Deposit Inflows and Outflows in Failing Banks: The Role of Deposit Insurance

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Abstract

Using unique, daily, account-level balances we investigate deposit stability and the drivers of deposit outflows and inflows in a distressed bank. On *outflows*, we find a run-off where uninsured depositors flee the bank following bad regulatory news. Government deposit guarantees, both regular deposit insurance and temporary deposit insurance measures, reduce the outflow of deposits. We also characterize which accounts are more stable (e.g., checking accounts and older accounts). We further provide important new evidence that simultaneous with the run-off, gross funding *inflows* (run-*in*) are large and of first order impact — a result which is missed when looking at aggregated deposit data alone. Losses of uninsured deposits were largely offset with new insured deposits as the bank approached failure. We show our results hold more generally using a large sample of banks that faced regulatory action. Our results raise questions about depositor discipline, widely considered to be one of the key pillars of financial stability.

Keywords: deposit insurance, deposit inflows, funding stability, depositor discipline

JEL Classification: G21, G28, D12, G01

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1 Introduction

There were many bank failures during and after the financial crisis of 2007-2009. In this period, many systemically important institutions, as well as numerous smaller firms, faced severe liquidity stress. The inability of financial institutions to maintain stable funding sources was central to the crisis, which resulted in the high-profile failure or near failure of many financial institutions and unprecedented emergency liquidity support by governments around the world. Large quantities of deposits exited from failing banks, prompting a host of academic studies and regulatory responses attempting to find ways to reduce illiquidity and funding stress.

Many governments extended the scope and limit of deposit insurance in an effort to reduce deposit outflows during the crisis; in the US, deposit insurance was increased from $100,000 to $250,000, and other countries, such as the UK, took similar measures. At the same time, governments introduced temporary deposit insurance measures, such as the Transaction Account Guarantee (TAG) Program, which removed the cap for deposit insurance coverage for many deposit accounts in the US during the crisis. New post-crisis liquidity regulation advocated by Basel requires that banks maintain adequate "stability-adjusted" funding consistent with their "liquidity-adjusted" assets. For such liquidity regulations to be effective, they must accurately characterize the stability of various funding sources. Despite the importance of these measures, there is little empirical evidence on whether deposit insurance matters; what deposits are stable; or whether we need to look beyond the focus on deposit outflows to inflows and, if so, how this might distort our liquidity requirements.

In this paper we take a first stab at answering the following questions. How effective was deposit insurance — both regular deposit insurance as well as temporary measures such as TAG — in preventing the outflow of deposits? What kind of depositors withdraw? How stable are different kinds of deposits? Do depositors discipline banks and, if so, is it effective? While the focus of attention by academicians and regulators alike has been on deposit *outflows*, what about deposit inflows — are they material? How appropriate is the measurement of some of the new liquidity regulations such as LCR and NSFR?

We use a unique, highly granular dataset to assess the impacts of these liquidity-related policy interventions on funding stability, with a particular focus on deposit insurance; in the process, we also develop a number of other interesting results on the drivers of deposit(or) stability. The data we use were collected by the FDIC from a US bank[1] shortly after

[1]Throughout, unless otherwise noted, we use the term "bank" to refer to any insured depository institution, whether it be a commercial bank, thrift, or credit union. We use the term "financial institution" when

its failure, and they allow us to measure daily, account-level balances and attributes for several years. Importantly, unlike with aggregated data such as Call Reports, we are able to separately assess inflows and outflows — a distinction that turns out to be first order important. We then generalize our results by studying a large panel of U.S. banks that faced regulatory action.

It is especially illuminating to consider gross[2] funding outflows and inflows separately. Essentially all prior research, lacking such a detailed dataset, can focus only on net flows; as our surprising finding of depositor run-in demonstrates, focusing on net flows is insufficient. Our separate consideration of gross outflows and inflows gives rise to our first two sets of results.

We first examine outflows in our daily-frequency data using Cox hazard models (in addition to probits and linear probability models). We find that FDIC insurance and other government guarantees, including temporary measures such as TAG, significantly reduce the withdrawals of insured depositors in response to ailing bank health. Our results thus support the notion that deposit insurance — even temporary measures which one might worry are not well-understood by depositors — does indeed improve funding stability. We additionally find numerous systematic patterns with respect to deposit stability, in that checking accounts are more stable than savings accounts, and depositors receiving regular direct deposits are less likely to leave the bank. We also find that depositors who have been with the bank longer are less likely to exit, even when faced with bad regulatory news. Next, our evidence supports the finding that term deposits at this bank were more risk sensitive and less "sticky" than transaction deposits. This is at odds with many economists' intuition, but likely reflects the relative sophistication of term depositors and the inherently forward-looking nature of a non-demandable deposit. Finally, we show that when uninsured depositors leave the bank under stress, they typically withdraw a large share even of *insured* funds. This result is especially relevant for financial stability, as even a substantial share of banks' insured funding may flee in response to bad news.

Next, we study deposit inflows. To the best of our knowledge, we are the first to show that in the presence of government guarantees, gross funding *inflows* are of first order impact

needed, which includes all of the institutions under the term "bank," as well as institutions such as non-bank finance companies, insurance companies, hedge funds and other entities often referred to as "shadow banks."

[2]We use the term "gross" somewhat loosely here. When we refer to gross outflows, we are actually referring to the net change in funding from existing depositors. Gross inflows refer to net changes in funding from new depositors. Especially in periods of stress, existing depositors almost exclusively flee the bank (i.e., they generate no gross inflows) and new depositors continue arriving (generating no gross outflows), such that our use of the term "gross" functionally coincides with its traditional definition.

— even in imminently failing banks. The failed bank we study was able to replace about a third of its deposit base in the last year of its life, while it was publicly known to be under supervisory scrutiny for its declining condition. About half of these new deposits arrived in the last ninety days before failure, after public regulatory reports showed the bank to be critically undercapitalized. The bank attracted these deposits almost exclusively from small financial institutions around the US, most with no previous relationship, using internet deposit listing services.[3] The new deposits were almost all term deposits paying above-market interest rates and structured to fall just under the FDIC insurance limit.

We then use a mix of public data and confidential supervisory data to show that our findings generalize to other US banks. We identify cases in which other banks were subject to regulatory actions similar to the one faced by our bank. We find that banks facing such actions substitute funding away from brokered deposits and time deposits over $250,000, but increase their reliance on listing service deposits and time deposits below $250,000. Banks especially increase reliance on term deposits with balances above $100,000 but below $250,000, suggestive of term deposits structured to fall just under the insurance limit. These results suggest our findings from the detailed micro data generalize to all US banks.

Our finding of massive run-in to a failing bank that is simultaneously facing run-offs has implications for the moral hazard arising from deposit insurance. On one hand, the run-in we document may be a beneficial phenomenon reflecting the fact that deposit insurance improves funding stability, allowing illiquid but solvent institutions to maintain sufficient private funding to avoid failure. On the other hand, our finding may reflect significant moral hazard arising from deposit insurance, allowing banks to choose socially inefficiently high levels of risk (while transferring much of this risk to the government) or to "gamble for resurrection." The issue of whether or not these inflows are socially beneficial is related to the causes of bank funding instability, the rationale for deposit insurance, and the literature on panic- versus fundamentals-driven bank runs (Jacklin and Bhattacharya (1988), Gorton (1988), Saunders and Wilson (1996), Calomiris and Mason (1997)).

Our findings on inflows also show the importance of separately assessing net and gross flows in liquidity regulations. Several prominent scholars have recently highlighted the dearth

[3]Listing services are firms which provide potential depositors with a list of deposit rates (one for each participating bank) for a number of standard deposit products, often sorted from the highest rate to the lowest and displayed on a website. For supervisory purposes, listing services are not considered to be third-party deposit placement services. We follow this supervisory convention; henceforth, unless otherwise noted, we use the terms "placed deposit" and "listing service deposit" as mutually exclusive terms. For more detail on the supervisory definition and treatment of listed, placed, and brokered deposits, see FDIC's "Frequently Asked Questions on Identifying, Accepting and Reporting Brokered Deposits."

of research on new liquidity rules, in spite of liquidity concerns in the last financial crisis (Diamond and Kashyap (2016), Allen and Gale (2017)). Basel rules, such as the Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR), generally assume that banks see no funding inflows that are not contractually required, but it is not clear if the deposit run-off rates assumed in the rules are gross or net. We use our unique data to assess these rules and further to show that this ambiguity can meaningfully impact the stringency of the rules. We also directly compare our observed run-off to the rates assumed in the Basel III liquidity regulations. We find that, while LCR run-off rates appear appropriately conservative, NSFR run-off rates may be too low, especially during periods of extreme stress.

Our paper contributes to the existing literature in a number of ways. Much of the empirical literature on bank runs employ aggregate data. This literature in general finds that banks with worse fundamentals experience greater deposit withdrawals in a crisis (Gorton (1988); Saunders and Wilson (1996); Calomiris and Mason (1997)), and that large amounts of uninsured deposits can lead to unstable banks (Egan, Hortaçsu, and Matvos (2017)). A small set of papers examines responses of individual deposit(or)s to bank runs. These papers either use snapshots of data (Davenport and McDill (2006)) or data from banks in other countries, such as India (Iyer and Puri (2012); Iyer, Puri, and Ryan (2016)); Denmark (Iyer, Jensen, Johannesen, and Sheridan (2016)); and Switzerland (Brown, Guin, and Morkoetter (2014)). To the best of our knowledge, ours is the first paper to use continuous, daily, account-level depositor data for a failed bank in the US to systematically show the importance of deposit inflows in a failing bank occurring simultaneously with large deposit outflows. Our data covers a period in time when temporary deposit insurance measures such as TAG came into effect. As such, we are able to add to the literature by examining the effectiveness of both regular deposit insurance measures as well as temporary deposit insurance measures on which regulators worldwide have put much faith. We are also able to provide evidence on the stability of accounts based on their deposit product type, length of depositor relationship, and legal ownership. Additionally we throw light on new, post-crisis rules such as LCR and NSFR. Finally, we provide important new evidence of substantial deposit inflows in times of stress, raising significant questions about the effectiveness of depositor discipline on bank behavior. We are able to generalize the results on deposit inflows across a large sample of US banks that were subject to regulatory action. This is an important new result that has implications for future work on deposit stability by both academicians and regulators.

The remainder of the paper is organized as follows: Section 2 provides a brief history of the bank to highlight our key findings along with some description to provide context

for later analysis. Then, Section 3 presents regression results on the drivers of deposit liquidation; Section 4 presents results on inflows of new depositors; and Section 5 generalizes our qualitative findings to all US banks. Section 6 documents our assessment of the LCR and NSFR rules in relation to the bank. Section 7 concludes.

2 Data Description and Background

We construct our dataset from data collected by the FDIC shortly after the bank's failure, building daily account balances for each deposit account. We associate accounts with their primary owner and his or her relevant characteristics. We are able to reliably construct daily deposit account balances from early 2006 until the bank's failure. We observe all account transactions over this period, including a reasonably granular description of the transaction and the dollar amount. We checked our constructed account balances against regulatory reports on total deposits, deposits by account category, and deposits by branch.[4] Summary statistics are shown in Table 1.

Until mid-2007, this bank appeared relatively healthy. The bank had approximately $2 billion in assets and primarily made residential real estate loans at this point in its life, but it also offered wealth management services. While the bank employed Federal Home Loan Bank advances (FHLBs), we find no evidence that it took discount window loans or TARP funds. The bank sourced deposits from physical branches as well as internet depositors with a particular focus on savings accounts. The balances in accounts with some uninsured balances, both transaction and term deposits[5], were steadily rising (see Figure 1).

By mid-2007, there are signs of the growing financial-system-wide stress at our bank. Between then and August 2008, there was net run-off in uninsured balances. Figure 1 shows that this was particularly rapid among term deposits. While less than 40% of uninsured transaction balances ran off during the period, over 50% of uninsured term deposit balances did so; this is the first indication of our finding that term depositors are more risk-sensitive. There was comparatively little change in insured deposits. While this period excludes the worst of the financial crisis, stress was building in the financial sector — Bear Stearns and IndyMac failed, Northern Rock experienced a run, and some money markets had frozen.

[4]We also checked individual accounts to ensure that accounts had zero balance before account opening and after closing and that transactions were not missed.

[5]Throughout this paper, we use the phrase "transaction account" to refer to all non-maturity accounts, namely, both checking and savings accounts. We acknowledge that the phrase "transaction account" has a more precise meaning in certain contexts, such as in the Federal Reserve's Regulation D. Additionally, we use "term deposit" and "certificate of deposit" ("CD") as synonyms.

Thus, it is not surprising that depositors, particularly sophisticated depositors, begin to react. During this time period, the bank significantly curtailed its residential lending activities. Thereafter and up until failure, the bank continued to make commercial and personal loans, along with a small number of residential mortgages.

Fall of 2008 saw severe credit and liquidity risks realized across the financial system as well as significant changes in financial policy. The most important policy change for our purpose was the increase in the FDIC's deposit insurance limit from $100,000 to $250,000 effective October 3, 2008.[6] Additionally, the FDIC's TAG program became effective on October 14, 2008, temporarily providing unlimited deposit insurance for negotiable order of withdrawal (NOW) accounts, non-interest-bearing demand deposit accounts, and interest on lawyer trust accounts (IOLTAs), which cover all categories of checking accounts at our bank. The change in deposit insurance is evident in Figure 1, where uninsured deposits drop and insured deposits jump between the Pre-Crisis and Post-Crisis periods denoted with grey bars. Much of the sudden change in balances by insurance status is mechanical, as deposit accounts between $100,000 and $250,000 suddenly became insured. Much of the remaining change among transaction accounts reflects the almost simultaneous application of TAG guarantees. In contrast, changes in term deposit balances are partly driven by the bank's rapid acquisition of placed deposits, as shown in Figure 3 and discussed at greater length below. Further supporting the notion that term depositors at the bank are more sophisticated and risk-sensitive, uninsured CD balances never increase substantially after October 2008.

The inflow of uninsured transaction deposits suggests that the time immediately after the financial crisis was one of limited stress at our bank. The acute system-wide stress of the crisis had receded and the bank's health had not yet significantly deteriorated.[7] Then, about a year before the bank's failure, its primary federal regulator took its first publicly announced action to address the declining health of the bank through a Cease and Desist (C&D) order.[8] The C&D order cited a variety of issues at the bank including insufficient capital and poor board and management oversight, and it was made public immediately, appearing in the

[6] Initially, this increase was through the end of 2010, but it was made permanent by the Dodd Frank Act.

[7] Acharya and Mora (2015) document a similar inflow of deposits into the banking system after government actions in late 2008, suggesting the actions reaffirmed markets' confidence in the financial safety net and thus the safety of the financial system (see also Pennacchi (2006), Strahan (2006)).

[8] The bank had previously been subject to a non-public memorandum of understanding (MOU) as well as a later troubled condition letter (TCL). These were intended to address many of the same problems which led to the bank's demise. Such confidential, informal enforcement actions are a common element of regulators' response to ailing bank health in earlier stages, when failure is relatively unlikely.

local press within a couple of business days. It was described by a banking analyst quoted in the local press as unusually harsh and indicative of high supervisory concern about the bank. Reports in the local press also remarked on the bank's poor health as revealed by its financial ratios in recent public regulatory reports.[9] As can be seen in Figure 1, and unsurprisingly given the negative attention on the bank, there is an increase in aggregate run-off for transaction accounts — both insured and uninsured. As noted above, there were few uninsured term deposits left at the bank, although the few that remain still respond to the news.

Finally, three to four months before the bank failed, the banks' public regulatory filings (including amendments to previous filings) began showing the bank to be "significantly undercapitalized" and, within weeks, to be "critically undercapitalized." The term "critically undercapitalized" is defined by law as the lowest of five ranges for bank capitalization ratios. Banks are considered critically undercapitalized if their leverage ratio falls below 2%; nearly insolvent in book value terms. Importantly, Prompt Correction Action (PCA) guidelines generally require federal regulators to place a bank into receivership or conservatorship (i.e., fail the bank) within 90 days of it becoming critically undercapitalized.[10] Depositors would expect the bank to fail soon, and uninsured deposit run-off accelerated substantially, as shown in the far right of the top panel of Figure 1.

Ultimately, the bank failed, and its primary federal regulator concluded that its failure was a result of heavy credit losses on the loan portfolio, which was highly concentrated in residential mortgage products, including adjustable rate mortgages. The resolution of the bank cost the FDIC approximately 10% of the bank's assets. For context, of the 54 banks with assets between $1 and $10 billion which failed[11] between 2007-2014, the average cost was 18% of bank assets with a right skew, placing this bank's losses in the middle third of the loss rate distribution. Note that although this bank did see a great deal of deposit inflows and outflows, especially close to failure, at no point did it experience a bank run of the type described by Diamond and Dybvig (1983).

2.1 Defining Time Periods of Special Relevance

For the purpose of our empirical analysis, we separately analyze depositor behavior in each of four windows of time available to us, described below. We identified these time periods

[9] We are unable to confirm the exact date of the regulatory report's release due to institutional transitions.
[10] See 12 U.S.C. §1831o for more detail.
[11] We exclude open bank assistance (OBA) from our definition of failure in computing this statistic.

using the bank's data and macroeconomic events in order to conduct our tests. In reverse chronological order, the time periods are:

- *Formal Enforcement Action.* This is a period of significant bank-specific distress and represents the primary time period of interest. This period begins with the C&D order (the formal enforcement action) and ends with the failure of the bank. Unlike earlier periods, the stress arose from bank-specific adverse information, rather than from system-wide anxiety.

- *Post-Crisis.* The Post-Crisis period begins in December 2008, shortly after the government's emergency actions in fall 2008, and runs until the end of May 2009. The Post-Crisis period was a period of considerable distress across the financial system. Unlike in the Formal period, though, there were not significant revelations of bank-specific trouble. As such, the Post-Crisis period allows us to compare depositor behavior in response to market-wide stress. We exclude a few months in the fall of 2008 to avoid the confounding effects of emergency actions by the US government, as well as markets' expectations related to those actions.

- *Pre-Crisis.* The next time period we focus on is the year-long period before the financial crisis ending just before September 2008. As discussed above, uninsured deposits began running off during this period, particularly uninsured term deposits.

- *Placebo.* We utilize a period of time in 2006 as a placebo period, establishing baseline depositor behavior when neither the bank nor the financial system were perceived to be especially troubled.

3 Analysis of Deposit Run-*Off*

This section presents an analysis using several regression models. We regress a dummy indicating whether the account liquidates on a variety of account and depositor characteristics in the context of Cox proportional hazard, linear probability (LPM), and probit models. Because the liquidation behavior of term deposits is quite different from that of transaction deposits, we run regressions separately on the two categories. For both term and transaction deposits, we run separate regressions for each of the four time periods described above: Placebo, Pre-Crisis, Post-Crisis, and Formal Enforcement Action.

All variables used in the regressions are defined in Table 2, with one other consideration related to TAG and Dodd Frank Act (DFA) deposit guarantees. In regressions estimated

on the Placebo and Pre-Crisis periods, we replace the *Covered by TAG/DFA* dummy with a dummy variable which is equal to 1 if the account is a checking account and over the FDIC limit as of the start of the regression period. In those regressions, the replacement dummy variable is used to establish baseline behavior for large checking accounts, which is the same set of accounts covered by TAG subsequent to the crisis. Then, in the Formal period, we replace the *Covered by TAG/DFA* dummy with a *Covered by DFA* dummy. TAG ends and DFA guarantees begin midway through the Formal Enforcement Action period, with the ultimate effect that NOW accounts are no longer covered by unlimited insurance. Given that TAG's expiration was known in advance, we may expect depositors in large NOW accounts to liquidate balances prior to the scheduled end of their deposit guarantees. This would generate a positive relationship between NOW status and liquidation at the same time that non-interest checking and IOLTA accounts (both still covered by DFA) may show a negative relationship. Thus, we only mark accounts covered by the DFA guarantees (but not TAG) with 1 for this dummy in the Formal Enforcement Action period.

In the discussion of the results, we generally compare the Cox model results across different time periods. The Cox results are expressed as hazard ratios, meaning that they can be directly compared in spite of the fact that the time periods of the regressions are of different length; this is not true of the LPM and probit results, as they are run as cross sections and simply consider the probability of ever liquidating during the time period. We include dummies for the branch with which the bank associated each account, though we do not report their coefficients. Regressions here explain the rate of account liquidation[12] as a function of deposit(or) characteristics; for a discussion of run-off rates, see Section 6 and its analysis of liquidity regulation.

3.1 Drivers of Transaction Deposit Run-Off

Focusing first on transaction deposits, Tables 3, 4, 5, and 6 present the regression estimates for each of the four time periods.

The Placebo period in 2006 (Table 3) establishes a baseline for "normal" depositor behavior with little financial stress. First, we find that the *Uninsured* dummy is statistically significant and positive, implying uninsured accounts liquidate at a rate about 14% faster than the baseline hazard and demonstrating that deposit insurance improves banks' funding

[12]Recall that liquidation refers to withdrawing 50% or more of deposits as of the start of the period and then remaining that low for 61 days or longer. Results are robust to other thresholds of 75%, 90%, and 95%. For more details, see Table 2.

stability. Second, the interaction of the *Uninsured* dummy with the *Checking* dummy is not statistically different from zero, showing that uninsured checking accounts liquidate at the same rate as other uninsured accounts in normal times. This is a useful finding as it serves as a baseline against which to assess the impacts of TAG; during and after the crisis, this set of accounts was covered by the temporary, unlimited FDIC insurance provided by TAG. Next, the coefficient on checking is negative and significant, with depositors liquidating checking accounts at only a little more than half the baseline hazard rate, making checking accounts a relatively stable funding source. Fourth, we also show that accounts which are receiving direct deposits roughly every two weeks (indicative of direct-deposited paychecks) are also less likely to liquidate, doing so at 65% of the baseline rate, as indicated by the negative and significant *Direct Deposit* dummy. Finally, the *Trust* dummy is insignificant, meaning that accounts held by trusts liquidate at about the same rate as the baseline hazard.

We also control for other account and depositor characteristics. Because there is relatively little variation across time periods in our coefficient estimates for these additional controls, we will discuss them mainly with respect to the Placebo period. For instance, depositors with a longer relationship with the bank are generally more stable as shown by the negative and significant coefficient on *Log(Age)*, though the coefficients are only significant in the Placebo and Formal periods. The rate at which depositors conduct transactions has a significant, non-linear relationship with liquidation behavior, as both *Prior Transactions* coefficients are significant but with opposite signs. Accounts with very infrequent transactions (possibly unaware depositors) and accounts with very frequent transactions (suggestive of operationally important accounts, from the depositors' perspective) are less likely to liquidate than the baseline hazard. Accounts in the middle, with moderate usage, are more likely to liquidate than the baseline. While there are statistically significant differences in this basic result across time periods, the differences are economically insignificant. Finally, transaction accounts marked by the *Institutional* dummy are not significantly more or less likely to liquidate than the baseline account in all periods.

Moving to the Pre-Crisis period in Table 4, we see that little changes. The coefficient estimates for the *Uninsured* dummy are similar to their estimates from the Placebo period, though they are less consistently significant. The interaction of *Checking* and *Uninsured* remains statistically insignificant, and checking accounts and accounts receiving regular direct deposits remain roughly as stable (relative to the baseline hazard rate) compared to the Placebo period. The coefficient on trust accounts remains insignificant. Importantly, column 4 of Table 4 shows only the *Prior Transactions* coefficients are statistically different

from their Placebo period counterparts, although the sign and statistical significance remain unchanged. The finding of similarities between the Placebo and Pre-Crisis periods is generally consistent with the historical discussion above, where transaction deposits did not much react to building financial weaknesses before the crisis.

Table 5 presents results for the Post-Crisis period. Surprisingly, the *Uninsured* dummy is not statistically different from its earlier value (see column 4), but the point estimate is much larger: such accounts liquidate at a 44% higher rate than other accounts at the time. Similarly, the *Covered by TAG/DFA* dummy, formerly the interaction of *Checking* and *Uninsured* dummies before the advent of TAG, shows that such accounts liquidate less often. Although only the LPM coefficient estimate is statistically different from zero, the Cox model estimates TAG-covered accounts liquidate at a 30% lower rate than the baseline hazard, and column 4 shows this estimate to be statistically different from the Placebo period. Table 5 also shows that checking accounts remain more stable than non-checking transaction accounts (i.e., savings accounts), liquidating about 30% less often, but the coefficient on the *Checking* dummy is statistically smaller than in the Placebo period. Accounts receiving bi-weekly direct deposits were previously less likely to liquidate than other accounts, and the impact is even stronger in the Post-Crisis period than the Placebo, as shown by the statistically significantly larger magnitude of the coefficient on *Direct Deposit*. The impact of prior transactions is statistically (but not economically) significantly different from the Placebo period. Unlike in prior periods, the *Trust* dummy is significantly negative - trust accounts are stickier than other accounts in the period, running off about 26% slower.

Finally, Table 6 presents results for the Formal period. The impact of FDIC insurance is statistically stronger than in the Placebo period: uninsured accounts now liquidate at a rate 92% faster than other accounts according to the *Uninsured* dummy. Accounts covered by DFA guarantees liquidate about 15% slower than other accounts. However, the estimates are not significant across all specifications, and the difference relative to the Placebo period coefficient on *Checking* × *Uninsured* is not statistically significant. Table 6 also shows that checking accounts; accounts receiving direct deposits every other week; and accounts held by depositors with longer relationships with the bank continue to be statistically significantly stickier that other accounts. While checking accounts remain less likely to liquidate than other accounts in the Formal period (doing so about 20% slower), the impact is statistically smaller than the corresponding estimate in the Placebo period; checking accounts remain sticky following bank-specific bad news, but less so than in response to market-wide stress. In contrast, the impact of the length of depositor relationships is stronger in the Formal

period than in the Placebo period; such accounts are more sticky according to the negative *Log(Age)* dummy. There is no such change for the *Direct Deposit* dummy. Trust accounts reverse their behavior from the Post-Crisis period and run off 17% *faster* than the baseline rate as shown by the *Trust* dummy.

These results have several important implications. First, we provide clear evidence that deposit insurance improves banks' funding stability, particularly in periods of stress. More generally, the large impacts in periods of stress demonstrate that depositors were aware of the bank's declining health and the limit of deposit insurance. For outflows, absent the gross run-in we analyze in the next section, this would suggest depositor discipline is present. Second, in the Post-Crisis period, when TAG was in effect, the point estimates for *Uninsured* and *Covered by TAG/DFA* are statistically indistinguishable. The point estimates in the first two rows of Table 5 are similar in size, and a t-test of differences in the magnitudes of the coefficients fails to reject the null of no difference with a p-value of .94, indicating they are extremely similar. Given that TAG was new and unconventional, the program and its operational details would have been unfamiliar to depositors. Thus, it is interesting to find that depositors apparently view it as similar to regular deposit insurance. By contrast, the impact of DFA guarantees in the Formal period is weaker, perhaps reflecting lower public awareness of the DFA guarantees. That said, there are relatively few accounts covered by DFA guarantees which were over the regular FDIC limit, so the coefficients are estimated with less precision than in earlier periods. Third, our finding that checking accounts and accounts receiving regular direct deposits are relatively stable in all environments supports assumptions made in rules such as the LCR and NSFR: to be considered the most stable form of funding for LCR purposes, deposit accounts must be fully insured retail deposits and either 1) a checking account or 2) held by a depositor with other relationships with the bank (such as loans, other accounts, bill payment services, etc.; Basel Committee (2013)).[13] Finally, our finding on trust accounts suggests that such depositors are more sophisticated. Trusts are useful primarily to help wealthy individuals to protect their wealth, such that the average trust depositor is likely both wealthier and more financially savvy than the average depositor. Trust depositors should thus be more able to determine the solvency of the bank, a fact which could generate the observed behavior: they are less likely than others to flee in periods of general distress (Post-Crisis) when the bank itself is not near failure, but more likely to do so as the bank approaches failure in the Formal period.

[13]Note that our definition of "checking account" is synonymous with the definition of "transaction account" in Federal Reserve Regulation D.

3.2 Drivers of Term Deposit Run-Off

Next, we conduct a parallel analysis of term deposits. Table 7 presents results for the Placebo period regressions. First, the *Uninsured* dummy is statistically insignificant, meaning that uninsured CDs do not liquidate more than insured accounts, probably because bank solvency was not a concern. Next, as we saw for transaction deposits, the effect of depositor relationship age as indicated by the *Log(Age)* dummy is negative and, in some specifications, significant.[14] Likely due to relationship depth, such accounts are more stable. Third, the further a CD is from its maturity date, the less likely it is to liquidate. Mechanically, this reflects the fact that few term deposits withdraw before maturity, especially in the Placebo period. Fourth, placed deposits (often thought of as similar to "hot money") liquidate three times as fast as other accounts as shown by the *Placed* dummy, and the impact is statistically significant. There are few institutional deposits at the bank in the Placebo period, but they appear to liquidate slightly more often than the baseline. Finally, trust deposits, as indicated by the *Trust* dummy, are less likely to liquidate than other accounts.

Table 8 shows comparable results for the Pre-Crisis period. The *Uninsured* dummy is now statistically different from zero and its Placebo period value. Uninsured term deposits run-off at a rate about 17% faster than insured deposits, consistent with our finding from Section 2 that uninsured term deposits began running off during this period. Similarly, supportive of our finding from Section 2 that term deposits began running off sooner than transaction deposits, the impact of insurance in this period is larger than the corresponding estimate for transaction deposits. The stabilizing impact of depositor relationship age is stronger relative to the Placebo period (as seen in the *Log(Age)* coefficient) and the impact of time to maturity is attenuated (as shown by the *Log(Days to Maturity)* coefficient), though both are statistically significant; the latter likely reflects the fact that there are more early liquidations than in the Placebo period. The table also shows that placed deposits continue to liquidate three times as fast as other accounts. Finally, trust accounts are no longer more stable than other term deposit accounts, with the *Trust* dummy becoming insignificant.

Table 9 shows responses in the Post-Crisis period. Point estimates for the impact of FDIC insurance are substantially higher than in earlier periods — uninsured accounts liquidate 64% faster than other accounts — and statistically different from the Placebo period. The results also show that placed deposits, which we expect would be particularly risk-sensitive, run off very rapidly, with the coefficient on the *Placed* dummy showing liquidations at 5.6 times the rate of the baseline deposit. The negative coefficients on the length of depositor relationship

[14] Note that we treat the age of placed deposits differently, as discussed in Table 2.

and time to maturity continue to indicate that longer relationships or times to maturity are stabilizing features. Institutional and trust accounts are not statistically significant, though their coefficient point estimates differ statistically from their Placebo period values.

Finally, Table 10 shows estimates for the Formal period. The FDIC insurance dummy remains large, significantly different from zero, statistically larger than in the Placebo period, and close to the point estimate from the Post-Crisis period; uninsured CDs now run off 66% faster. The effect of the *Log(Age)* variable remains negative, but the effect is attenuated, and it is significant only in some specifications. CDs further from maturity are still less likely to liquidate, as seen in the negative *Log(Days to Maturity)* coefficient. Like trust transaction accounts in the Formal period, the *Trust* dummy demonstrates trust term accounts are more likely to liquidate. Finally, the results show a large response from wholesale accounts. Institutional deposits, both faxed/listed and, to a lesser extent, other institutional deposits, are more likely to liquidate given the two positive and significant *Institutional* dummies. However, many such deposits entered after the start of the Formal period, such that they are not included in these regressions. The *Placed* deposits dummy, on the other hand, attests that such deposits run off at a rate fourteen times faster than other term deposit accounts, an incredibly high response showing the high risk sensitivity of these wholesale deposits.

These results provide several significant insights. First and most obviously, the results for term deposits again confirm the stabilizing impact of deposit insurance. Second, taking the magnitude of the impact of insurance in each period as a reflection of term depositors' bank solvency concerns, our results also confirm that term deposits were more risk-sensitive and ran off earlier than transaction deposits (a finding suggested by the discussion of Section 2 and figures referenced therein). Additionally, we show that placed deposits exhibit a great deal of churn in all periods, but they respond even stronger under stress; this supports the view that placed deposits are hot money. As in the transaction deposit regressions, we find that longer depositor relationships help stabilize bank funding, and the strong response of trust depositors in the Formal period is again suggestive of depositor sophistication.

Our finding that uninsured term deposits ran off earlier than transaction deposits may, at first, be surprising. Many economists' intuition here is motivated by theoretical models of bank runs, which emphasize the role of deposit demandability on funding instability. We suggest two reasons why term deposits are relatively unstable, in spite of their lack of demandability. First, term depositors at our bank, particularly uninsured term depositors, tend to be more sophisticated. A greater share of term depositors than transaction depositors are corporate entities (especially depository institutions), and these corporate entities may

manage their assets more carefully. Second, the decision to open or renew a term deposit is inherently more forward-looking than decisions regarding transaction accounts because of term deposits' early withdrawal fees.[15]

3.3 Account Liquidation and the Withdrawal of Insured Funds

Having established the increased propensity of uninsured depositors to drawn down their deposits, we now investigate whether such depositors tend to draw down either to the insurance limit or well below it.

Table 11 presents our results for withdrawals from transaction accounts.[16] Each row represents one of our four periods, and for each period we consider the set of accounts with balances above $2,000 under insurance limit at the start of the period. The columns then show balances of these accounts at the end of the period, in six bins. Relative to the Placebo and Pre-Crisis period, depositors in the latter two periods, especially the Formal period, tend to draw down well below the limit: the largest groupings in the Formal period, relative to previous periods, are accounts with $1 or less and those between $2000 and $2000 under half the insurance limit ($2000 to $123000, in this period), with far fewer accounts remaining above the deposit insurance limit than in other periods. Under stress, uninsured depositors tend to withdraw much more than required to achieve full insurance coverage, usually either drawing down to less than half of the insurance limit or liquidating all funds.

This finding has significant implications for financial stability, since even some insured funds are likely to flee banks in response to stress, and can serve to inform banking theory models (such as Davila and Goldstein (2016)).[17]

[15]This rationale may be behavioral; generally, this bank's term depositors did not pay an early withdrawal fee beyond forfeiting interest earned, and sometimes less than that. Over our sample period, a few dozen early CD breakages resulted in penalties which exceeded earned interest by as much as 2% of the principal balance (usually 1% or less), but most of these penalties were reversed by the bank and credited back to the depositor. Thus, it would appear there were low monetary costs to early CD withdrawal. However, we do not know if all customers would have received such favorable terms if they withdrew early, and those getting favorable terms may be most likely to withdraw early. The very low breakage rate supports the assertion term depositors behaved as though they were making the deposits for the entire CD term, however.

[16]We do not show a comparable table for term deposits because their behavior is simpler: generally, they remain with the bank in full or exit entirely.

[17]Iyer et al. (2016a) find similar behavior among uninsured Danish bank depositors: in response to bad news about the bank during the financial crisis, they tended to follow the heuristic of splitting accounts in half between two banks to achieve full insurance coverage.

4 Analysis of Deposit Run-*In*

The previous section focused on depositor run-*off*, which is traditionally the area of attention with respect to bank funding stability. In this section, we demonstrate that run-*in* is also important to funding stability, even in a bank publicly known to be at high risk of failure. After providing an overview of the run-in dynamics at the bank, we use a regression framework to establish the characteristics of new depositors; present time series evidence that this run-in was not solely driven by factors external to the bank; and provide evidence that the run-in was instead attracted by the combination of credible deposit insurance and above-market rates. We complete the section with a discussion of the policy implications of this brand new finding.

In the last year of it's life, the bank attracted a striking volume of new, insured deposits, about half of which arrived in the last 90 days before failure — when the bank was publicly known to be critically undercapitalized. Figure 2 shows that the inflows of insured funds totaled about $400 million, about a third of the bank's deposit base and roughly equal to the volume of fleeing deposits; because of these flows, the bank's total deposit balances declined very little as the bank approached failure. Figure 3 reveals that the inflows represented a remarkable shift in deposit composition: as placed term deposits (and transaction accounts) fled the bank, they were replaced by institutional CDs, attracted mostly through internet deposit listing services and held almost exclusively by small banks from across the country. Finally, Table 1 provides additional detail. Reflecting the fact that the new deposits were structured to fall just under the insurance limit, only 0.6% of new deposit accounts in the Formal period were uninsured, down from 4.0% in the Placebo period. Relatedly, the share of CDs in new deposits is increasing over time; in the Formal period, nearly 90% of new accounts were CDs. Finally, 82% of new deposits in the Formal period came from institutional depositors (Listed, Faxed, and Other Institutional), up from 2.8% in the Placebo period.

4.1 Characteristics of New Depositors

Having shown that the bank saw substantial deposit inflows, especially late in life, we conduct a classification regression analysis to characterize the differences between new and extant depositors in each period. The dependent variable is a dummy variable equal to 1 if the depositor is new and 0 if the depositor is old, with the right hand side being a vector

of account characteristics.[18] A zero coefficient on an explanatory variable signifies that characteristic is equally distributed between new and old depositors, and a positive value means it is more common among new depositors than old.

Table 12 presents the results of these regressions. The *Uninsured* dummy shows that Uninsured accounts are consistently and significantly five to eight percentage points less common among new depositors than existing depositors. The relative commonality of uninsured accounts remains constant through time because, while the proportion of extant accounts that are uninsured at the bank falls over time, so does the proportion of new depositors that are uninsured. Focusing on the effects of TAG, as shown by the *TAG* dummy, uninsured checking accounts arrive in relatively large numbers in the Placebo period. Potentially due to concerns about the economy, this trend reverses in the Pre-Crisis period, with uninsured transaction accounts being rarer among new depositors. However, suggesting that TAG was effective, in the Post-Crisis and Formal periods, over-the-limit transaction accounts are equally prevalent among new and existing depositors. The *Checking* dummy shows that checking deposits are less prevalent among new depositors than existing depositors, and term deposits are more prevalent. This is consistent with the low run-off rates of checking accounts and higher run-off rates of CDs. As checking accounts are less likely to liquidate, the extant population should have a higher proportion of checking customers than the new population. Trust accounts, as indicated by the *Trust* dummy, are also notably more common in the Post-Crisis and Formal period. Finally, we see significant variation in wholesale deposits. We observe that *Placed* deposits are less common among new depositors compared to old depositors in most periods, save the Post-Crisis period, when we saw the highest inflows of such deposits in Figure 3. Faxed and listing service deposits, while usually more common among new depositors than extant ones due to high turnover, are drastically more common in the Formal period compared to previous periods. A randomly selected listed or faxed deposit is 87 percentage points more likely to be a new depositor than an old one as seen by its respective coefficient, all else equal. Other institutional deposits are always more common amongst new depositors compared to old depositors, although due to their small starting number, the Pre-Crisis period sees their highest relative prevalence among new depositors.

[18] Throughout the paper, unless otherwise noted, a depositor is considered new in any given time period if they open an account within the period and have never previously appeared in the bank's deposit records.

4.2 Drivers of Gross Depositor Run-In

While the previous section illustrates the prevalence of certain depositor characteristics among extant and new depositors, it does not explain the overall prevalence of new depositors compared to old depositors. This section builds upon the last by analyzing the time series of new deposits as a share of total deposits. The left hand side of the regression is the proportion of deposits that are new as of that day, while the explanatory variables are time period dummies and macroeconomic controls. Among the time dummies, the omitted period is the Placebo period, with dummies for the remaining three periods — Pre-Crisis, Post-Crisis, and Formal — as well as dummies for the spans of time between those periods.

Table 13 presents the regression estimates. Focusing first on the macroeconomic controls, we find coefficient estimates consistent with economic intuition. High stock market volatility, as represented by *Log(VIX)*, is positively associated with new deposit inflows, as depositors seek safe and liquid assets. Higher GDP growth and stock returns are also associated with higher deposit inflows, consistent with wealth effects. Other measures that might impact aggregate deposit flows, such as housing starts or the bank's growth profile, are not statistically significant drivers of new deposits. The time series of new depositors' share of deposits is also strongly persistent at the daily frequency, as shown by the positive and significant AR(1) term.[19]

Now consider the time period dummies in Table 13. Although many of the time dummies are significant in specification 1, most become insignificant in specification 2 with the addition of macroeconomic variables. However, even after the inclusion of macroeconomic controls, two time dummies remain significant: Placebo to Pre-Crisis, and Formal. The span between the Placebo and Pre-Crisis periods was a time of deposit growth for the bank, and the dummy's significance likely reflects this fact. More interestingly, we show that the Formal period dummy remains significant and large in magnitude. Given our set of controls, this suggests that the cause of the inflows was driven by bank-specific conditions.

In fact, Figure 4 suggests the bank-specific cause was the high deposit rates offered by the bank in the Formal period. The figure shows the rates the bank paid on newly issued 12-month CDs, a common deposit product that is representative for the bank.[20] The figure

[19]Note that this is not a mechanical result of constructing the series with overlapping measurement periods, as we define "new depositors" at the daily frequency.

[20]Rather than taking the average deposit rate being paid on all 12-month CDs at each date, we construct the series as the 31-day centered moving average of rates offered on newly issued CDs. In this way, the rate series better reflects the rate a hypothetical depositor would have faced had they approached the bank on that date. We use a moving average because there are some days in which no new 12-month CDs are issued.

shows the bank paid relatively high deposit rates throughout its life. However, as deposits flowed in over the last year of its life, the bank consistently paid rates above the 95th percentile of the industry distribution, often approaching the 100th percentile. Interestingly, the time period between the Placebo and Pre-Crisis periods, the other time dummy that remains significant, is also a period in which the bank consistently paid rates above the 95th percentile. Unfortunately, because the price and quantity of deposits are jointly determined and we lack a natural experiment, we do not directly estimate the impact of deposit pricing on deposit flows.

4.3 Policy Implications of Run-In

The change in deposit composition documented above has several important policy implications. First, it suggests that depositor discipline was ineffective in restraining bank risk-taking. While some depositors enforced discipline on the bank by leaving, new depositors offset the disciplining effect by opening new accounts. This finding is concerning especially because the Basel framework considers market (in this context, depositor) discipline of banks to be the third of three "pillars" of financial stability (among others, Martinez-Peria and Schmukler (1999); Park and Peristiani (1998)).

Second, by preventing the bank from failing for lack of funding, these new deposits extended the life of the bank. The pessimistic view is that this phenomenon would allow fundamentally insolvent banks to survive. US experience, especially in the Savings & Loan Crisis of the 1980s, has demonstrated that prolonging the life of insolvent banking institutions can be costly; providing more time for them to "gamble for resurrection" tends to increase the cost of resolving them when they ultimately fail (Dewatripont and Tirole (1994)). This argument is supported by the fact that, of all US banks which received a formal enforcement action between 2000 and 2012, about 54% have since failed or been acquired by another bank.[21] These failures and mergers tend to occur relatively soon after the enforcement action, with 36% occurring within the first three years after the enforcement action and the remaining 18% occurring thereafter. Considering that this bank's enforcement action was particularly harsh, it seems unlikely that this bank was viable as of the enforcement action.[22] A more optimistic view would be that inflows of insured term deposits to troubled banks are a beneficial mechanism that preserve banks' funding and reduce the risk of liquidity failures among fundamentally solvent banks.

[21] Acquisitions are slightly more common than failures among this sample of banks.

[22] The bank also tried and failed to raise capital from at least one private source during the period.

Third, the large inflow of new deposits suggests that deposit rate restrictions placed on troubled banks are insufficient to prevent rapid insured deposit acquisition. Motivated by the depositor discipline and moral hazard concerns above, US law prohibits less than well capitalized institutions from paying deposit rates more than 75 basis points above the national average deposit rate. The bank we study was subject to these restrictions during the Formal period, and yet was able to attract deposits equal to around a third of its deposit base. The top panel of Table 1 shows that the bank complied with the rate restrictions; the spread to the market average on new accounts in the Formal period was around 69 basis points.[23] Because the bank was able to attract so many new deposits while under the restrictions, we conclude the rate restrictions were at best a minimally binding constraint on the bank's behavior. However, it remains unclear whether the rate caps would be more effective if short, riskless rates were substantially above zero; the fed funds rate was at the zero lower bound (ZLB) for the entire period in which the rate caps were in place for our bank. To the extent that the dispersion of deposit rates is reduced when average rates are low (as suggested in Figure 4), the 75bp cap on the deposit rate spread would be less binding while at the ZLB.

The final reason that the shift in deposit composition matters to policymakers is that it transfers risk to the FDIC.[24] In addition to fleeing insured deposits, about $150 million of uninsured transaction deposits also left. Because the bank replaced these fleeing uninsured deposits with insured institutional CDs, the share of the bank's deposits covered by insurance and the credit risk exposure of the FDIC increased as the bank approached failure.

5 Generalization to Other Banks

The unusually granular data for our bank allows us to identify striking changes in deposit composition as it approached failure, but we unfortunately have such data for only a single bank. When we initiated this project, we asked for data from a sample of 10 banks to be recovered and put on a secure server on which we could access the data. Given the data is

[23]Note that the spreads reported in the table are relative to our computed national average rate rather than that defined by the FDIC. We calculate our own national average series using a method identical to that used for the FDIC series. We use our computed series as the official data do not cover our entire sample period, and we wish to keep series consistency across our sample. The source data underlying the official average data changes with vintage, and we have not been able to recover the correct vintages. As a result, our averages tend to differ slightly from the official data. Using the official data over the supported period gives the same qualitative conclusions.

[24]See Egan et al. (2017) for analysis of the interaction between this risk transfer and interest rate restrictions.

stored outside the organization and has a lot of sensitive data it, took well over a year to pull and upload this data in an accessible and secure way. We then examined the deposit data in each bank. Unfortunately, for the bulk of the banks, the deposit data is either incomplete or missing. For some of the banks, the data also cannot be appropriately linked; for example, databases sometimes lack identifiers to link transactions (from one database, and necessary for calculating account balances) with deposit accounts (from another database). As reported earlier, for the bank we study we are confident that the deposit data is complete by matching to the Call Reports, but this is not true for the other banks. Given these data constraints on micro data from failed banks, we use an alternative approach using a variety of other data sets available for a large set of banks. This section analyzes a combination of public and private regulatory data to demonstrate that our major findings generalize to other banks remarkably well.

To generalize our results, the experiment that we conduct is to investigate if banks that face a regulatory action see similar patterns in their deposits. In particular, we investigate the impact of "treatment" with a regulatory action on five funding measures. The five funding measures are the share of each bank's total deposit funding in the form of brokered deposits, listing service deposits, small term deposits (those under $100,000), medium term deposits (those over $100,000 but under $250,000), and large term deposits (those over $250,000).[25] Each series is regressed on a dummy ("treatment") variable for whether or not the bank was facing regulatory action similar to our bank, as well as a set of control variables. We define a bank to be facing regulatory action if it is under a formal enforcement action that includes capital-related provisions or if it is less than well capitalized[26] without a brokered deposit waiver. The treatment variable is defined using data from public Call Reports and confidential FDIC data. The advantage of this approach is that it gives us a large panel of banks — around 10,000 banks, hundreds or thousands of which (depending upon the specification) faced regulatory action.

The control variables are all derived from Call Reports. Control variables are non-performing assets as share of assets, to capture bank health; one-year asset growth rate, to capture the growth and current risk profile of the bank; the natural logarithm of assets, to capture size; deposits as a share of assets, to capture the banks' reliance on deposits generally; and CDs as a share of deposits, to capture their reliance on time deposits particularly.[27] We

[25]The average bank in our sample has 3.1% of its deposits classified as brokered, 1.6% as listed, 20.2% as small term deposits, 13.1% as medium term deposits, and 5.5% as large term deposits above $250,000.

[26]See 12 U.S.C. §1831o for capital category definitions.

[27]We altered the raw Call Report data by correcting for apparent reporting errors and by winsorizing.

use quarterly data for all US banks from 2000 to 2016, with 2,358 banks facing regulatory action and 9,158 not facing them at some point during this time. However, because we rely on the Call Report taxonomy of deposit accounts and because this taxonomy has changed through time, some regressions use shorter samples.[28] Note that all regressions also include bank and quarter fixed effects, which will capture time-varying macroeconomic factors.

Finally, we conduct our analysis under three different model specifications. Two of the specifications are simple OLS models and differ only in the specification of the treatment dummy. In one, we have a single treatment dummy which is equal to one in any bank-quarter where regulatory action was in place; in this case, the untreated ("control") group is all banks not contemporaneously under a regulatory action. In another, we use separate dummy variables for each quarter from four quarters before the imposition of treatment to four quarters after, plus an additional dummy for five or more quarters of continuous treatment; in this case, the control group is banks which will not face such action for at least the next four quarters. Finally, we estimate a third specification on propensity-score-matched banks. Banks' propensity to be treated is determined by a logistic regression using the same covariates as in the above regressions, plus contemporaneous funding shares. Then, banks with similar propensity scores — where one was treated and the other was not — are compared after four quarters of continuous treatment to observe the effects of that treatment. The results are consistent across all specifications.

Table 14 shows the results of regressions with a single regulatory action dummy variable. Consistent with our earlier findings, banks under regulatory action reduce their reliance on brokered deposits while increasing listing service deposits. These two compositional shifts do not completely offset one another, but banks may also be seeking other classes of deposits. In addition, there is an increase in the reliance on term deposits below $100,000 as well as between $100,000 and $250,000, with a decrease in deposits above $250,000.

Table 15 and the accompanying Figure 5 demonstrate the time path of the effects of regulatory action on the same deposit categories. Relative to banks who are more than

Specifically, in a handful of bank-quarters, banks appear to have reported brokered deposits in dollars, inconsistent with the Call Report standard of thousands of dollars, requiring us to divide by 1000. When funding shares calculated from Call Reports were a fraction of a percent above 100% or below 0%, we assume this is due to rounding error, and we round to 100% or 0%, respectively. Finally, we bounded one-year asset growth rates between −50% and 100%, affecting about 2% of bank-quarters. Importantly, none of these changes materially affects the point estimates of the treatment variable.

[28] Listing service deposits were not separately identified or reported on Call Reports before the first quarter of 2011, and data necessary to disaggregate term deposits by size is available beginning in 2010. This limited our listing service deposit sample to 559 treated and 7,020 untreated banks and our term deposit sample to 807 treated and 7,141 untreated banks.

four quarters away from regulatory action, banks one to four quarters before an action have statistically significantly more brokered deposits. Following the application of such restrictions, these banks become much *less* likely to source such deposits, reflecting the concurrent application of brokered deposit restrictions. The exact opposite pattern appears with listing service deposits, with banks prior to such events having fewer and those after having more. Presumably, this pattern reflects inflows of listing service deposits conceptually similar to those documented previously. Small time deposits are relatively more prevalent in banks in the last few quarters before regulatory action than in the control group, and the difference becomes even more stark after regulatory action. Medium time deposits make up a smaller share of funding at banks prior to regulatory action compared to the control group, but also become more common following regulatory action. Finally, large time deposits are equally as common among banks far from regulatory action as well as those within only a few quarters of action, but they become much less common among banks following regulatory action. Table 16 shows that our generalization results are robust to using a propensity-score-matched specification.

This analysis generalizes our earlier findings along several dimensions. These regressions consistently find that banks under regulatory action reduce reliance on brokered deposits (due to concurrently applied brokered deposit restrictions) and deposits above the insurance limit (reflecting the flight of uninsured depositors from the ailing bank). These regressions show that banks under regulatory action increase reliance on listing service deposits, much as our bank did. Treated banks also increase reliance on term deposits under the insurance limit, and especially those between $100,000 and $250,000. Recall that our bank structured most of its new deposits during the Formal period to fall just under the insurance limit — within this range.

6 Run-Off, Run-In, and Regulatory Liquidity Ratios

As a final empirical exercise, we use our novel failed bank data to assess the realism of deposit run-off rates assumed in the two post-crisis liquidity ratios, LCR and NSFR.[29] We show that the stringency of the ratios depends on how the ratios incorporate the depositor run-in documented above. The rules are unclear as to how run-in should be viewed, reflecting

[29]The rules were initially published by the Basel Committee and are now being implemented by country-level supervisory agencies. We focus on the US supervisory agencies' final LCR rule (Federal Register (2014)), as well as their proposed NSFR rule (Federal Register (2016)). The US agencies have not yet finalized the NSFR rule. Note that the results would be little changed if we used the Basel proposals instead.

the fact that the policymakers who developed the ratios lacked sufficiently rich data to study gross flows. Although the LCR and NSFR rules generally assume that banks see no funding inflows that are not contractually required, it is not clear if the deposit run-off rates assumed in the rules are gross or net. Further, it is of independent interest to empirically assess new liquidity regulations; in fact, several scholars have recently bemoaned the dearth of research in this area (Diamond and Kashyap (2016), Allen and Gale (2017)). We conclude that the deposit run-off rate assumptions in the LCR are sufficiently conservative, but that the NSFR rates may not be.

Given the nature of our data, our analysis focuses solely on *run-off rate assumptions for deposit products* in the two liquidity ratios. Thus, we are not assessing other aspects of the rules, such as the liquidity of assets. We compute the rule-implied aggregate deposit run-off rate for the bank by categorizing all accounts into the relevant LCR/NSFR run-off categories and then taking the value-weighted average of the categories' assumed run-off rates. To the extent that the bank's actual run-off rate exceeds this rule-implied rate, we consider the rules to be insufficiently conservative.[30]

Before turning to the results, we must highlight an area of ambiguity in the rules related to operational deposits. Operational deposits are business deposits which are maintained at the bank as part of an arrangement in which the bank provides clearing, custodial, or cash management services, including accounts used for payroll. Operational deposit balances are assumed to be more stable and thus have a lower assumed run-off rate than non-operational business deposits. There are not clear guidelines on how to determine the division of accounts, meaning that banks have the incentive and discretion to overstate the operational share of their business deposit balances, opening the door for regulatory arbitrage. To reflect this ambiguity, we construct a range of rule-implied run-off rates; the bottom of the range reflects the assumption that all deposits which could be operational actually are, and the top of the range treats them as nonoperational.

Turning to the results, our analysis suggests that the LCR deposit run-off rates are sufficiently conservative. The results are shown in top panel of Figure 6, where net declines in deposit balances (aggregate run-off) are represented with positive values and increases in deposit balances (aggregate run-in) are negative. At no point does the observed run-off exceed the maximum value of the LCR-consistent range, though it comes fairly close in 2008. In that period, for many allocations of business deposits between operational and

[30]We acknowledge that our results should be interpreted with some caution: the bank we study would not be subject to the rules even if it still existed, as it was too small.

non-operational categories, the bank's run-off would have exceeded the allowable rate.

In contrast, we find evidence that the NSFR run-off rates may be too low, at least if the intent of the rule was to ensure resilience in the face of severe funding stress (Figure 6, bottom panel). Run-off exceeds the NSFR range both in the period of system-wide anxiety around the crisis and subsequent to the publication of bank-specific adverse information in the year before failure. In the former case, the observed runoff exceeds the rule-implied range regardless of the treatment of run-in. In the year the before failure, the result is sensitive to the treatment of the massive depositor run-in.

7 Conclusion

In this paper we use a highly granular and unique dataset to identify important new findings related to deposit inflows and outflows in a failing bank. Our most important finding is that gross deposit *inflows* are of first order impact in failing banks' balance sheets, despite the banks' elevated default risk and supervisory actions meant to prevent rapid deposit acquisition. This result strongly supports the notion that deposit insurance increases the willingness of depositors to fund banks, as it supports cheap lending to a nearly bankrupt firm. This mechanism may prevent the failure of solvent banks facing liquidity issues. More concerning, however, is that it also reflects the other side of the insurance coin — moral hazard. By enabling failing banks to rapidly acquire relatively cheap and risk-insensitive funding, deposit insurance may allow fundamentally insolvent banks to gamble for resurrection. Further, that the bank attracted these inflows through the comparatively new channel of internet listing services stands as a warning that technological innovation can open new avenues for moral hazard.

We identified a number of policy-relevant findings related to gross deposit *outflows*. Most important, we provide further evidence that deposit insurance improves funding stability. We also provide the first empirical evidence that temporary, crisis-era expansions of deposit insurance, such as FDIC's TAG, are as effective as ordinary deposit insurance. Our other findings on outflows agree with the intuition already written into regulations, such as that checking accounts and accounts receiving regular direct deposits are more stable. Other findings may be somewhat less intuitive, such as the fact that, despite their lack of demandability, term deposits are more risk-sensitive and unstable than demandable deposits. We then demonstrate that our main findings generalize to other banks by using a combination of public regulatory filings and confidential supervisory data. Finally, we illustrate the im-

portance of understanding and measuring both outflows and inflows by demonstrating the sensitivity of LCR and NSFR stringency to assumptions on gross inflows. This also provides evidence as to the realism of deposit run-off rates assumed in the rules.

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Table 1: Summary Statistics, by Period

(a) New Depositors

	Placebo (1)	*Pre-Crisis* (2)	*Post-Crisis* (3)	*Formal* (4)	*Failure* (5)
Number of New Accounts	2858	1872	813	2199	-
New Depositors Per Day	13.355	5.128	4.492	6.525	-
Uninsured at Start of Account	0.040	0.024	0.010	0.006	-
Starting Balance	28111	33482	66207	168262	-
CD	0.446	0.498	0.406	0.869	-
Savings	0.504	0.386	0.424	0.070	-
Checking	0.049	0.116	0.170	0.061	-
Checking & Uninsured	0.009	0.006	0.005	0.000	-
↪ *(TAG/DFA-covered accounts)*					
Starting Interest Rate	4.698	3.468	1.552	1.191	-
Starting Interest Spread to Market	2.883	1.919	0.877	0.693	-
Institutional - Listed/Faxed	0.000	0.007	0.032	0.752	-
Institutional - Other	0.028	0.222	0.225	0.066	-
Placed	0.001	0.029	0.181	0.009	-
Trust	0.037	0.031	0.082	0.037	-

(b) Extant Depositors

Number of Accounts	42257	46332	38927	31114	25847
Uninsured at Start of Period	.064	0.084	0.011	0.022	0.016
Starting Balance	27865	27466	32057	44886	48642
CD	0.196	0.256	0.226	0.127	0.194
Savings	0.728	0.676	0.694	0.762	0.674
Checking	0.077	0.068	0.080	0.111	0.132
Checking & Uninsured	0.006	0.007	0.004	0.004	0.004
↪ *(TAG/DFA-covered accounts)*					
Direct Deposit	0.027	0.029	0.023	0.034	0.031
Starting Interest Rate	4.095	4.372	2.484	0.936	0.880
Starting Interest Spread to Market	2.979	3.090	1.763	0.740	0.665
Institutional - Listed/Faxed	0.000	0.000	0.001	0.003	0.083
Institutional - Other	0.014	0.016	0.028	0.050	0.068
Placed	0.013	0.016	0.047	0.039	0.008
Trust	0.015	0.017	0.017	0.023	0.028
Age of Relationship in Years	2.241	3.103	4.25	5.810	6.120
Years Since Start of Previous Period	-	1.25	1.25	1.78	0.92

Panel (a) shows summary statistics across all new depositors opening accounts in each of the four event periods. Depositors who already had an account at the bank at the beginning of each period are excluded. Panel (b) shows corresponding statistics for depositors who were extant at the bank, as of the beginning of each period.

Table 2: Variable Definitions

Variable	*Definition*
Liquidation	A dummy variable equal to 1 if a deposit account balance falls below 50% of the account balance as measured at the beginning of the regression period, and the balance stays that low or lower for at least 61 days, which includes the account closing. This dummy captures a generally accepted notion of account liquidation consistent with related studies (for example, Iyer and Puri (2012)). Results in this paper are robust to different thresholds of 75%, 90%, and 95%.
Uninsured	A dummy variable equal to 1 if there are *any* uninsured balances in the account as of the start of the measurement period. Deposit insurance limits apply separately to different ownership types, so we account separately for individual, corporate, municipal, joint, IRA, employee beneift plans, revocable trust, and irrevocable trust ownership categories. An exact insurance determination can sometimes be difficult, as joint and trust accounts have complex ownership structures which are often incompletely documented, hence we construct this variable conservatively. Accounts we flag as insured have all funds insured. Accounts we flag as uninsured should have some uninsured funds in them, but it is possible that they are occasionally covered because of complex joint ownership. As a result, estimates in our regressions are lower bounds on the effects of being over the FDIC insurance limit.
Covered by TAG/DFA	A dummy variable equal to 1 if the accounts was covered by additional, temporary guarantee schemes in the years after the financial crisis as of the start of the regression period; 0 otherwise. The two additional guarantee schemes were the Transaction Account Guarantee (TAG) program and guarantees from by the Dodd Frank Act (DFA). TAG, a sub-program of the FDIC's Temporary Liquidity Guarantee Program (TLGP), placed temporary but unlimited (in dollar terms) guarantees on products which comprise all categories of checking accounts at this bank. These guarantees were in force from October 14, 2008 until December 31, 2010. The DFA guarantees similarly provided unlimited insurance for non-interest-bearing demand deposit accounts and IOLTA accounts, but not NOW accounts. The DFA guarantees were in force from December 31, 2010 until December 31, 2012.
Direct Deposit	A dummy variable equal to 1 if the account is receiving an ACH deposit roughly every two weeks as of the start of the regression period; 0 otherwise, and always 0 for term deposits.
Log(Age)	The natural log of the years elapsed since the primary account holder first appears in the bank's deposit records, as of the start of the regression period. If an individual was a secondary depositor on an account before they became a primary account holder on another account, or closed an older account, we use the date at which the original account was opened. Relationship age serves as a measure of the depth of the depositor relationship. The age of the account is dated differently in the case of placed deposits; see placed deposits below for details.
Log(Days to Maturity)	The natural log of the number of days until the maturity of the account, as of the start of the regression period. This is defined only for term accounts.

This table defines the variables used in the regressions of Section 3.

Table 2: Variable Definitions

Variable	*Definition*
Prior Transactions	The proportion of days in the past year, as of the start of the measurement period, in which the account holder performed at least one transaction involving the account under study. A value of 0 thus implies no activity and 100 implies activity every day. We exclude transactions which are exogenous to the depositor such as monthly interest credits or fees. This serves as another measure of depositors' relationship depth. This variable is always 0 for term accounts.
Institutional-Listed/Faxed	A dummy variable equal to 1 if the deposit is owned by a bank, savings association, credit union, financial corporate, municipality, or non-financial corporation, or if it is a "business" product type as marked in the bank's records; 0 otherwise. Additionally, the deposit must have been opened via an internet listing service or facsimile as identified by the bank's records. We group faxed deposits with listed because internal bank documentation, depositor behavior, and depositor types (namely, small depository institutions making up a large portion of these deposits towards the end of the bank's life) all indicate that the faxed deposits were almost exclusively gathered from depositors who saw the rates on listing services and then faxed their deposit request to the bank. This excludes third-party deposit placement services (such as deposit brokers) as we capture these entities with a separate dummy variable.
Institutional-Other	A dummy variable exactly defined As *Institutional - Listed/Faxed* above, but we have no evidence that the deposits were received from a listing service or facsimile order.
Placed	A dummy variable equal to 1 if the deposit was placed by a fiduciary or deposit broker instead of by an individual depositor; 0 otherwise and always 0 for transaction accounts. Many CDs at the bank are not held by individuals but instead held by institutions acting as fiduciaries for others, and these fiduciaries do not consistently reveal the identity of the underlying holders of the account to the bank. These deposits reflect a less personal connection with the bank. For these accounts, the age of the account variable is dated to the start of the individual account, not the first relationship of the reported holder of the account, as the reported holder is only a fiduciary that may not make final decisions. Note that we assume all placed deposits are insured, which is supported by internal FDIC analysis of several failed banks and the websites of the deposit placement services present at our bank, as they advertise that they structure their deposits so as to achieve full insurance coverage.
Trust	A dummy variable equal to 1 if the account is held by a trust and 0 otherwise. Trust accounts require effort to establish, and they are a useful legal device more for wealthier or more complex depositors. As such, we expect accounts held in trust to represent more sophisticated end-depositors.

This table defines the variables used in the regressions of Section 3.

Table 3: Who Withdraws? Placebo Period; Transaction Deposits

	Cox P.H.	*LPM*	*Probit*
	(1)	(2)	(3)
Uninsured	1.140**	0.0300**	0.0306**
	(2.27)	(2.21)	(2.16)
Checking & Uninsured	1.164	0.0210	0.0317
↪*Later Covered by TAG/DFA*	(1.07)	(0.64)	(0.91)
Checking	0.526***	−0.137***	−0.123***
	(−11.01)	(−11.99)	(−13.71)
Direct Deposit	0.648***	−0.104***	−0.0928***
	(−5.87)	(−6.45)	(−7.19)
Log(Age)	0.989	−0.00757***	−0.00565**
	(−1.00)	(−2.73)	(−2.09)
Prior Transactions	1.071***	0.0145***	0.0148***
	(23.40)	(22.71)	(22.55)
Prior Transactions^2	0.999***	−0.000186***	−0.000196***
	(−16.86)	(−19.28)	(−18.42)
Institutional - Any	0.874	−0.0203	−0.0248
	(−1.17)	(−0.81)	(−1.02)
Trust	0.966	−0.00207	−0.00429
	(−0.25)	(−0.07)	(−0.14)
Branch Controls	Yes	Yes	Yes
N	6125877	33973	33973
Log Likelihood	−91348.3	−19977.1	−19220.4
Model P-Value	< 0.001	< 0.001	< 0.001
No. of Liquidations	8920	8920	8920

Estimates from Cox proportional hazard, linear probability, and probit models for the probability of account liquidation during the placebo period, well before the financial crisis. Liquidation is defined as withdrawing 50% or more of the account balance and remaining below that level for 60 days or more. Cox estimates are expressed as hazard ratios, LPM estimates are OLS coefficient estimates, and Probit estimates are marginal effects. T-statistics are in parentheses. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *.

Table 4: Who Withdraws? Pre-Crisis Period; Transaction Deposits

	Cox P.H.	*LPM*	*Probit*	*Difference vs. Placebo*
	(1)	(2)	(3)	(4)
Uninsured	1.067	0.0283**	0.0282**	
	(1.53)	(2.18)	(2.14)	
Checking & Uninsured	1.152	0.0332	0.0416	
↪*Later Covered by TAG/DFA*	(1.36)	(1.07)	(1.30)	
Checking	0.591***	−0.152***	−0.145***	
	(−10.43)	(−11.46)	(−12.45)	
Direct Deposit	0.647***	−0.120***	−0.116***	
	(−7.14)	(−7.04)	(−7.62)	
Log(Age)	0.986	−0.00399	−0.00328	
	(−1.05)	(−0.94)	(−0.77)	
Prior Transactions	1.053***	0.0126***	0.0134***	†††
	(18.95)	(16.67)	(16.87)	
Prior Transactions^2	0.999***	−0.000169***	−0.000189***	††
	(−15.30)	(−15.36)	(−15.08)	
Institutional - Any	1.076	0.0234	0.0229	
	(0.88)	(0.98)	(0.92)	
Trust	1.014	0.0262	0.0273	
	(0.13)	(0.86)	(0.87)	
Branch Controls	Yes	Yes	Yes	
N	9897521	34476	34476	
Log Likelihood	−132171.2	−23717.7	−22606.0	
Model P-Value	< 0.001	< 0.001	< 0.001	
No. of Liquidations	12960	12960	12960	

Estimates from Cox proportional hazard, linear probability, and probit models for the probability of account liquidation during the pre-crisis period. Liquidation is defined as withdrawing 50% or more of the account balance and remaining below that level for 60 days or more. Cox estimates are expressed as hazard ratios, LPM estimates are OLS coefficient estimates, and Probit estimates are marginal effects. T-statistics are in parentheses. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *. Column (4) indicates whether the hazard rate for the Cox model (in column (1)) is statistically different from the corresponding estimate in the Placebo period. Differences significant at the 99% level are represented by †††, 95% by ††, and 10% by †.

Table 5: Who Withdraws? Post-Crisis Period; Transaction Deposits

	Cox P.H.	*LPM*	*Probit*	*Difference vs. Placebo*
	(1)	(2)	(3)	(4)
Uninsured	1.444**	0.0770**	0.0710**	
	(2.41)	(2.37)	(1.99)	
Covered by TAG/DFA	0.708	−0.0791*	−0.0549	†
↪*Formerly*	(−1.45)	(−1.69)	(−1.53)	
Checking & Uninsured				
Checking	0.697***	−0.0612***	−0.0550***	†††
	(−5.40)	(−5.49)	(−5.80)	
Direct Deposit	0.502***	−0.112***	−0.0977***	††
	(−6.61)	(−7.09)	(−9.02)	
Log(Age)	0.990	−0.000270	0.000609	
	(−0.42)	(−0.07)	(0.15)	
Prior Transactions	1.052***	0.00818***	0.00837***	†††
	(13.14)	(12.61)	(12.65)	
Prior Transactions^2	0.999***	−0.000108***	−0.000117***	†††
	(−10.81)	(−11.59)	(−11.25)	
Institutional - Any	1.069	0.0122	0.00997	
	(0.71)	(0.70)	(0.57)	
Trust	0.739**	−0.0489**	−0.0485**	
	(−2.07)	(−2.13)	(−2.40)	
Branch Controls	Yes	Yes	Yes	
N	4835656	30112	30112	
Log Likelihood	−59487.6	−14680.5	−14703.3	
Model P-Value	< 0.001	< 0.001	< 0.001	
No. of Liquidations	5841	5841	5841	

Estimates from Cox proportional hazard, linear probability, and probit models for the probability of account liquidation during the post-crisis period. Liquidation is defined as withdrawing 50% or more of the account balance and remaining below that level for 60 days or more. Cox estimates are expressed as hazard ratios, LPM estimates are OLS coefficient estimates, and Probit estimates are marginal effects. T-statistics are in parentheses. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *. Column (4) indicates whether the hazard rate for the Cox model (in column (1)) is statistically different from the corresponding estimate in the Placebo period. Differences significant at the 99% level are represented by †††, 95% by ††, and 10% by †.

Table 6: Who Withdraws? Formal Enforcement Action; Transaction Deposits

	Cox P.H.	*LPM*	*Probit*	*Difference vs. Placebo*
	(1)	(2)	(3)	(4)
Uninsured	1.919***	0.230***	0.224***	†††
	(10.00)	(10.76)	(9.10)	
Covered by DFA	0.844	−0.0792*	−0.0577	
↪*Formerly*	(−1.11)	(−1.67)	(−1.44)	
Covered by TAG/DFA				
Checking	0.805***	−0.0625***	−0.0597***	†††
	(−4.38)	(−5.15)	(−5.37)	
Direct Deposit	0.735***	−0.0548***	−0.0579***	
	(−3.87)	(−3.14)	(−3.61)	
Log(Age)	0.936***	−0.0147***	−0.0139**	††
	(−3.11)	(−2.63)	(−2.53)	
Prior Transactions	1.013***	0.00448***	0.00467***	†††
	(3.95)	(5.77)	(5.85)	
Prior Transactions^2	1.000***	−0.0000698***	−0.0000752***	†††
	(−4.77)	(−6.48)	(−6.47)	
Institutional - Any	0.997	−0.00184	−0.00250	
	(−0.04)	(−0.11)	(−0.16)	
Trust	1.169**	0.0577***	0.0533**	
	(2.11)	(2.68)	(2.37)	
Branch Controls	Yes	Yes	Yes	
N	7032455	27145	27145	
Log Likelihood	−74902.1	−16439.4	−15786.8	
Model P-Value	< 0.001	< 0.001	< 0.001	
No. of Liquidations	7547	7547	7547	

Estimates from Cox proportional hazard, linear probability, and probit models for the probability of account liquidation in response to the formal enforcement action. Liquidation is defined as withdrawing 50% or more of the account balance and remaining below that level for 60 days or more. Cox estimates are expressed as hazard ratios, LPM estimates are OLS coefficient estimates, and Probit estimates are marginal effects. T-statistics are in parentheses. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *. Column (4) indicates whether the hazard rate for the Cox model (in column (1)) is statistically different from the corresponding estimate in the Placebo period. Differences significant at the 99% level are represented by †††, 95% by ††, and 10% by †.

Table 7: Who Withdraws? Placebo Period; Term Deposits

	Cox P.H.	*LPM*	*Probit*
	(1)	(2)	(3)
Uninsured	1.023	0.00349	0.00524
	(0.35)	(0.23)	(0.33)
Log(Age)	0.975	−0.00802*	−0.00879*
	(−1.35)	(−1.86)	(−1.90)
Log(Days to Maturity)	0.641***	−0.130***	−0.136***
	(−25.98)	(−24.22)	(−23.05)
Placed	2.935***	0.203***	0.221***
	(14.10)	(9.27)	(8.48)
Institutional - Listed/Faxed	–	–	–
↪*Omitted - too few obs.*	–	–	–
Institutional - Other	1.681***	0.0634	0.0666
	(2.65)	(1.30)	(1.16)
Trust	0.735**	−0.0708***	−0.0801***
	(−2.49)	(−2.78)	(−3.15)
Branch Controls	Yes	Yes	Yes
N	1180628	6567	6566
Log Likelihood	−15734.6	−4012.7	−3822.4
Model P-Value	< 0.001	< 0.001	< 0.001
No. of Liquidations	1867	1867	1867

Estimates from Cox proportional hazard, linear probability, and probit models for the probability of account liquidation during the placebo period, well before the financial crisis. Liquidation is defined as withdrawing 50% or more of the account balance and remaining below that level for 60 days or more. Cox estimates are expressed as hazard ratios, LPM estimates are OLS coefficient estimates, and Probit estimates are marginal effects. T-statistics are in parentheses. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *.

Table 8: Who Withdraws? Pre-Crisis Period; Term Deposits

	Cox P.H.	*LPM*	*Probit*	*Difference vs. Placebo*
	(1)	(2)	(3)	(4)
Uninsured	1.173***	0.0487***	0.0495***	†
	(4.73)	(4.21)	(4.31)	
Log(Age)	0.938***	−0.0385***	−0.0398***	†
	(−6.12)	(−10.29)	(−10.27)	
Log(Days to Maturity)	0.783***	−0.0599***	−0.0631***	†††
	(−27.62)	(−18.35)	(−18.01)	
Placed	3.042***	0.179***	0.200***	
	(19.74)	(7.90)	(11.33)	
Institutional - Listed/Faxed	0.308	−0.400*	−0.413**	
	(−1.18)	(−1.94)	(−2.00)	
Institutional - Other	1.730***	0.0829	0.0873*	
	(3.77)	(1.60)	(1.82)	
Trust	1.011	0.000833	0.00320	††
	(0.17)	(0.04)	(0.14)	
Branch Controls	Yes	Yes	Yes	
N	2487654	10438	10436	
Log Likelihood	−50099.8	−6700.0	−6374.4	
Model P-Value	< 0.001	< 0.001	< 0.001	
No. of Liquidations	5749	5749	5749	

Estimates from Cox proportional hazard, linear probability, and probit models for the probability of account liquidation during the pre-crisis period. Liquidation is defined as withdrawing 50% or more of the account balance and remaining below that level for 60 days or more. Cox estimates are expressed as hazard ratios, LPM estimates are OLS coefficient estimates, and Probit estimates are marginal effects. T-statistics are in parentheses. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *. Column (4) indicates whether the hazard rate for the Cox model (in column (1)) is statistically different from the corresponding estimate in the Placebo period. Differences significant at the 99% level are represented by †††, 95% by ††, and 10% by †.

Table 9: Who Withdraws? Post-Crisis Period; Term Deposits

	Cox P.H.	*LPM*	*Probit*	*Difference vs. Placebo*
	(1)	(2)	(3)	(4)
Uninsured	1.641**	0.0691*	0.0882*	††
	(2.51)	(1.86)	(1.68)	
Log(Age)	0.950**	−0.00148	−0.00145	
	(−2.29)	(−0.38)	(−0.28)	
Log(Days to Maturity)	0.470***	−0.194***	−0.209***	†††
	(−55.79)	(−52.97)	(−42.52)	
Placed	5.592***	0.284***	0.345***	†††
	(25.20)	(21.63)	(17.66)	
Institutional - Listed/Faxed	0.886	−0.0328	−0.128	
	(−0.17)	(−0.40)	(−1.22)	
Institutional - Other	0.741	−0.00493	−0.0443	†††
	(−1.36)	(−0.15)	(−1.02)	
Trust	1.047	−0.00842	−0.0146	†
	(0.29)	(−0.36)	(−0.47)	
Branch Controls	Yes	Yes	Yes	
N	1263007	8328	8328	
Log Likelihood	−18393.4	−3803.9	−3738.6	
Model P-Value	< 0.001	< 0.001	< 0.001	
No. of Liquidations	2251	2251	2251	

Estimates from Cox proportional hazard, linear probability, and probit models for the probability of account liquidation during the post-crisis period. Liquidation is defined as withdrawing 50% or more of the account balance and remaining below that level for 60 days or more. Cox estimates are expressed as hazard ratios, LPM estimates are OLS coefficient estimates, and Probit estimates are marginal effects. T-statistics are in parentheses. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *. Column (4) indicates whether the hazard rate for the Cox model (in column (1)) is statistically different from the corresponding estimate in the Placebo period. Differences significant at the 99% level are represented by †††, 95% by ††, and 10% by †.

Table 10: Who Withdraws? Formal Enforcement Action; Term Deposits

	Cox P.H.	*LPM*	*Probit*	*Difference vs. Placebo*
	(1)	(2)	(3)	(4)
Uninsured	1.666***	0.0983**	0.109*	††
	(2.61)	(2.02)	(1.89)	
Log(Age)	1.034	-0.0120	−0.0176*	†
	(1.19)	(−1.61)	(−1.66)	
Log(Days to Maturity)	0.592***	−0.0601***	−0.0799***	†††
	(−27.36)	(−10.82)	(−10.53)	
Placed	14.29***	0.597***	0.616***	†††
	(29.46)	(26.50)	(36.33)	
Institutional - Listed/Faxed	1.858***	0.0927**	0.0968*	
	(3.38)	(1.99)	(1.71)	
Institutional - Other	1.396**	−0.0313	−0.0438	
	(2.18)	(−0.95)	(−0.98)	
Trust	1.401**	0.00166	0.00398	†††
	(2.23)	(0.05)	(0.09)	
Branch Controls	Yes	Yes	Yes	
N	855693	3511	3508	
Log Likelihood	−11783.6	−1803.7	−1729.4	
Model P-Value	< 0.001	< 0.001	< 0.001	
No. of Liquidations	1629	1629	1629	

Estimates from Cox proportional hazard, linear probability, and probit models for the probability of account liquidation in response to the formal enforcement action. Liquidation is defined as withdrawing 50% or more of the account balance and remaining below that level for 60 days or more. Cox estimates are expressed as hazard ratios, LPM estimates are OLS coefficient estimates, and Probit estimates are marginal effects. T-statistics are in parentheses. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *. Column (4) indicates whether the hazard rate for the Cox model (in column (1)) is statistically different from the corresponding estimate in the Placebo period. Differences significant at the 99% level are represented by †††, 95% by ††, and 10% by †.

Table 11: Uninsured Transaction Account Migration

Deposit Insurance Limit = $100,000

Bin Range	*<$1*	*$1 - 2,000*	*$2,000-48,000*	*$48,000-98,000*	*$98,000-102,000*	*>$102,000*
Placebo	5.8%	8.2%	11.4%	10.3%	11.7%	52.6%
Pre-Crisis	9.0%	8.1%	9.9%	15.5%	16.2%	41.3%

Deposit Insurance Limit = $250,000

Bin Range	*<$1*	*$1 - 2,000*	*$2,000-123,000*	*$123,000-248,000*	*$248,000-252,000*	*>$252,000*
Post-Crisis	2.1%	6.0%	14.5%	12.0%	1.7%	63.7%
Formal	21.7%	6.4%	21.9%	14.4%	7.8%	27.6%

For all transaction accounts which had a balance of $2,000 shy of the current deposit insurance limit or higher at the beginning of each period, this table shows their distribution into various account dollar-size bins at the end of the period.

Table 12: New Depositor Characteristics

	Placebo	*Pre-Crisis*	*Post-Crisis*	*Formal*
	(1)	(2)	(3)	(4)
Uninsured	−0.0798***	−0.0538***	−0.0785***	−0.0509***
	(−16.00)	(−16.58)	(−9.64)	(−8.85)
Covered by TAG/DFA	0.0707***	−0.0398***	0.00123	−0.0150
↪ *Or*	(4.33)	(−3.67)	(0.09)	(−1.10)
Checking & Uninsured				
Checking	−0.0315***	−0.0137***	−0.0191***	−0.00348
	(−6.83)	(−3.69)	(−6.78)	(−1.26)
Term Deposit	0.106***	0.0475***	0.00447**	0.0718***
	(36.24)	(23.55)	(2.49)	(27.26)
Placed	−0.148***	0.0000419	0.0614***	−0.0746***
	(−14.38)	(0.01)	(17.95)	(−16.39)
Institutional - Listed/Faxed	−0.153	0.631***	0.517***	0.869***
	(−1.44)	(15.53)	(27.00)	(215.92)
Institutional - Other	0.0281***	0.309***	0.0818***	0.0336***
	(2.63)	(50.53)	(17.93)	(8.52)
Trust	0.0106	−0.00139	0.0249***	0.0389***
	(1.19)	(−0.22)	(4.68)	(7.43)
Branch Controls	Yes	Yes	Yes	Yes
N	45115	48204	39740	33313
Log Likelihood	980.0	13890.7	23623.9	20255.6
Model P-Value	< 0.001	< 0.001	< 0.001	< 0.001

Estimates of account-level regressions, with one observation per account that is extant at the start of that period or that will arrive during that period, of a dummy variable which equals one for newly arrived depositors' accounts and zero otherwise, on account characteristics. The results show what deposit(or) attributes were associated with new deposit(or)s. All models are estimated with OLS. T-statistics are in parentheses. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *.

Table 13: What Explains the Share of Depositors that Are New?

	(1)	(2)	(3)
Time Period Dummies:			
Pre-Placebo	0.000509***	0.000139	0.000142
	(2.68)	(1.50)	(1.58)
Placebo to Pre-Crisis	0.000179*	0.000141**	0.000150**
	(1.77)	(2.03)	(2.19)
Pre-Crisis	−0.000159***	0.0000226	0.0000323
	(−2.94)	(0.16)	(0.24)
Crisis	0.000000299	0.000200	0.000191
	(0.00)	(0.86)	(0.86)
Post-Crisis	−0.0000613	0.000214	0.000215
	(−0.96)	(0.80)	(0.84)
Post-Crisis to Formal	−0.000134**	0.000114	0.000106
	(−2.37)	(0.48)	(0.47)
Formal	0.000535***	0.000570**	0.000578**
	(2.58)	(2.16)	(2.27)
Macro Controls:			
Log(VIX)		0.000225***	0.000224***
		(2.71)	(2.74)
GDP Growth		0.0000246***	0.0000266***
		(2.60)	(2.67)
Housing Starts		0.000000325	0.000000314
		(1.46)	(1.47)
Daily S&P500 Return		0.00240*	0.00221*
		(1.78)	(1.68)
Daily Deposit Growth			0.0146
			(1.64)
AR(1)		0.448***	0.436***
		(13.63)	(12.88)
Constant	0.000295***	−0.000993**	−0.000980**
	(5.94)	(−2.21)	(−2.25)
N	2079	2078	2078
Model P-Value	< 0.001	< 0.001	< 0.001

Estimates from daily-frequency regressions of the share of depositors at the bank who are new (as of that day) on various controls. All models are OLS, with Newey-West standard errors of lag length 9. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *.

Table 14: Impact of Regulatory Action on Funding Shares For US Banks

	Brokered	*Listed*	*Sm. Term*	*Med. Term*	*Lg. Term*
	(1)	(2)	(3)	(4)	(5)
Under Reg. Action	−0.0124***	0.00826***	0.00364***	0.00466***	−0.00830***
	(−22.72)	(11.40)	(5.21)	(6.25)	(−12.10)
NPL_t/A_t	0.000102**	0.0000224	0.00117***	−0.0000903	−0.00108***
	(2.38)	(0.42)	(22.32)	(−1.62)	(−20.97)
$\%\Delta A_t$	0.000238***	0.000127***	−0.000282***	0.000215***	0.0000668***
	(54.53)	(18.82)	(−41.97)	(29.95)	(10.13)
$ln(A_t)$	0.0283***	0.00354***	0.0127***	−0.00837***	−0.00432***
	(137.87)	(8.31)	(31.87)	(−19.66)	(−11.05)
$\text{Deposits}_t/A_t$	0.0429***	0.0162***	0.0179***	0.0181***	−0.0360***
	(35.62)	(7.44)	(8.33)	(7.92)	(−17.11)
$\text{Term Dep}_t/A_t$	0.144***	0.162***	0.291***	0.393***	0.316***
	(173.14)	(112.02)	(211.50)	(267.68)	(234.54)
Constant	−0.419***	−0.116***	−0.0358***	0.0415***	−0.00575
	(−176.09)	(−22.44)	(−7.40)	(8.04)	(−1.21)
Bank & Quarter FE	Yes	Yes	Yes	Yes	Yes
N	554180	162123	193306	193306	193306
R^2	0.136	0.083	0.688	0.338	0.241
Model P-Value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Estimates from regressing funding shares on a regulatory action dummy and bank-level controls for all US banks from 2000 to 2016. The regulatory action dummy is based on public and confidential supervisory data; other variables are from the regulatory filings of all US banks. Observational units are bank-quarters, with brokered deposit data available from 2000 to 2016, listing service deposits from 2011 to 2016, and all other term deposit data from 2010 to 2016. Small term deposits are those with balances of $100,000 or less; medium term deposits are between $100,001 and $250,000; and large term deposits are those over $250,000. T-statistics in parentheses. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *.

Table 15: Impact of Regulatory Action on Funding Shares For US Banks, Quarterly Dummies

	Brokered	*Listed*	*Sm. Term*	*Med. Term*	*Lg. Term*
	(1)	(2)	(3)	(4)	(5)
$(t-4)$	0.0117***	−0.00958***	0.00443**	−0.00857***	0.00414**
	(11.71)	(−5.00)	(2.49)	(−4.51)	(2.37)
$(t-3)$	0.0107***	−0.00951***	0.00725***	−0.00863***	0.00138
	(11.12)	(−5.63)	(4.68)	(−5.22)	(0.91)
$(t-2)$	0.00951***	−0.00633***	0.00759***	−0.00838***	0.000785
	(10.20)	(−4.01)	(5.29)	(−5.46)	(0.56)
$(t-1)$	0.00704***	−0.00535***	0.00653***	−0.00663***	0.0000987
	(8.03)	(−3.78)	(5.03)	(−4.77)	(0.08)
(t)	0.00729***	−0.00260*	0.00639***	−0.00559***	−0.000797
	(8.33)	(−1.91)	(5.14)	(−4.21)	(−0.65)
$(t+1)$	0.00512***	0.0000124	0.0122***	−0.00743***	−0.00476***
	(4.03)	(0.01)	(7.90)	(−4.51)	(−3.14)
$(t+2)$	−0.00667***	0.00477***	0.0140***	−0.00457***	−0.00945***
	(−4.50)	(2.72)	(9.10)	(−2.77)	(−6.25)
$(t+3)$	−0.0148***	0.00594***	0.0114***	−0.000210	−0.0112***
	(−9.13)	(3.54)	(7.63)	(−0.13)	(−7.62)
$(t+4)$	−0.0213***	0.00669***	0.00759***	0.00284*	−0.0104***
	(−12.53)	(4.10)	(5.06)	(1.77)	(−7.08)
$(t+i), i \geq 5$	−0.0385***	0.0121***	−0.00000122	0.0114***	−0.0114***
	(−41.34)	(12.85)	(−0.00)	(11.19)	(−12.18)
NPL_t/A_t	0.000192***	0.0000499	0.00114***	−0.0000804	−0.00106***
	(4.43)	(0.94)	(21.74)	(−1.43)	(−20.58)
$\%\Delta A_t$	0.000233***	0.000126***	−0.000280***	0.000213***	0.0000668***
	(53.55)	(18.66)	(−41.63)	(29.65)	(10.12)
$ln(A_t)$	0.0279***	0.00383***	0.0122***	−0.00761***	−0.00455***
	(135.80)	(8.98)	(30.38)	(−17.78)	(−11.58)
$\text{Deposits}_t/A_t$	0.0433***	0.0155***	0.0186***	0.0165***	−0.0352***
	(36.05)	(7.13)	(8.69)	(7.21)	(−16.70)
$\text{Term Dep}_t/A_t$	0.144***	0.162***	0.290***	0.393***	0.316***
	(173.11)	(112.00)	(211.38)	(267.89)	(234.61)
Constant	−0.414***	−0.118***	−0.0301***	0.0340***	−0.00384
	(−174.03)	(−22.96)	(−6.22)	(6.56)	(−0.81)
Bank & Quarter FE	Yes	Yes	Yes	Yes	Yes
N	554180	162123	193306	193306	193306
R^2	0.139	0.085	0.688	0.339	0.241
Model P-Value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Estimates from regressing funding shares on quarterly regulatory action dummies and bank-level controls for all US banks from 2000 to 2016. The regulatory action dummies are based on public and confidential supervisory data; other variables are from the regulatory filings of US banks. Observational units are bank-quarters, with brokered deposit data available from 2000 to 2016, listing service deposits from 2011 to 2016, and all other term deposit data from 2010 to 2016. T-statistics in parentheses. Small term deposits are those with balances of $100,000 or less; medium term deposits are between $100,001 and $250,000; and large term deposits are those over $250,000. Time period t is the quarter in which the regulatory action began. Estimates significant at 99% are denoted with ***, 95% with **, and 90% with *.

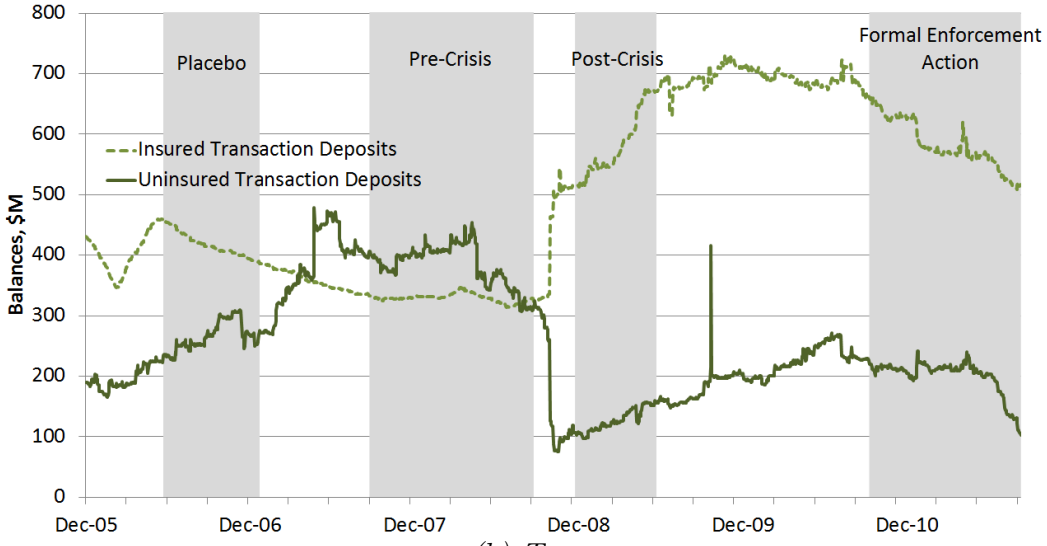
Table 16: Matched Effects of Regulatory Action on Funding Shares for All US Banks, 4 Quarters after Treatment

	Brokered	*Listed*	*Sm. Term*	*Med. Term*	*Lg. Term*
	(1)	(2)	(3)	(4)	(5)
Untreated	0.0407	0.0312	0.1754	0.1421	0.0527
Matched Untreated	0.0365	0.0437	0.1996	0.1677	0.0517
Treated	0.0195	0.0998	0.2341	0.2278	0.0430
T-Stat on Differences	−3.46	3.90	3.88	4.73	−2.63
N Untreated	29611	29597	29597	29597	29597
N Treated	142	142	142	142	142

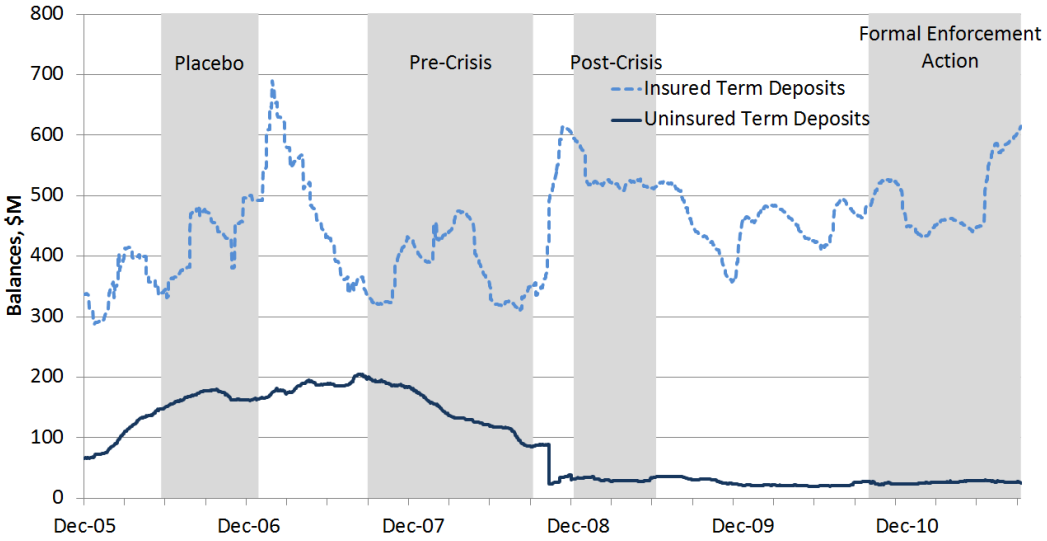
Estimates from propensity-score-matching for a regulatory treatment based on bank covariates to measure the effects on certain deposit products as a share of total deposits for all US Banks. The regulatory action dummy is based on a combination of public and confidential supervisory data; all other variables are from the regulatory filings of all US banks. Observation units are bank-quarters, with brokered deposit data available from 2000 to 2016, listing service deposits from 2011 to 2016, and all other term deposit data from 2010 to 2016. Only banks that at some time come under an enforcement action between 2000-2016 are used for matching. T-statistics in parentheses. Matching is done using a logistic model to generate a propensity score for being treated with regulatory action based on the covariates used in the above regressions (1 year asset growth, natural log of assets, nonperforming loans as share of assets, deposits as a share of assets) as well as all outcome variables (brokered deposits, listing service deposits, all three categories of CD; as shares of deposits). Then treated banks in one quarter are matched to untreated banks in the same quarter at the time of treatment based on this score. Matches are done based on normal kernel weighting, so that close matches are weighted proportionally more. We then observe the difference between treated and untreated 4 quarters after treatment.

Figure 1: Deposit Balances

(a) Transaction

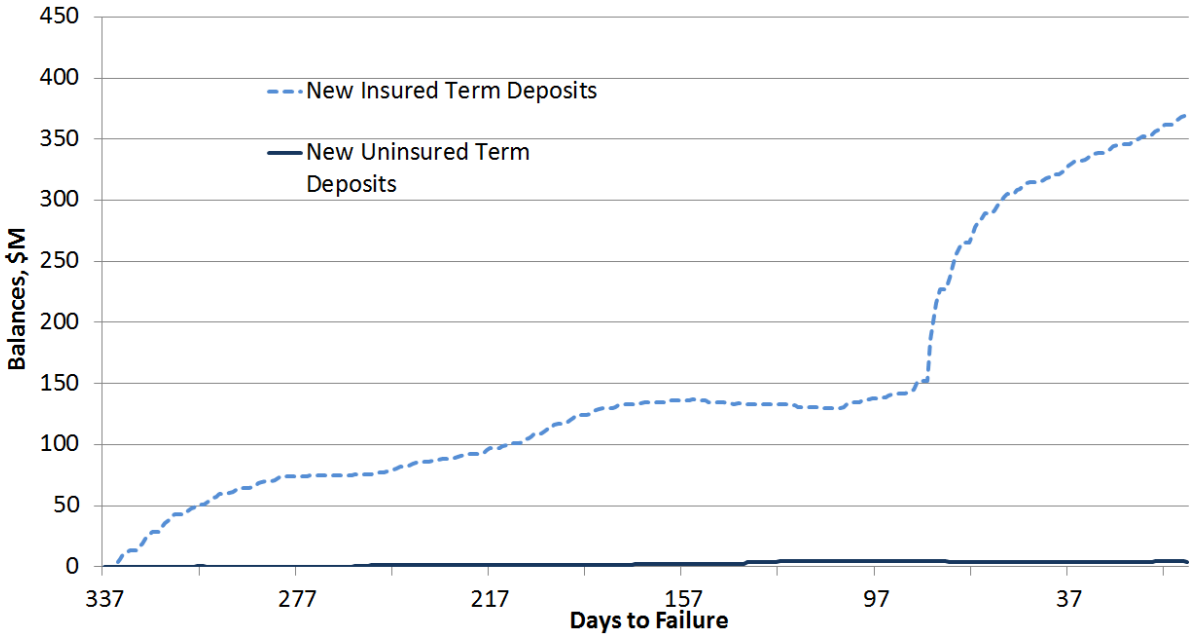


(b) Term



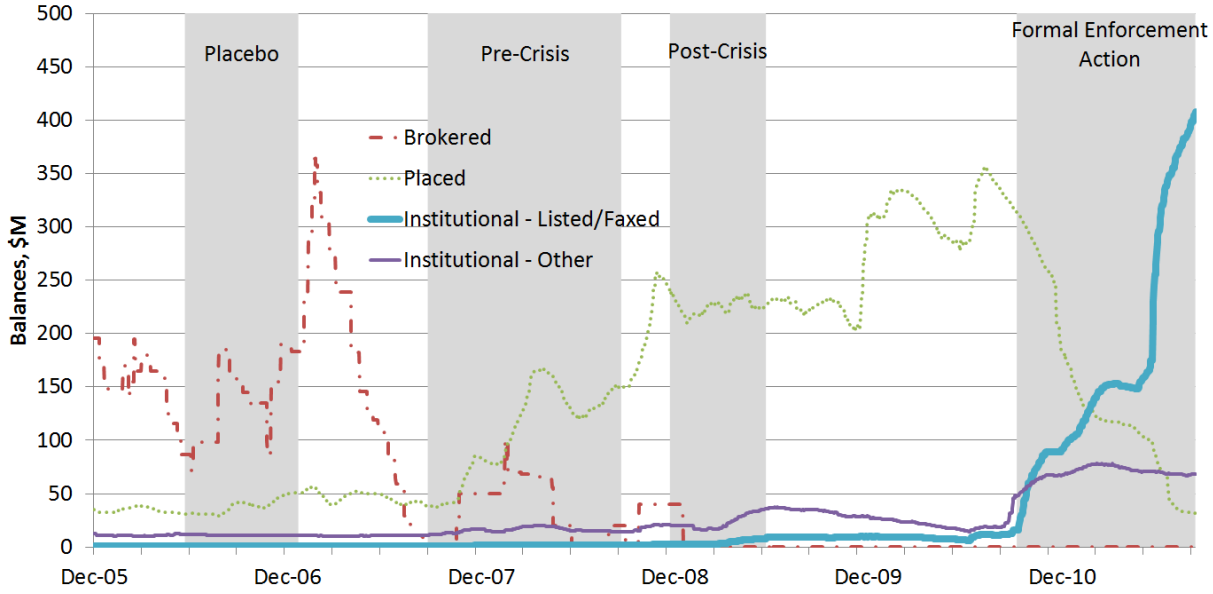
Total balances in transaction (top panel) and term (bottom panel) deposit accounts. Grey bars denote the time periods analyzed in the regressions of Section 3, and overlaid text identifies the name of each period. Note that the dramatic, brief spike in uninsured transaction deposits between the Post-Crisis and Formal periods reflects a single transaction in which another subsidiary of the bank's holding company passed funds through the bank in such a manner that they remained within the bank for a few days.

Figure 2: Term Deposit Balances From New Depositors



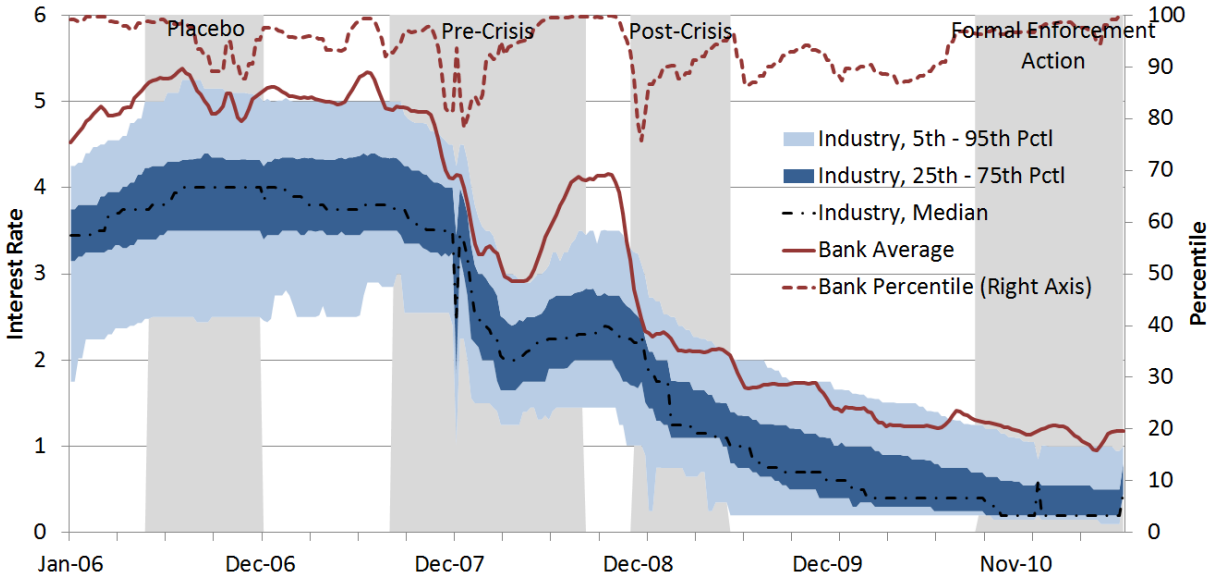
Balances in term deposit accounts from depositors who opened their first deposit account with the bank after the formal enforcement action — new depositors.

Figure 3: Term Deposit Balances in Brokered, Placed, and Institutional Accounts



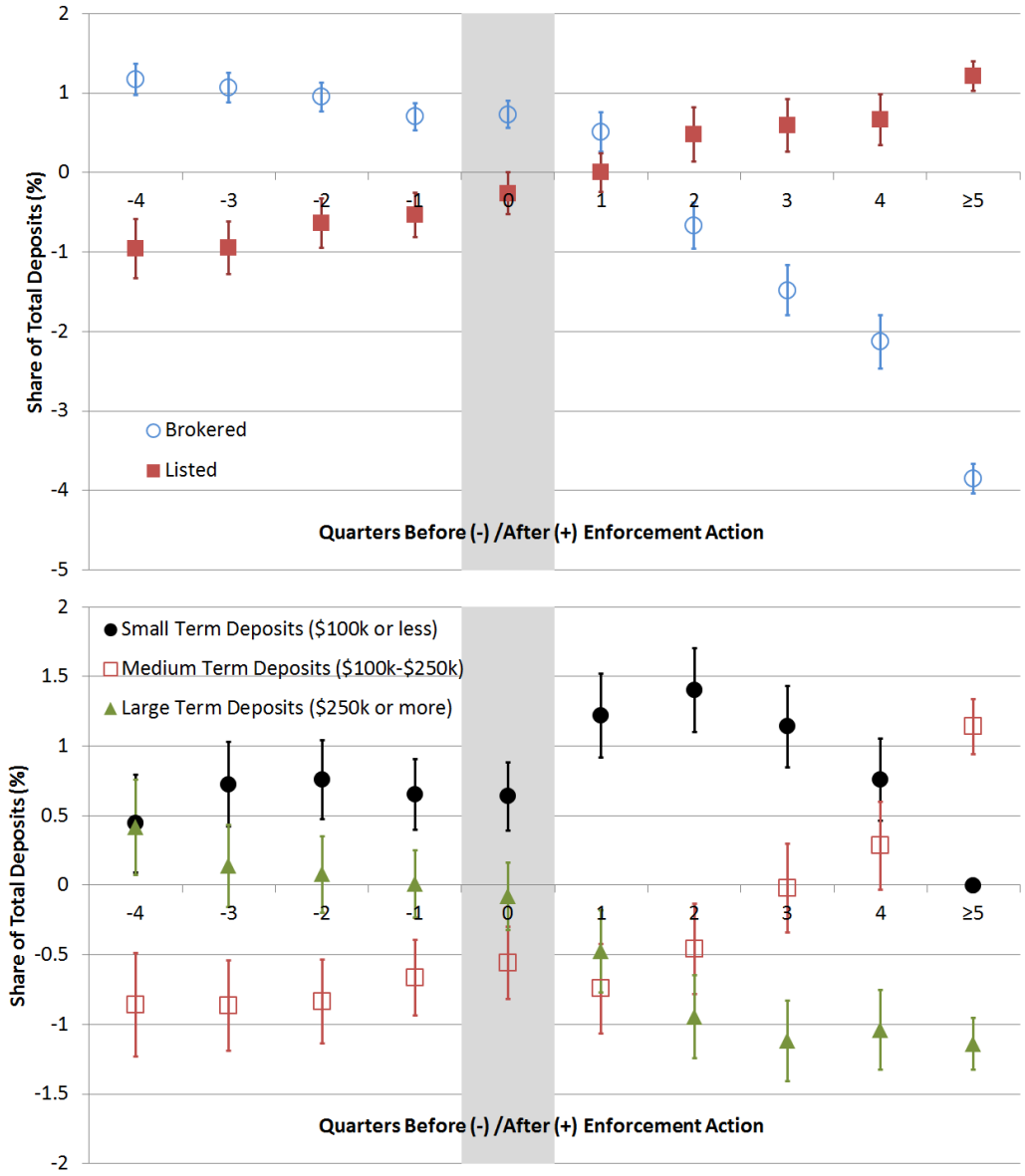
Term deposit account balances in brokered accounts (dash-dotted red), placed accounts (dotted green), institutional deposits obtained via rate listing services and faxes (bold blue), and other institutional deposits (solid, thin purple). Placed deposits are those placed by a third party on behalf the underlying depositor, where that third party does not meet the definition of deposit broker. Note that this is a different notion of placed deposits relative to that used in the regressions; here, we split placed and brokered deposits into two categories, whereas both were grouped as "placed" in the regressions. Among placed and brokered deposits, the underlying depositors are often not identified to the bank accepting the deposits. Grey bars denote the time periods analyzed in the regressions of Section 3, and overlaid text identifies the name of each period.

Figure 4: 12-Month CD Rates Relative to the Market Distribution



31-day moving average (fifteen days before, day of, and fifteen days after) of all rates offered by the bank on newly issued 12-month term deposits with balances below $100,000 ("Bank Average;" solid red line) shown on the left axis, while the percentile relative to the distribution of banking industry rates (from RateWatch) for the same product is on the right axis. The bank average series is a measure of the rate which would have been faced by a depositor considering depositing funds at the bank that day. "Newly issued" term deposits include newly established term deposit accounts as well as rollovers of existing term deposits upon the expiration of the previous product.

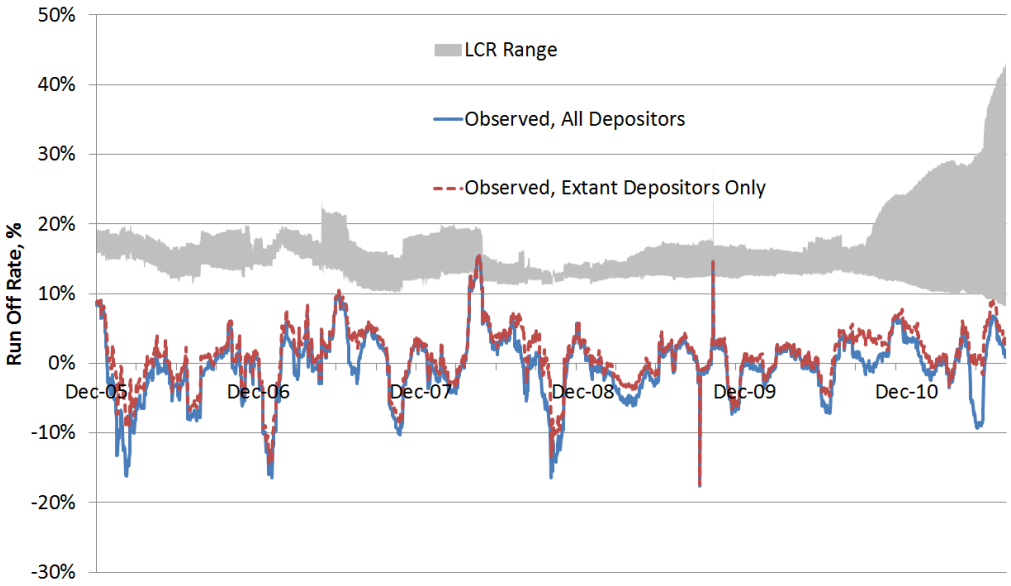
Figure 5: Impact of Regulatory Action on Funding Shares



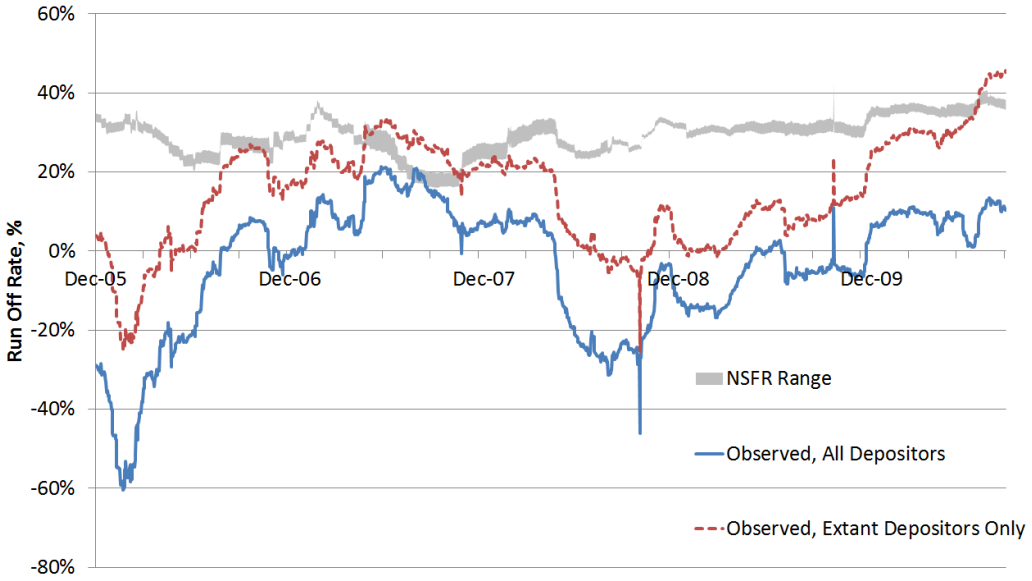
Graphical presentation of the impact of regulatory action on funding shares, using the estimates from Table 15. Small term deposits are those with balances of $100,000 or less; medium term deposits are between $100,001 and $250,000; and large term deposits are those over $250,000. Time period t is the quarter in which the enforcement action was issued. Error bands represent 95% asymptotic confidence intervals

Figure 6: LCR and NSFR Comparison

(a) LCR



(b) NSFR



Observed run-off rates versus those assumed in the LCR (top panel) and NSFR (bottom panel). Grey intervals present ranges of run-off rates consistent with rules, where the ranges arise from uncertainty as to the share of business deposits which are considered operational; the extremes of the grey intervals correspond to the parameterizations wherein either all or no business deposits are operational. The solid blue and dotted red lines show observed run-off considering all depositors and only depositors who were at the bank as of the calculation date, respectively. All run-off rates are calculated in a forward-looking manner. That is, at any given date, the plotted values correspond to run-off observed over the following 30 days (LCR) or year (NSFR).