We are able to contrast depositor behavior to this fundamental shock with an earlier panic at the same bank. Our results suggest that these withdrawals are due in part to the information known to depositors though overall this information appears to be very coarse. Our results provide direct evidence of depositor monitoring and the significance of fragility in a bank's capital structure, and helps inform banking regulation.

* Rajkamal Iyer: MIT, 50 Memorial Drive, Cambridge-02142. Email: riyer@mit.edu. Manju Puri: Fuqua School of Business, Duke University, 1 Towerview Drive, Durham NC-27708, and NBER. Email: mpuri@duke.edu. Nicholas Ryan: MIT, 50 Memorial Drive, Cambridge-02142. Email: nickryan@mit.edu. We are grateful to Mr. Gokul Parikh, and the staff of the bank for all their help.

I. Introduction

Do depositors monitor banks? Can depositors distinguish fundamental shocks to bank solvency from noise? Are some depositors better at monitoring than others? Answering these questions is important to understanding the role of fragility in the bank capital structure and making sound regulation. Leading theories of banking emphasize the importance of fragility—the possibility of liquidation by depositors—as a commitment mechanism for banks (Calomiris and Kahn, 1991; Diamond and Rajan, 2001). Calomiris and Kahn (1991) argue that the ability of depositors to withdraw deposits on demand provides incentive for informed depositors to monitor banks and trigger a run if the bank is likely to expropriate depositor funds. Diamond and Rajan (2001) argue that the threat of runs commits banks to share rents that accrue through their loan-collection skills, facilitating liquidity creation. These theories emphasize how bank fragility solves agency problems, yet bank runs may be costly *ex post* for an individual bank and even *ex ante*, from the perspective of the whole financial system (Kaufman, 1994; Calomiris and Mason, 2003). Fragility allows panics and unjustified runs that can lead to the failure of solvent but illiquid banks (Diamond and Dvybig, 1983). Understanding the role of depositors in monitoring banks is important in understanding bank fragility, yet direct evidence has been scare primarily because of the lack of data.

In this paper we are able to access detailed micro-level depositor data from a bank in India that experienced a shock to its solvency and is subsequently placed in receivership. We exploit the public and private information events to see how different kinds of depositors (e.g., insured vs. uninsured) respond. Further, we are able to contrast depositor behavior for the shock that resulted in the bank going into receivership with a prior, non-fundamental shock at the same bank. This comparison allows us to test if depositors (or some kinds of depositors) can distinguish between fundamental and non-fundamental shocks.

We first study the fundamental shock that the bank faced. The bank in question experienced large non-payment of dues and was subject to runs and regulatory intervention that ultimately placed the bank in receivership. We exploit the release of private and public information during this failure to examine the behavior of different classes of depositors and the timing of their withdrawals. The time line is the following. The bank has a build-up of bad loans. This build-up is followed by an audit by the central bank, which is private information and which documented the bank had negative net worth. This audit is followed, after a month, by public regulatory action wherein the central bank imposes severe restrictions on the bank's activity. We first examine what classes of depositors run when there is a public release of information regarding regulatory action. We particularly focus on the behavior of uninsured depositors, i.e., depositors with balances above the deposit insurance limit. We also examine whether other depositor characteristics like the length of the relationship with the bank or loan linkages with the bank affect behavior. Finally we study the strength and timing of liquidation by insiders. We find that there is larger run by depositors immediately following the disclosure of regulatory action against the bank. Uninsured depositors are far more likely to run than insured depositors. The magnitude of runs by depositors that are insured is modest, despite the fact that there are large delays in settlement of deposit insurance claims. We also find that depositors that have loan linkages with the bank or who are bank staff, i.e. insiders, are more likely to run. Depositors with a longer relationship with the bank are less likely to run.

We then examine the behavior of depositors before the public release of information. We find that there is a silent run prior to regulatory action that is driven by uninsured depositors, depositors with loan linkages and staff members. The overall magnitude of this advance run, which begins immediately after the regulatory audit, is smaller than that after the public release of information. A regulatory audit can be a precursor to regulatory action and the conduct of this audit was information only available, in principle, to the bank. Note that though the financial information about non-performing assets was available in the prior annual report of the bank, we do not find any significant

withdrawals before the regulatory audit. The observed depositor monitoring is strictly complementary to regulatory intervention.

The results show that uninsured depositors and depositors with loan linkages are the most responsive to information regarding bank solvency. However, this action by depositors cannot pin down the informational content of their signals about the solvency of the bank. Would depositors have taken the same action in response to a non-fundamental shock or panic? If these depositors simply run because they have more to lose in response to any shock, it would be difficult to argue that they monitor the bank.

We examine this question by studying a prior, non-fundamental shock at the same bank. Eight years prior to the fundamental shock, the bank we are studying faced a run due to the failure of another large bank in the same city, which had illegally loaned money to a stock trader for a great loss. Our bank had no fundamental linkages to the failed bank and experienced a run for only a few days following this prior shock. We use this shock as the counter-factual of a fundamental shock and examine whether the behavior of uninsured depositors and depositors with loan linkages differed across the two shocks. We find weaker runs by uninsured depositors immediately after the non-fundamental shock, as compared to the fundamental shock. Depositors with loan linkages are actually *less* likely to run than other depositors in the non-fundamental shock. Uninsured depositors and depositors with loan linkages are thus more likely to run when there is a shock to a banks' solvency as against a non-fundamental shock or panic.

To address the concern that unobservable characteristics of depositors may be correlated with being uninsured or with loan linkages, we estimate the determinants of running amongst the pool of depositors that held accounts during both shocks. We find that uninsured depositors are much more likely to run in a fundamental shock and that this difference is robust to adding depositor fixed effects. In the same sample we also find that depositors with loan linkages are more likely to run in a fundamental shock.

Our results help inform banking regulation. Deposit insurance policies across the world have been primarily set up to reduce fragility in the banking system. While these policies help in mitigating depositor panic, our results suggest that insurance reduces the extent of monitoring. For banks, such as many community or cooperative banks, where a large fraction of depositors are small, the monitoring role of depositors is limited and the task of ensuring bank solvency may lie entirely with regulators. To the best of our knowledge, ours is the first paper to provide direct evidence of depositor monitoring of banks.

Our results also hold relevance for the debate on narrow banking proposals and regulatory policies regarding cross-selling products. We find that loan relationships help depositors monitor banks somewhat better. Thus having banks perform both deposit taking and lending under the same umbrella could improve monitoring.

Our results contribute to the literature on banking by providing empirical evidence on the effects of fragility. Models of banking highlight the fragile bank capital structure as necessary to induce depositor monitoring and to overcome agency problems (e.g., Calomiris and Kahn, 1991; Diamond and Rajan, 2001). Fragility can have aggregate consequences (Allen and Gale, 2000). We find monitoring by uninsured depositors, consistent with the canonical models of banking, but it is driven by regulatory action and limited in extent; even uninsured depositors do not approach complete liquidation. We do not observe what monitoring would have been in a *laissez faire* environment where depositors had to gather information themselves.

On the extent of monitoring, the run in response to the fundamental shock was somewhat narrower but deeper than during the panic. The overall difference between the events is small despite distinct responses to the shocks for some depositor classes. Even after the public release of information about solvency risk, we find that a large fraction of depositors do not run. This suggests that depositors' signals are very coarse and the costs of fragility high (Diamond and Dybvig, 1983). The majority of depositors rely on public release of regulatory action as a coordination mechanism, as in the global games

literature on bank runs and currency attacks (Morris and Shin, 1999, 2002; Angeletos, and Pavan, 2007).

The rest of the paper is structured as follows. Section II discusses the bank and the timing of the shocks studied. Section III introduces the data on depositors and defines variables used in the empirical analysis. Section IV contains the empirical results on how depositor characteristics relate to liquidation during the fundamental shock, both before and after the public release of information, and during the non-fundamental shock. Section V concludes by discussing how the results of this study bear on theories of banking.

II. Institutional Environment and Event Description

A. Institutional Details

The Indian banking system consists mainly of public sector banks, private banks and cooperative banks. The Reserve Bank of India (RBI) is the main regulatory authority of the banking system and monitors bank portfolios and capital requirements for all three types. Cooperative banks, additionally, are supervised by the state government on matters of governance.

Deposit insurance exists but coverage is incomplete and claims can be difficult to make. The Deposit Insurance and Credit Guarantee Corporation, part of the RBI, provides deposit insurance up to INR 100,000 (roughly USD 2,500) for each depositor at a bank. The deposit insurance is funded by a flat premium charged on insured deposits and required to be borne by the banks themselves. Though deposit insurance is present, there are several delays in processing the claims of depositors. The central bank first suspends convertibility when a bank approaches failure and then takes a decision of whether to liquidate a bank or arrange a merger with another bank. During this period depositors are allowed a one-time nominal withdrawal up to a maximum amount that is stipulated by the

central bank.[1] If a bank fails, the deposits held by a depositor cannot be adjusted against loans outstanding. The stipulated cash reserve ratio and statutory liquidity ratio to be maintained by the banks are 5.5% and 25% respectively.[2]

Cooperative banks are not different in kind than banks with other ownership structures. Depositors of cooperative banks are not required to hold an equity claim in the bank. Any depositor can avail of a loan from the bank and potential borrowers are not required to open a deposit account when taking a loan. Shareholders of cooperative banks have limited liability and generally do not receive dividends.[3] Thus the nature of cooperative banks does not select depositors with different characteristics than at banks with other ownership structures. Community banks are the closest analogues to cooperative banks in the United States and play an important role in the U.S. economy (Kroszner, 2007).[4]

B. Event Description

We now turn to the description of the event that we study in this paper. The Bank we study functioned well until 2005. Thereafter, the management changed and the bank took heedless and possibly corrupt risks. In May 2007 an RBI inspection privately noted that

[1] In most cases, depositors are allowed a withdrawal of up to Rs. 1,000 (25$) per account.
[2] The Statutory Liquidity Ratio (SLR) is the minimum allowable ratio of liquid assets, given by cash, gold and unencumbered approved securities, to the total of demand and time liabilities.
[3] The bank issues shares at face value. To be a borrower the bank, the bank asks a depositor to buy shares worth 2% of loan amount which can be redeemed at face value at the end of the loan. In general dividends are not paid by the bank as reserves are used to build up capital to meet capital-adequacy requirements.
[4] In a speech on March, 5, 2007, Federal Reserve Governor, Randall Kroszner states, "Community banks play an important role in the United States economy, as they have throughout our history…many community banks continue to thrive by providing traditional relationship banking services to members of their communities. Their local presence and personal interactions give community bankers an advantage in providing financial services to those customers for whom, despite technological advances, information remains difficult and costly to obtain...I believe that the most significant characteristics of community banks are: 1) their importance in small-business lending; 2) their tendency to lend to individuals and businesses in their local areas; 3) their tendency to rely on retail deposits for funding; and 4) their emphasis on personal service." Cooperative banks display the same four significant characteristics as community banks.

the bank had introduced proscribed insurance products and made two unsecured loans far in excess of the exposure ceiling. These two loans totaled INR 230 million (USD 6m) or 60% of the bank's total non-performing assets as of March 31, 2008. The main precipitating event for the bank's collapse was the non-performance of these large loans. After a routine inspection for the financial year showed the poor state of the bank's finances, the RBI brought the bank under greater scrutiny and conducted a further audit of the bank's books in November, 2008. In response to the findings of the audit, in a letter received by the bank on January 5, 2009, the central bank ordered restrictions on bank activity including the partial suspension of convertibility. Depositors were prevented from prematurely liquidating their term deposits. There was no restriction on withdrawals from transaction accounts. The bank was also forbidden to take new deposits, make new loans or pay dividends. Note that the audit by the central bank was private information and not revealed to the depositors. However, the balance sheets of the bank in 2007 and 2008 reflected the deteriorating condition of its loans. On May 13th, 2009, the central bank finally decided that the bank should be placed under receivership and mandated a withdrawal limit of INR 1,000 for all depositors. There were long delays in processing the deposit insurance claims. This crisis occurred in an otherwise good economic environment. The state economy grew by just over 9% during the year the bank was under scrutiny. No other banks that failed during the event window. Other banks in the region were gaining deposits. The failure was idiosyncratic in nature and not due to weak economic fundamentals.

The aggregate pattern of withdrawals by depositors is presented in Figure 1. Prior to the RBI inspection on November 4, 2008, transaction balances had been largely stable over the fiscal year to date. After the regulatory audit by the central bank there is a gradual but significant run, in which deposits decline 16% from November 4, the date of the audit, to January 27th. On January 28th, newspapers reported on the regulatory action against the bank including partial suspension of convertibility. In the week following this public release of information there is a large run on the bank and transaction balances decline by a further 25%. In Section IV we study the behavior of individual depositors over this event window using micro data

III. Data

We obtain administrative data from the bank that experienced the above crisis in 2009 and had also been subject to a prior run, not related to its fundamentals, in 2001. This bank had seven branches around the city at the time of the 2001 shock and had opened one more by 2009. The data record all deposit balances, transactions and loans from January 2000 through December 2005 and from April 2007 through June 2009. The bank changed its database format and computer system in the interval between these periods and so identifiers and variable definitions do not necessarily line-up across the two events. We note the few instances when this change may affect the analysis in the Section [Empirical Results].

Transaction accounts are defined as current (checking) or savings account types, both of which hold demandable deposits. Daily transaction-account balances are directly available from the bank's database for the later period. For the earlier period, daily balances are calculated from monthly balance and daily transactions files at the account level. We test the reliability of this calculation by matching balances at month-end to the opening balance the next month for the same account.

Liquidation in the cross-section is defined as the withdrawal of 50% of transaction balances over the 7 days beginning the day before the shock. (We will often refer to this group as "runners," as opposed to "stayers," and will vary this definition as a robustness check.) We also estimate hazard models, at a daily frequency, in which liquidation is defined as the withdrawal of 50% of transaction balances in any single day. Transaction balances 90 days prior to the shock (120 days in hazard specifications) are used to measure *ex ante* depositor liquid assets and to group depositors into asset categories. To measure past account activity, we use the share of days over the year prior to the information release, excluding the 90 days immediately prior, on which the depositor had a transaction. Account age is defined as the duration an account has been opened in years as on the date of the shock, (either March 13th, 2001, for the non-fundamental shock or

January 27th, 2001 for the fundamental shock). We top-code account age at seven years, as the age of accounts older than seven years were apparently not recorded or missing when the bank computerized its records.

Family identifiers and depositor loan linkages are defined based on depositor surnames and addresses. We compare each depositor to all others based on surname and address to classify them as belonging to families.[5] We also have data on borrowers from the bank. We define loan linkages for depositors by matching on customer surname and address. Accounts are compared on surname and address using the same criteria as the family match and taken as belonging to the same customer if there is a match. Depositors matched in this manner are defined as having a loan linkage in each crisis if they, or any member of their family, have a loan outstanding with the bank on the date of each run. The definition of loan linkage excludes overdraft accounts against fixed deposits as such accounts may impose restrictions on the withdrawal of deposits. Staff members hold distinct account types. We define depositors as having a staff linkage if either they themselves or a member of their family holds a staff account type.

Some specifications use data on depositors present during both runs. This constant sample is determined using a match on depositor name, surname and address. This match uses the same principle as described above.

IV. Empirical Results

A. *Liquidation After the Public Information Release*

[5] We calculate the ratio $R = 1 - L / MaxOps$, where L is the Levenshtein edit distance between strings, the minimal number of character operations required to change one string into another, and *MaxOps* the maximum number of character operations that could be required to change one string into another given the lengths of each. Accounts are declared as linked if $R_{Surname} > 0.75$ and $R_{Address} > 0.80$ for the surname and address, respectively; we consider this criteria fairly conservative.

The tendency of depositors to withdraw after the public information release depends strongly on depositor characteristics. Table [1] shows summary statistics for all depositors and by liquidation status, comparing the characteristics of those depositors that withdrew more than 50% of their transaction balance over the week beginning at the information release to those that did not. Amongst all 29,852 depositors, 3.9% liquidate their accounts during the run week. This share of runners is similar to that reported by Iyer and Puri (2011). On average, depositors hold a transaction balance of Rs. 5,460 and about one percent have a balance above the deposit insurance limit of Rs. 100,000. With respect to additional relationships with the bank, 1.5% of depositors have a loan linkage and 3.2% of depositors have a staff linkage. Account activity is generally modest, with any transaction on 1.5% of days and an unconditional mean transaction size of about Rs. 140.

Runners and stayers differ significantly on all observable dimensions. Runners have transaction balances seven times larger than stayers, are ten times more likely to have balances above the deposit insurance limit, and are much more active in terms of number and size of transactions. Runners have held their accounts for about a year less. Runners are much more likely to have a loan or a staff linkage. That depositors with loan linkages are more likely to run is different from that reported in Iyer and Puri (2011). The run studied in this paper was precipitated by a fundamental shock to the solvency of the bank studied, in contrast to that studied by Iyer and Puri, which studies a panic. We investigate below the extent to which the difference in the nature of the shock may cause the differences in withdrawal behavior by depositors with loan linkages.

Table [2], Panel A shows the magnitude of the run broken out by the level of prior balance during the fundamental shock in 2009. Fully 29% of depositors with balances above the insurance limit ran during the run week, as compared to 9% of depositors with balances above Rs. 1,000 but below the insurance limit of Rs. 100,000. Nearly forty percent of depositors above the insurance limit had some withdrawal during the run week.

During the run week, we use both linear probability and probit models for the likelihood of liquidation to test the relationships suggested by Tables [1] and [2] in a multivariate framework. We apply the linear probability model, though liquidation is a binary outcome, in part because it allows the inclusion of a large number of fixed effects in later specifications that use data on depositors present in both shocks.

The estimates in Table [3] support the conclusions of the earlier tables. Columns (1) and (2) show linear probability models, and (3) and (4) the marginal effects from comparable probit models. The earlier column in each pair has a linear control for transaction balances and the latter column has dummies for balance categories. Looking at column (1), depositors with loan linkages are 4.4 percentage points more likely to run, which is significant at the five-percent level. Recall that about four percent of depositors run, so this is an effective doubling of the tendency to liquidate. Each additional year of a depositor having an account with the bank decreases the tendency to run by about 0.66 percentage points. Being a staff member increases the tendency to run by over two percentage points, consistent with staff having better information about the fundamentals of the bank. A one-standard deviation (About Rs. 32,000) increase in transaction balances prior to the run increases the tendency to liquidate by 0.00055 x 32 = 1.8 percentage points, comparable to the effect of being a member of bank staff. The magnitude of these effects is generally steady across the specifications shown and in alternative specifications where liquidation is defined as withdrawal of 25 or 75 percent of balances instead of 50 percent (not shown).

Columns (2) and (4) show that the effect of balance is coming largely through depositors with balances above the insurance limit, who are about twenty percentage points more likely to run than the omitted category of depositors holding less than Rs. 1,000 in balance. Depositors with high balances may be better informed and also stand to lose more in the event of a failure due to temporary loss of funds below the insurance limit and permanent loss above the limit. The incentive to withdraw is in principle continuous around Rs. 100,000, as depositors with balances just above the limit remain mostly

insured. Alternative specifications (not shown) test for a discontinuity at the insurance limit and indeed do not find evidence that liquidation changes discretely at that point.

Depositor balances and relationships with the bank are important, robust correlates of the tendency to run. The decision to withdraw is a function of the probability of failure and how much depositors stand to lose in such a failure. Consistent with their relationships providing more information about the bank, depositors with loan linkages and staff linkages are more likely to withdraw during the run. Depositors with higher balances, who may also have better information about fundamentals and have stronger incentives to withdraw, are far more likely to run. Recall that balances above Rs. 1,000 may receive insurance payouts only after a significant delay and that balances above Rs. 100,000 are not insured. Exposure above this insurance limit is the single strongest predictor of liquidation.

B. *Liquidation Prior to the Public Information Release*

The models above considered liquidation in cross-section after the public release of information. As balances, shown in Figure [1], declined significantly prior to the public release of information, it is important to consider withdrawals over a broader window leading up to the run.

To measure how depositors react to the release of information over time, we estimate Cox hazard models, both strictly proportional and with time-varying coefficients. Failure is defined as withdrawal of 50% of balances during any given day. As the likelihood of transactions on any given day is very low, this definition in practice is not dissimilar to the definition employed in the cross-section of withdrawal of 50% over the run week. We exclude depositors with balances less than Rs. 100 as of 120 days before the run to make the model easier to estimate by maximum likelihood. As these accounts have low activity, we expect the omission to have little effect, but the omitted category for balances in the hazard models should be taken as Rs. [100,1000). The model with time-varying coefficients holds the *ex ante* characteristics of depositors fixed over the event window,

from 120 days before to 30 days after the shock, and estimates how the effects of these characteristics change over time. This model specifies the hazard as:

$$\Lambda_i(t) = \Lambda_0(t)\, exp\{\, \beta_1(t)\, AccountAge_i + \beta_2(t)\, StaffLinkage_i + \beta_3(t)\, LoanLinkage_i + \beta_4(t)\, Bal1kTo100k_i + \beta_5(t)\, BalAbove100k_i + \beta_6(t)\, DailyTransactions_i \,\}.$$

The only difference from the baseline Cox proportional hazard model is that each coefficient is allowed to vary over time. Each time-varying coefficient is modeled with a basis of cubic B-splines with knots every 30 days from 120 days before to 30 days after the day of the public information release, for a total of eight parameters. This specification allows the coefficient to change smoothly as a cubic function within each 30-day window and constrains the first and second derivatives of each $\beta(t)$ to be constant at each knot.

Hazard ratios from the base hazard model, reported in Table [4] Column (1), agree with the cross-sectional models that focused on the week of the run. Having an older account decreases the likelihood of liquidation. Staff linkages roughly triple the propensity to liquidate and loan linkages increase it by a factor of 1.58. The relative strength of these effects is reversed, as compared to the cross-sectional analysis, where loan linkages were more powerful than staff linkages. The hazard model covers a broader window than just the run week and staff were more likely to move earlier in this period than other depositors, so the staff effect is larger in the hazard model. Having a balance, prior to the event window, above the insurance limit increases liquidation hazard by a factor of four. This very large magnitude is generally consistent with the magnitude from the cross-sectional regressions, where members of the highest balance bin had a propensity to withdraw 17 to 23 percentage points greater than the overall average of 3.9%. Daily transactions are highly predictive of liquidation.

Table [4] Column (2) reports hazard ratios from the time-varying hazard model as on the day of the public information release. These are formally the exponentiated coefficients on the constant value for each characteristic, which are interpretable as the effect of that

characteristic on the run date, as the B-spline corresponding to the knot at that date has been omitted from each coefficient basis. Staff are more likely to liquidate around the run, relative to the hazard ratio estimated over the event window. High-balance depositors are far more likely to liquidate relative to the proportional specifications. The hazard ratio for depositors above the deposit insurance limit, relative to those in the omitted balance bin Rs. [100,1000), is twenty-five. This ratio is far larger than the ratio of four reported in the proportional hazard model, and captures that high balance depositors, like staff, become more likely to liquidate around times when information about the bank's solvency is revealed. As this coefficient difference suggests, a likelihood-ratio test of the alternative time-varying model against the null proportional hazards model rejects the null model with a p-value of 0.000 ($\chi^2_{(42)} =$ 261.74).

Looking at the full path of coefficients over the event window shows that staff and high-balance depositors are both more responsive to releases of information. For the same time-varying hazard specification as shown in Table [4] Column (2), Figures [5] through [7] show three coefficients of interest, on staff linkages, loan linkages and high balances, continuously on each date over the event window. The hazard ratio corresponding to the staff linkage, shown in Figure [5], is around four and significantly different from one both at the time that RBI inspected the bank and around the public release of information, whereas staff are no more likely to run than other depositors in the middle of the event window. This camel-backed pattern is strongly suggestive that staff are responding to releases of information about the fundamentals of the bank. Figure [6] shows that, while depositors with loan linkages are generally more likely to withdraw over the event window, this effect is not any stronger during periods of information release. Figure [7] shows the time-varying hazard of liquidation for depositors above the insurance limit. These depositors, like staff, are significantly more likely to withdraw during the period after the RBI inspection. After a lull in the middle of the event window, the hazard associated with high balance increases enormously around the date of the public release of information to reach the factor of 25 reported in Table [4], Column (2).

The hazard specifications show significant effects of balance and depositor ties to the bank, via staff and loan linkages. The non-monotonic patterns of coefficients on staff and high balances, with much higher liquidation hazards around information events, suggest these depositors may have better access to information. Depositors above the insurance cover have greater incentives to act on any information that is released and may therefore be more responsive to any given information than other depositors.

C. *Comparison to Non-Fundamental Shock*

The finding that loan linkages increase the tendency of depositors to withdraw is a striking contrast to Iyer and Puri (2011). We attribute this contrast to the differential nature of the shocks that precipitated the two runs. Iyer and Puri (2011) study a run triggered by a fraud at a bank other than the bank for which they had data, and to which their bank had no direct exposure. They find that depositors with loan linkages are less likely to run, and offered several possible reasons, including that depositors fear the withdrawal of credit in the future, or that they have better information about the fundamentals of the bank. To the extent that the explanation is due to better information, it is logical that in this paper, where the bank under study itself [committed the fraud], we find that depositors with loan linkages are more likely to run. Depositors who are also borrowers may not be blindly loyal but simply more responsive due to better information that allows them to react to fundamental shocks but not panics.

To test that the differential nature of the shock is what shifted borrower behavior, we first compare the magnitude of runs by different categories of depositors across the shocks. We obtain depositor data in 2001 at the time of the shock as reported in Iyer and Puri (2011). In 2001, the bank we study is located in the same area and also experienced a run when a neighboring bank failed (see figure 2). Our bank had no fundamental linkages with the failed bank in terms of interbank linkages or loans outstanding with the failed bank. Furthermore, our bank faced depositor withdrawals for a few days after the date of

failure of the large bank, with activity returning to pre-run levels in the subsequent period.[6]

The Table [2], Panel B shows the same comparisons as the fundamental shock for depositors during the non-fundamental shock, in 2001. Note that the differential tendency of depositors above the deposit insurance limit to run is more pronounced in the fundamental shock, in Panel A, than in the non-fundamental shock. Comparison of Figure 3 and 4 also presents a similar picture. These high-balance depositors are 3.2 times more likely to liquidate during the run following the fundamental shock but only 1.5 times more likely to liquidate after the non-fundamental shock, relative to the moderate balance category. The mean withdrawal during the run week for high-balance depositors, moreover, is roughly twice as large after the fundamental shock. High-balance depositors may be better informed about the seriousness of the fundamental shock than others. The fundamental shock is narrower, in that fewer depositors withdraw during the run, but deeper, as those depositors withdraw more.

We then estimate several liquidation regressions in a sample of depositors present both during the fundamental shock of 2009 and during the earlier, non-fundamental shock of 2001 studied by Iyer and Puri (2011). To be present in this constant sample a depositor must have stayed with the bank after the initial shock. Table [5] presents coefficients from linear probability models analogous to those shown in Table [3] but estimated in this constant sample. Columns (1) and (2) estimate the propensity to liquidate as a function of depositor characteristics in the fundamental and non-fundamental shocks, respectively. The loan linkage coefficient in the constant sample during the fundamental shock is somewhat smaller than that reported in the full sample. The coefficient during the non-fundamental shock is -0.012, not significantly different than zero and very close to the -0.014 reported by Iyer and Puri (2011) (Table 2, Column 2). Column (3) estimates a pooled regression across both runs with interaction terms for the fundamental shock. The coefficient on loan linkages is positive and similar in magnitude to that in Table [3], but insignificant (p-value 0.16). Notably, the effect of being above the

[6] See Iyer and Puri (2011) for a detailed description of the shock.

insurance limit is large and positive, but only in the fundamental shock. The main effect for being above the insurance limit in the pooled sample is not statistically different than zero. Finally, column (4) adds fixed effects to the pooled regression in column (3), so that the interaction terms reflect the different in the behavior of individual borrowers across the two shocks. The loan linkage interaction term with the fundamental shock is positive and different from zero in this specification, though not very precisely estimated. The effect of being above the insurance limit does not change appreciably after adding fixed effects.

The difference in the behavior of depositors with loan linkages appears to be due to the nature of the shock. Prior to the non-fundamental shock, the failure of a large cooperative bank, depositors of the bank with loan linkages are neither more nor less likely than others to liquidate, as shown in Figure [9], but they are significantly less likely to do so at the time of the shock. Depositors with loan linkages may not be only loyal to the bank or fearful of losing access to credit, but more responsive to information about the bank's fundamentals.

V. Conclusion

This paper examines the importance of fragility in the bank capital structure. We examine the extent to which depositors can monitor banks and whether some depositors are better at monitoring than others. Finally, we study whether depositors can distinguish fundamental shocks to bank solvency from irrelevant noise. While we find monitoring by depositors that are uninsured, we find that the extent of monitoring is limited. We also find that most of the depositor response is coordinated around regulatory actions. Contrasting the extent of runs by uninsured depositors in case of panic, we find that while the runs are lower in magnitude as compared to a fundamental shock, however, the difference in magnitude is not high. These results hold important policy implications.

A central debate regarding the extension of deposit insurance cover has been the loss in incentive of depositors to monitor banks. Our results suggest that especially for smaller

banks the monitoring role played by depositors is limited. In the light of the costs imposed by fragility, our results suggest that extending the deposit insurance cover (with proper pricing of the deposit insurance) to smaller banks with tighter regulatory supervision could be more effective.

References

Allen, Franklin, and Douglas Gale, 2000. "Comparing Financial Systems," MIT Press.

Angeletos, George-Marios and Alessandro Pavan. "Efficient Use of Information and Social Value of Information". Econometrica 75, 1103–1142

Calomiris, Charles, and Joseph Mason, 2003b. "Consequences of Bank Distress During the Great Depression," American Economic Review 93, 937-947.

Calomiris, Charles, and Charles Kahn, 1991. "The Role of Demandable Debt in Structuring Optimal Banking Arrangements," American Economic Review 81, 497 - 513.

Diamond, Douglas, and Philip Dybvig, 1983. "Bank Runs, Deposit Insurance, and Liquidity," Journal of Political Economy 91, 401-419.

Diamond, Douglas, and Raghuram Rajan, 2001. "Liquidity risk, liquidity creation and financial fragility: A theory of banking," Journal of Political Economy, 109(2), 287-327.

Iyer, Rajkamal and Manju Puri, 2011. "Understanding Bank Runs: The Importance of Depositor-Bank Relationships and Networks," Forthcoming American Economic Review.

Kroszner, Randall, 2007. "Community Banks: The Continuing Importance of Relationship Finance," Speech at America's Community Bankers Government Affairs Conference, Washington, D.C.

Morris, Stephen, and Hyun Song Shin, 1999. "Private versus Public Information in Coordination Problems," Working paper, Yale University and University of Oxford.

Morris, Stephen, and Hyun Song Shin, 2002. "The Social Value of Public Information", American Economic Review 92, 1521-1534.

1 Figures

Figure 1:

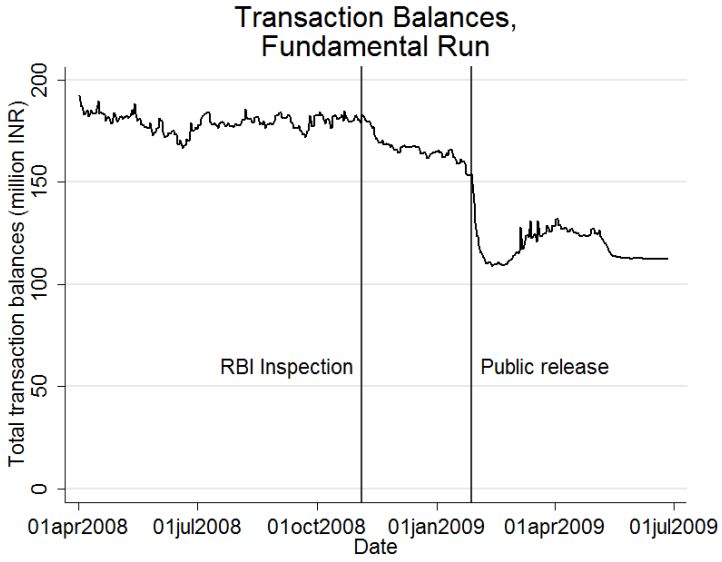


Figure 2:

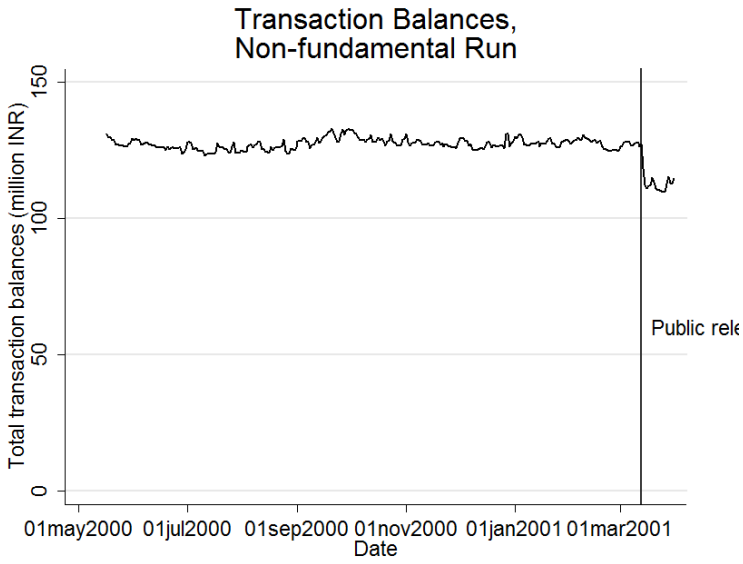


Figure 3:

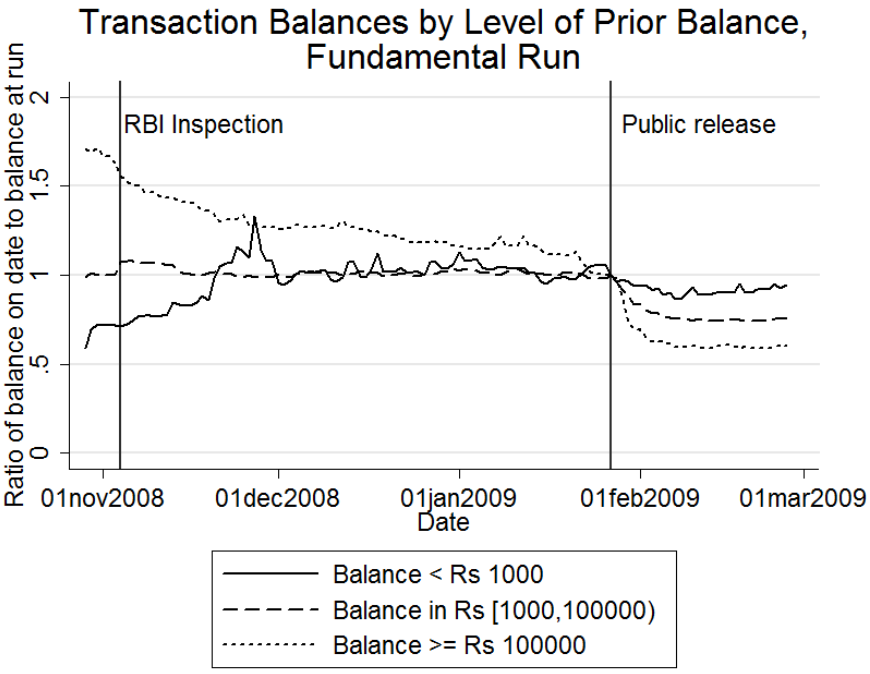


Figure 4:

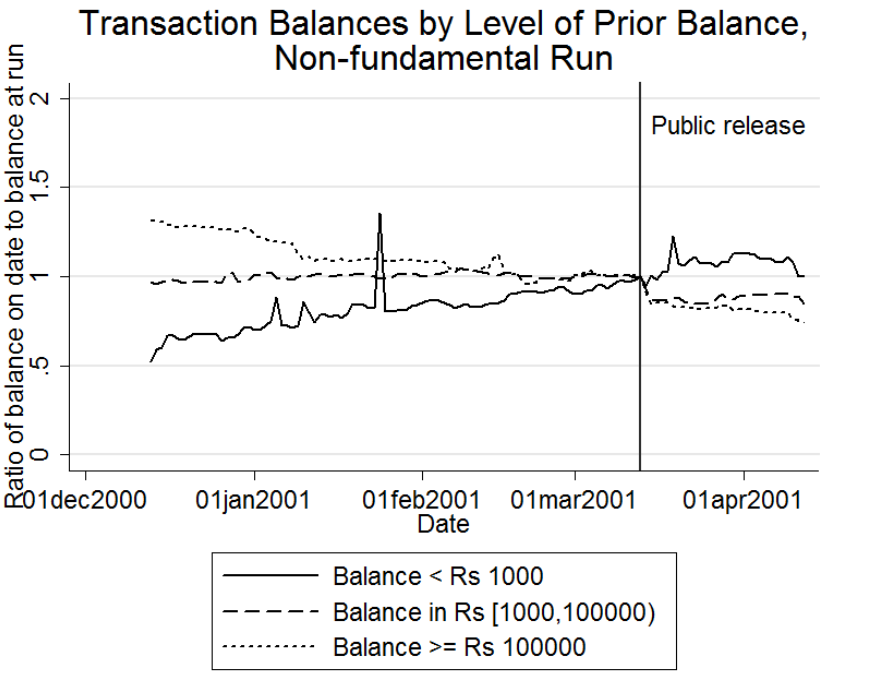


Figure 5:

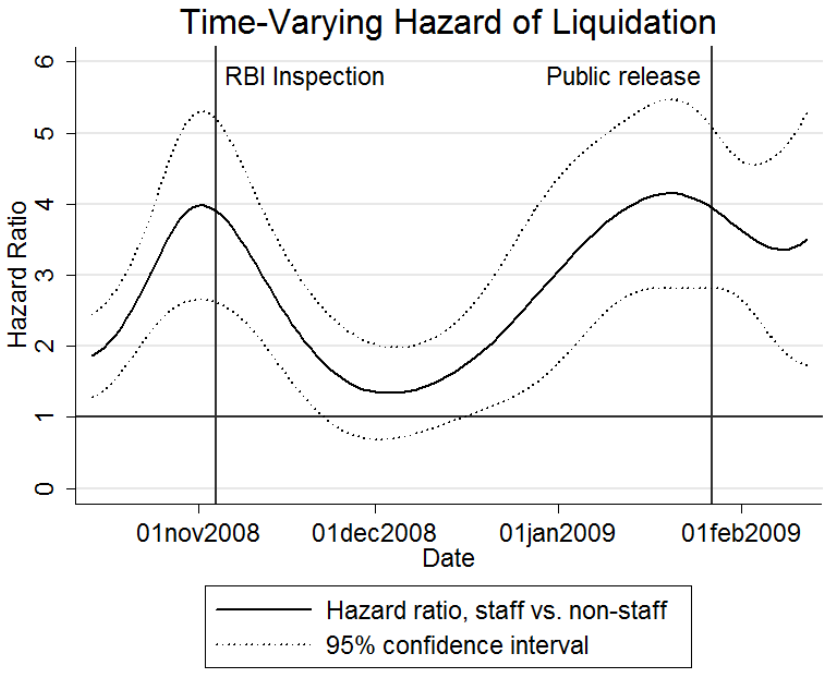


Figure 6:

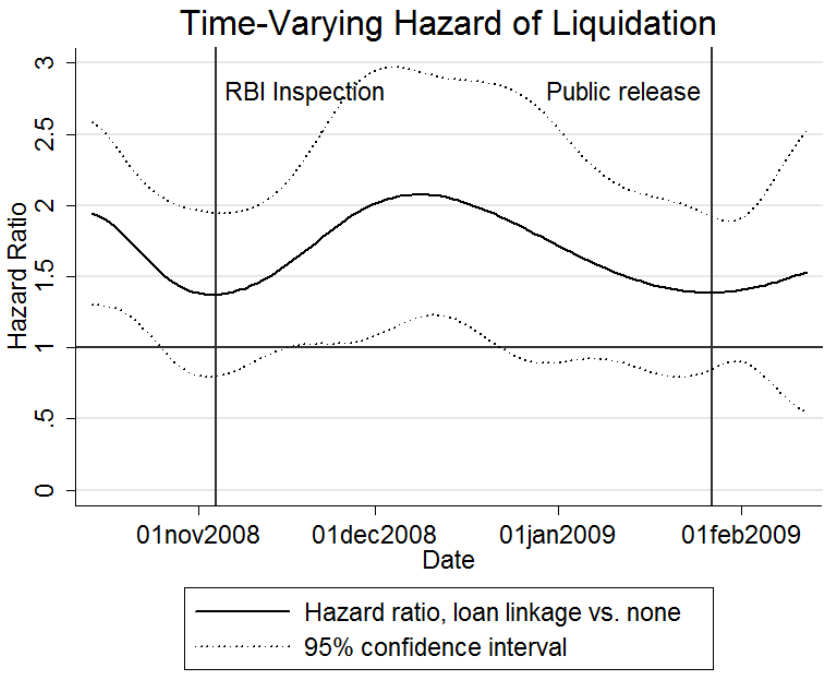
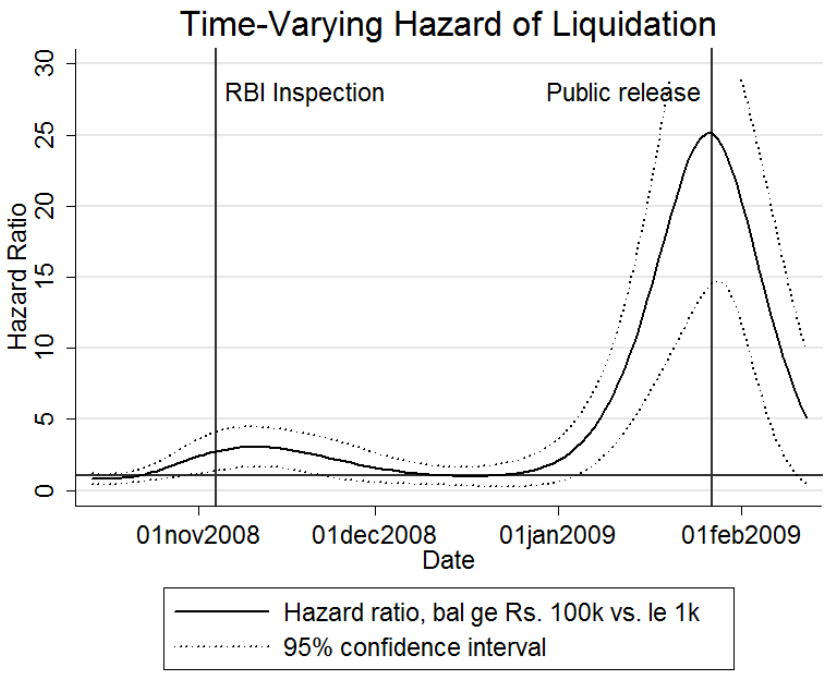


Figure 7:


Time-Varying Hazard of Liquidation
RBI Inspection
Public release
Hazard Ratio
0
5
10
15
20
25
30
01nov2008
01dec2008
01jan2009
01feb2009
Date
Hazard ratio, bal ge Rs. 100k vs. le 1k
95% confidence interval

2 Tables

Table 1: Summary Statistics by Liquidation, Fundamental

	Sample mean [sd]			
	All	Run	Stay	Run-Stay
Liquidation dummy (Withdraw 50%=1)	0.039	1	0	1
	[0.19]	[0]	[0]	(0)
Trans. balance, '000s, 90 days prior	5.46	31.1	4.43	26.6***
	[32.6]	[77.7]	[28.9]	(0.97)
Balance above 100k, 90 days prior	0.0093	0.068	0.0069	0.061***
	[0.096]	[0.25]	[0.083]	(0.0029)
Age of account in years at run	6.30	5.29	6.34	-1.05***
	[1.70]	[2.31]	[1.66]	(0.051)
Depositor or family has loan	0.015	0.048	0.014	0.034***
	[0.12]	[0.21]	[0.12]	(0.0037)
Depositor or family is staff	0.032	0.059	0.031	0.028***
	[0.17]	[0.24]	[0.17]	(0.0052)
Daily transactions, year prior to run	0.015	0.093	0.012	0.081***
	[0.054]	[0.13]	[0.046]	(0.0016)
Daily withdrawal, year prior to run	142.3	996.7	107.8	888.9***
	[1332.6]	[3883.5]	[1099.6]	(39.6)
Daily deposit, year prior to run	140.9	1011.7	105.7	906.0***
	[1318.2]	[3762.1]	[1098.0]	(39.2)
Observations	29852	1157	28695	

Table 3: Models for Liquidation, Fundamental

	(1) LPM	(2) LPM	(3) Probit	(4) Probit
Depositor or family has loan (d)	0.044**	0.038*	0.033**	0.017**
	(0.020)	(0.020)	(0.014)	(0.0086)
Age of account in years at run	−0.0066***	−0.0043***	−0.0055***	−0.0026***
	(0.0010)	(0.0010)	(0.00050)	(0.00036)
Depositor or family is staff (d)	0.022**	0.027***	0.023***	0.027***
	(0.0091)	(0.0091)	(0.0077)	(0.0074)
Mean daily trans. dummy, year prior	0.90***	0.82***	0.29***	0.14***
	(0.055)	(0.053)	(0.016)	(0.010)
Trans. balance, '000s, 90 days prior	0.00055***		0.00016***	
	(0.00014)		(0.000038)	
Bal in Rs [1k,100k) (d)		0.053***		0.059***
		(0.0028)		(0.0028)
Bal ge Rs 100k (d)		0.17***		0.23***
		(0.030)		(0.034)
Observations	29852	29852	29852	29852

Marginal effects; Standard errors in parentheses

(d) for discrete change of dummy variable from 0 to 1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Hazard Model for Liquidation, Fundamental

	(1) Cox	(2) Time varying
Age of account in years at run	0.83***	0.87***
	(0.01)	(0.01)
Depositor or family is staff	2.88***	3.95***
	(0.18)	(0.57)
Depositor or family has loan	1.58***	1.39*
	(0.12)	(0.27)
Bal in Rs [1k,100k)	4.20***	10.19***
	(0.17)	(1.22)
Bal ge Rs 100k	3.84***	25.08***
	(0.34)	(5.37)
Mean daily trans. dummy, year prior	527.48***	231.98***
	(49.04)	(84.01)
Time-varying splines	No	Yes
Observations	2867528	2867528

Exponentiated coefficients; Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Models for Liquidation, Constant

	(1) Fundamental	(2) Panic	(3) Pooled	(4) Fixed Effects
Depositor or family has loan	0.022	−0.012	−0.013	−0.0053
	(0.027)	(0.0089)	(0.0090)	(0.012)
Age of account in years at run	0.00035	−0.0023***	−0.0022***	−0.0024***
	(0.0045)	(0.00058)	(0.00058)	(0.00077)
Depositor or family is staff	0.0082	−0.021	−0.022	0.017
	(0.013)	(0.020)	(0.020)	(0.036)
Mean daily trans. dummy, year prior	1.50***	1.30***	1.39***	1.28***
	(0.14)	(0.13)	(0.095)	(0.15)
Bal in Rs [1k,100k)	0.040***	0.072***	0.070***	0.074***
	(0.0036)	(0.0053)	(0.0053)	(0.0080)
Bal ge Rs 100k	0.18***	−0.0072	−0.013	0.013
	(0.049)	(0.044)	(0.044)	(0.062)
Loan linkage X fund. shock			0.039	0.080**
			(0.028)	(0.032)
Account Age X fund. shock			0.00080**	0.00010
			(0.00040)	(0.00049)
Staff X fund. shock			0.031	0.030
			(0.024)	(0.032)
Bal in Rs [1k,100k) X fund.			−0.029***	−0.020***
			(0.0064)	(0.0069)
Bal ge Rs 100k X fund. shock			0.20***	0.24***
			(0.065)	(0.081)
Constant	−0.0018	0.012***	0.011***	0.011***
	(0.031)	(0.0023)	(0.0023)	(0.0039)
Observations	10864	10864	21728	21728

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$