Banks' Internal Capital Markets and Deposit Rates

Itzhak Ben-David
Fisher College of Business, The Ohio State University
and National Bureau of Economic Research

Ajay Palvia
Office of the Comptroller of the Currency

Chester Spatt
Tepper School of Business, Carnegie Mellon University
and National Bureau of Economic Research

December 2013

Abstract

A common belief is that deposit rates are determined primarily by supply: depositors require higher deposit rates from risky banks and hence create market discipline. An alternative mechanism is that market discipline is weak (potentially due to deposit insurance) and that internal demand for funding by banks determines rates. Using branch-level deposit rate data, we find no evidence for market discipline: rates are similar across bank capitalization levels. In contrast, banks' internal capital demand appears to be a dominant factor in determining deposit rates. We show that banks' loan growth has a causal effect on deposit rates: e.g., branches' rates are correlated with their state-level loan growth in states in which their bank has presence. Our results imply that market discipline is not in effect since deposit rates are determined by demand, rather than by supply-side forces.

Keywords: Banks, deposit rates, market discipline, internal capital market, branches
JEL Classification: G21

We thank Allen Berger, Isil Erel, and Christian Rauch for helpful comments. We benefited from comments of seminar participants at the Federal Reserve Bank of Cleveland, University of Cincinnati, Case Western University, Carnegie Mellon University, FMA meetings (Atlanta), the Office of the Comptroller of the Currency, and a webinar organized by the Global Association of Risk Professionals (GARP). The views presented in the paper do not necessarily reflect those of the Office of the Comptroller of the Currency, or the U.S. Department of the Treasury. Ben-David and Spatt acknowledge the financial support of the GARP Foundation. Ben-David's research is supported by the Dice Center at the Fisher College of Business and by the Neil Klatskin Chair in Finance and Real Estate.
Corresponding author: Itzhak Ben-David bendavid@fisher.osu.edu

1 Introduction

Banks' deposit rates are the market outcome of the supply of deposits by households and the demand for deposits by banks. The emphasis in the literature has been on the supply side of deposits: households and firms prefer to deposit their funds in safe banks and therefore they bid down the deposit rates of those banks. By doing so, depositors impose market discipline on banks, and forcing risky banks to pay a high price. There has been some empirical support for this view, much of it from foreign markets and the 1980's U.S. banking crisis. Yet, it is unclear whether deposit market discipline is still a decisive determinant of deposit rates in countries such as the U.S., where enhancements to capital regulation have led to substantially higher bank capital and therefore lower bank default risk on average.[1] The view that higher capital levels of capital leads to lower bank default risk was expressed by Diamond and Rajan (2000) and was tested empirically in Berger and Bouwman (2013) and Brown and Dinc (2011).

In addition to factors affecting deposit supply (e.g., risk-sensitive depositors), there are important demand-side factors that could determine bank deposit rates. In particular, the internal demand for funds within the bank is a channel through which deposit rates could be determined that has received less attention in the literature. According to this channel, banks' lending and borrowing are jointly determined: e.g., a decision to increase lending will lead the bank to increase deposit rates in order to attract new deposits. Some studies find evidence that is consistent with this view, however, it is difficult to reach conclusions about causality. For example, Jayaratne and Morgan (2000) find that loan growth is highly correlated with deposit growth, especially for banks that are poorly-capitalized. Gatev and Strahan (2006) present evidence from the syndicated loans market that the spread on commercial paper is correlated

[1] Figure 1 documents that on average capital levels during the recent financial crisis were about 200 basis points higher relative to those of the 1980's banking crisis.

with deposit flows to banks. Discerning the channels that determine deposit rates is important in order to understand whether market discipline exists in this market and in order to evaluate the mechanism through which banks' internal capital markets help liquidity creation (e.g., Berger and Bouwman 2009, Bouwman 2013).

In this paper we use branch-level deposit rates of U.S. banks (money-market deposits as well as certificate of deposits (CDs)) data between 2007 and 2012 to analyze the determinants of deposit rates. One broad finding of our study is that there is no evidence for market discipline for deposits in the U.S. during this period. We do find, however, that internal capital markets drive deposit rates and that banks' lending activity is a strong determinant of rates. Hence, deposit rates are determined by the demand for deposits rather than by the supply of deposits, as commonly thought.

We begin the empirical analysis by estimating the relation between deposit rates and bank risk. The view that depositors can impose market discipline on banks through deposit rates is motivated by older results that indicate that banks knowingly choose to shift risks to the Federal Deposit Insurance Corporation (FDIC) by seeking risky lending opportunities and funding them with deposits. The risk-shifting argument relies on the finding of Esty (1997) that stock-owned banks exhibited higher profit variability than mutual savings and loan organizations in the mid-1980s. Keeley (1990) argues that increased competition led to low-capital banks taking on more asset-risk and documents an inverse relation between bank capital ratios and large denomination CD rates. Shoven, Smart, and Waldfogel (1992) also argue that very high levels of competition unleashed by deregulation and witnessed by relatively high deposit rates throughout the 1980s, helped-to-set the stage for risk-shifting by troubled banks. Another strand of the literature studied market discipline in situations in which deposit insurance was not

available. For example, Park and Peristiani (1995) focus on accounts larger than $100,000 that were not fully insured by the FDIC. Peria and Schmukler (2001) find evidence for market discipline in South America.

Our empirical strategy in this part of the analysis is based on measuring the relation between deposit rates and proxies for bank risk. Following Dinc and Brown (2011) and Berger and Bouwman (2013), we select the capitalization of banks as our main proxy for bank risk. There are two main forces that determine the relation between deposit rates and bank risk. On the one hand, depositors avoid depositing funds in risky banks, driving their deposit rates up. On the other hand, while capitalization varies substantially, average capital levels are substantially higher following the Federal Deposit Insurance Corporation Improvement Act (FDICIA) which suggests reduced risk levels to deposit investors and may limit market discipline.[2] In addition, deposits in the U.S. (up to $100k pre-2008 and $250k post-2008) are insured by the FDIC, hence, weakening the sensitivity to bank risk and failure. Indeed, the depositors can limit the size of their deposits at an individual bank (and even use an intermediary to facilitate that)[3] to guarantee that the deposit is fully insured whenever the insurance is of significant value. Therefore, our prediction is that the relation between deposit rates and bank risk is potentially weak or non-existent.

Indeed, we do not find a negative relation between deposit rates and bank capital before or during/after the financial crisis, which suggests the absence of market discipline. During the period after 2008/Q4 we find a consistent positive relation between deposit rates and equity capital suggesting that the better capitalized banks are those that pay higher deposit rates. These

[2] For example, Aggrawal and Jacques (2001) document that banks increased capital ratios following FDICIA without compensating increases in risk.
[3] For example, one such intermediary that has been active in that space is the Promontory Financial Group.

results remain qualitatively similar across deposit horizons and deposit sizes. However, the association between higher equity capital and CD rates are strongest for smaller banks and banks with greater dependence on non-brokered deposits suggesting that our result is driven local and retail deposits. In a robustness analysis we verify that our results are not driven by the rate cap instituted by the FDIC in 2009, by the regulators' restrictions in earlier periods, or by banks participating in the Troubled Asset Relief Program (TARP). Such rate restrictions could have caused deposit rates to be uninformative about the riskiness of the banks' portfolios, and these banks may alter their investment policies (Berger, Bouwman, Kick, and Schaeck 2012). Our results remain virtually unchanged when we remove banks that are potentially subject to these restrictions.

We test another prediction of the market discipline hypothesis. It proposes that deposit rates should predict bank failure: depositors identify banks that are in poor financial shape and therefore demand high premium for their deposits. Ex post, these banks are more likely to fail on average. Our empirical test shows the opposite. For the four-quarter horizon, the relation between bank failure and deposit rates is negative (low deposit rates in the cross section predict bank failure) and statistically significant; it becomes statistically insignificant for the eight-quarter horizon. Furthermore, we find the time to failure is positively correlated with deposit rates. In sum, we find no support that for market discipline in the deposit market.

These results provide preliminary support for the view that CD rates are primarily an indicator of bank demand for funds rather than an indicator of bank riskiness as lower CD rates for weakly capitalized banks is suggestive of less aggressive deposit seeking by banks. Next, we turn to exploring directly the internal capital markets channel of determining deposit rates in order to directly relate bank internal loan demand to CD rates. Specifically, our hypothesis is that

banks determine deposit rates according to their internal funding needs. This hypothesis is part of a larger internal capital markets mechanism, which postulates that the bank determines lending and deposit activities jointly. Previous literature also suggests that internal capital markets are important in banks. Gatev, Schuermann, and Strahan (2009) find that banks' equity return volatility increases with unused loan commitments and decreases with the level of deposits. Cetorelli and Goldberg (2012) provide evidence consistent with international banks shifting funds across countries in order to overcome liquidity shocks during the Global Financial Crisis. Berger and DeYoung (2001) find mixed evidence about the efficiency of geographically-spread banks.

As we focus in this paper on the determinants of deposit rates, we are interested in the causal relation of how lending activity determines deposit rates. It is important to note that a causal relation in the other direction exists as well: an exogenous increase in the availability of deposits fosters banks' lending in remote locations. Gilje, Loutskina, and Strahan (2013) find that banks that were exposed to a shale oil shock in some branch locations increased their lending in other, non-shale locations, i.e., a shock to the supply of deposits generates lending activity. This evidence does not contradict our findings. Causality could run in both directions even for the same bank: the supply of deposits determines loan growth, and the demand for loans drives deposit rates. While Gilje, Loutskina, and Strahan (2013) isolate the effects in one direction, our study isolates the effect in the opposite direction; providing complementary evidence about the functioning of internal capital markets.

We provide several tests for the proposed mechanism of lending activity affecting deposit rates. Our first set of tests examines the relation between deposit rates, deposit flows, and loan growth. Despite these tests being endogenous, they provide a baseline for the analysis. We

document that there is a strong positive correlation between deposit rates and loan growth, i.e., banks that experience higher loan growth rate offer to pay higher rates on their deposits on average. The sensitivity of deposit rates to loan growth declined significantly following the financial crisis of 2008, when lending activity was relatively low. Furthermore, we show that there is a positive correlation between deposit flows to both deposit rates and loan growth. Examining deposit flows is important as it distinguishes the market discipline and the internal capital markets hypotheses. According to the market discipline story, a bank that pays high deposit rates is risky and therefore should not attract more deposits than a bank that pays low deposit rates. In contrast, the capital markets story suggests that banks increase deposit rates specifically in order to attract deposits; therefore one expects that in equilibrium deposit rates indeed attract deposit flows and hence deposit flows are positively correlated with deposit rates. We test this hypothesis and find that indeed deposit flows are positively correlated with deposit rates, favoring the internal capital market hypothesis. Furthermore, we replicate the main test of Jayaratne and Morgan (2000) in our more recent data and confirm that deposit growth is positively correlated with loan growth. This constitutes further evidence for the internal capital market mechanism.

While these results support the internal capital market hypothesis, they do not isolate the direction of the effect, i.e., they are endogenous. There could be two types of endogeneity issues. First, it is possible that the relation between loan growth and deposit rates captures some unobservable bank characteristic, e.g., riskiness that is observed only to depositors and not to the econometrician. Second, it is possible that the causality runs exclusively in the opposite direction and it is the one that governs the correlation between loan growth and deposit rates: for example,

banks are exposed to a positive deposit shock (and therefore potentially decrease deposit rates) and as a result initiate lending activity (as in Gilje, Loutskina, and Strahan (2013)).

We tackle the endogeneity issues with several empirical techniques. First, we examine the relation between bank-level deposit rates and the common component of loan growth that banks are exposed to. The advantage of using this measure of loan growth is that it is based on market-level lending activity rather than depending on the bank's endogenous lending decisions. Therefore, if deposit rates are driven by loan growth, then we expect to observe that banks' deposit rates are correlated with the systematic market-wide component of loan growth. To test this prediction, we replace the bank's specific loan growth variable with the state-level loan growth. We proxy state-level loan growth as the median loan growth of single-state banks. Indeed, the results of the analysis are very similar to previous results: deposit rates are strongly correlated with state-level loan growth.

Second, we exploit the branching structure of banks to provide causal evidence that loan growth is an important driver of deposit rates. Our test relies on the following logic. Many banks have branches in areas with different economic environments. The analysis examines whether loan growth in one state in which the bank operates (State A) affects the rates on deposits of the same bank in a different state (State B). If the bank indeed uses deposit funding to finance loans, then high loan growth in State A potentially forces the bank to compete for deposits in both States A and B. Indeed, we find that branch-level deposit rates are correlated with the loan growth rates in the state in which the branches are located, as well as with loan growth in other states in which the bank operates. We show that the effect is concentrated in banks that depend on deposits as a source of financing, and virtually disappeared during the financial crisis. We view this as strong evidence that loan growth is a first-order determinant of deposit rates.

Moreover, in the effort to understand the economic mechanism of the demand for deposits by banks, we impose stronger tests for the idea that the internal capital markets of banks play a critical role in determining deposit rates. We show that the relation between state-level loan growth and deposit rates is stronger for single-state banks relative to multi-state banks. Multi-state banks can use their network of branches to seek deposits in the event of a positive loan demand shock and therefore soften the effect. In contrast, single-state banks are limited in their ability to spread their demand for funding and therefore shocks to loan growth should have stronger impact on deposit rates.

Collectively, our findings show that deposit rates are determined by the demand by banks rather than by the supply by depositors.

2 Data and Variable Construction

2.1 Data

Our analysis makes use of several sources of data. We employ the bank Reports of Condition and Income, often referred to as Call Reports, to identify banks with low capital (equity to assets), as well as bank-related variables and controls such as loan growth, and asset size. The Call Report data comprises all of the mandatory filings by banks at a quarterly frequency. These data are available starting in 1984.

We use a panel dataset of deposit rate quotes provided by RateWatch at the branch level. RateWatch collects deposit rates and sells its data to industry participants. Clients of the firm are banks that are interested in knowing the rates that their competitors publish. RateWatch collects deposit rate information from banks via telephone, fax, email, and scrapping banks' websites.

The clients of the firm are banks often interested in their competitors' rate. The data is available on a weekly frequency since 2001; however, it is adjusted to bank mergers only since 2007. By comparing RateWatch's bank list to the list of banks that are in the Call Report, we estimate that its data covers about 75%-85% of the market depending on the year.

In order to merge bank financial data with deposit rate data, we consolidate the branch level quotes at the bank level. The final dataset covers the period of 2007/Q1 to 2012/Q3. We have deposit rates for accounts of \$10k, \$100k, \$250k, \$500k, and \$1m[4] for different maturities: money market rate and Certificate of Deposit (CD) rates for 6, 12, 24, 36, 48, and 60 months. In Tables 1 and 2 we split the analysis by account size and maturity. In the later part of the analysis we focus on the most commonly-available rates: 12-month CD rate for \$10k accounts. The Call report dataset indicates that only a relatively small fraction of bank deposit deposits are of longer maturity than 12 months. Thus, shorter-term deposit rates—such as 12 month CDs—are more likely to reflect aggregate deposit investor sentiment vis-à-vis bank risk. In our Call Report sample, about 80% of bank deposit deposits have less than 1-year in maturity remaining and about 97% of bank deposit deposits have less than 3 years of maturity remaining. For robustness, we also estimate our tests using 6 and 24 month deposit rates; the core results are unchanged.

To provide a robust measure of banks' rates, we average the weekly deposit rate observations for each quarter. Since our Call Report sample is at the bank level (as opposed to the branch level), we average the branch-level observations to the bank level, and hence our final database is at the bank-quarter level. Our final dataset consists of an unbalanced panel with 6,582 banks between 2007/Q1 to 2012/Q3 with 120,650 bank-quarter observations with observations of 12-month CD rate. In Table 6 we use a subset of inter-state banks for which we generate a

[4] Rates for the accounts larger than \$100k are available only for the later part of the sample, starting from 2011/Q1.

bank-state-quarter dataset, i.e., one observation for each bank's operation within a state-quarter. In this dataset, there are 25,284 bank-state-quarter observations, of 524 unique banks.

2.2 Variables

Our primary variables of interest, besides deposit rates, are bank capital, bank failure, deposit growth, and loan growth. Bank capital measures the risk of the bank to fail; in line with the literature (e.g., Berger and Bouwman 2013 and Brown and Dinc 2011), we measure it as equity-to-capital ratio defined as total bank equity divided by total bank assets. Bank failure is defined according the FDIC failure list,[5] which includes all failures and assistance transactions (purchase and assumptions, re-privatizations, etc.). Deposit growth is calculated as a one-quarter change in the total bank's deposits. In a parallel fashion, loan growth is computed as one-quarter change in the total outstanding loans. Unfortunately, the Call Report does not provide a breakdown for new deposits, deposits reinvested, and deposits matured, and similarly – loans originated, loans renewed, and loans terminated. The amount of total outstanding loans is net of non-performing loans and of loans that there is a reasonable concern that will become non-performing. Since our loan growth measure is derived from changes in the stock of loans, as opposed to flows of new loans, we cannot directly differentiate between loan growth declines emanating from reducing new lending and from writing-off losses from existing loans. To remedy this concern, we include in all our specifications a measure of charge-offs, thus controlling for the effect of loan write-offs on lending growth.

In addition, we include a large set of controls in our specifications. These include several proxies related to other aspects of financial health aside from capital including asset quality (ratio

[5] http://www.fdic.gov/bank/individual/failed/banklist.html

of performing loans to total loans), deposits-to-liabilities ratio, charge-off ratio, and loans-to-asset ratio.[6] In addition, we control for the ratio of time deposits to total deposits, the ratio of large deposits (i.e., deposits of $100k or more) to total deposits, and the ratio of brokered deposits. Organizational controls include bank size (proxied by logged assets), branch network size (proxied by the logged number of bank branches), multi-bank holding company affiliation dummy, new bank dummy (an indicator denoting the bank was established within the previous five years). Finally, we include measures of the asset composition: the ratio of real-estate related loans to total assets, and the fraction of commercial and industrial loans to total assets.

3 Tests of Market Discipline

3.1 The Correlation between Deposit Rates and Capital Ratios

We begin the empirical analysis by testing the correlation between deposit rates and capital ratio (equity-to-assets). In Table 2 we provide several specifications of regressions of rates on the equity-to-asset ratio (interacted with indicators for pre-crisis or during crisis):

$$Deposit\ rate_{i,q} = \alpha + \beta_1 E/A_{i,q-1} + \beta_2 E/A_{i,q-1} \times I(q \geq 2008/Q4) + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (1)$$

where $Deposit\ rate_{i,q}$ is the deposit rate of bank i at quarter q. $\mathrm{E/A}_{i,q-1}$ is the lagged equity-to-assets ratio. $I(q \geq 2008/Q4)$ is an indicator to whether quarter q is at or later than 2008/Q4. $B_{i,q-1}$ is a set of bank-quarter controls. T_q is a set of time (quarter) fixed effects. All specifications are estimated with robust standard errors clustered by bank.

[6] The loan-to-assets ratio measures the fraction of dollar loans on the bank's asset side divided by total assets. This is a proxy for bank illiquidity. In unreported results, we consider alternative measures such as liquid assets-to-total assets where liquid assets includes cash, federal funds sold and reverse repos, and non-MBS (Mortgage-Backed Securities). The core results are robust to such alternative definitions of liquidity.

In Panel A we regress deposit rates for different maturities (money market, and 6, 12, 24, 48, and 60 month CDs) on equity-to-assets ratio. If market discipline is an important force then deposit rates should be higher for poorly-capitalized banks, i.e., the coefficient on equity-to-assets should be negative. In fact, the panel shows that all coefficients but one are positive and most are statistically significant; the coefficients for money market, 6-month CD, and 12-month CD are significant at the 1% level. This means that deposit rates are actually *lower* on average for poorly-capitalized banks.

The relation between deposit rate and bank capital is plotted in Figure 2. For the purpose of this plot we split bank-quarters to ten equity-to-assets bins (within quarter). Then, we regress deposit rates (12-month CD rates for $10k accounts) on the equity-to-assets decile indicators, bank-level controls, and calendar fixed effects. We perform the analysis for two subsamples: pre-2008/Q4 and 2008/Q4 onward. Prior to the crisis, CD rates exhibit a U-shape with respect to the capital ratio. Following the crisis, CD rates increase with capital. In any case, the magnitude of the effect is low. E.g., rates that are in the bottom of the U-shape are lower by 0.07% on average than rates for banks that have very low or very high capital. From 2008/Q4 onward, CD rates of well-capitalized banks are higher by about 0.05% than those of poorly-capitalized banks.

In Panels B, C, and D of Table 2 we provide additional robustness analysis for our results about the no/weak relation between deposit rates and capital ratio. In Panel B, our different dependent variable is the deposit rate for the 12-month maturity. We examine however CD rates for different account sizes. The panel shows that prior to 2008/Q4 there is no relation between CD rates and equity-to-assets. From 2008/Q4 onward, the relation is positive for all account size. Again, this coefficient is the opposite from what should be expected if market discipline were in effect. In Panel C, we break the sample by the ratio of large deposits to total deposits. Large

deposits are deposits that are greater than $100k. None of the subsamples has a statistically significant negative relation between CD rates and capital ratio. In Panel D, we break the sample by bank assets (Columns (1) to (3)) and non-brokered deposit ratio (Columns (4) to (6)). As before, none of the subsets exhibits negative relationship between CD rates and bank capital. The positive relation between capital and CD rates appears to be stronger for smaller banks and for banks relying on non-brokered deposit funding.

In the analysis so far we do not find any association between deposit rates and capital ratio that indicates that market discipline is in force. We pursue additional analysis that tests the robustness of the results as well offer additional tests.

3.2 Deposit Rates and Bank Capital: Robustness

To ensure that our counter-intuitive results are not driven by government intervention in the market during the crisis, we provide additional analysis. First, regulators may have compelled capital-constrained banks to restrict lending activity and increase capital. Thus, our results may reflect bank strategy or regulatory pressure. To address this concern, we re-run the tests for the 12-month CD rates while excluding banks that are not well-capitalized by PCA (Prompt Corrective Action) levels; these levels are 10% total risk-based capital, 6% tier-1 risk based capital, and 5% tier-1 leverage. We find that only about 3% of banks are not well-capitalized over our sample period according to PCA levels. Excluding these few banks from the sample does not change the direction or statistical significance of the relation of CD rates and capital ratio (Table 2, Panel E, Column (1)). Therefore, while banks facing regulatory scrutiny for having very low capitalization might indeed have different incentives for lending and differing demand for deposits, our tests suggest that regulatory-driven factors do not influence our results.

Another concern is that the result that CD rates are positively correlated with banks' capital during the crisis because rates are capped by regulators (e.g., FDIC) or because of bank strategy that is directed by regulators. Such concern has been raised by Berger and Bouwman (2012) and Berger and Turk-Ariss (2012). Hence, we exclude from the analysis subsets of banks that were likely to be affected by the government intervention.

There are three distinct regulations of concern. First, during the Global Financial Crisis, the FDIC intervened in the deposit market. The FDIC was concerned that certain distressed banks raised CD rates in order to attract deposits. To prevent such behavior, the FDIC proposed capping the allowed rates in May 2009 and started to enforce these in January 2010. To ensure that our results are not driven by the FDIC ruling, we re-ran regressions akin to those in Table 2, Panel A, excluding the banks with "potentially" binding caps, i.e., banks with CD rates above the capped level. The rates caps are set separately for each CD maturity level and also by account size (less or equal to $100k or greater than $100k). We use the non-jumbo (less or equal to $100k) rate caps for 12-month CD rates which range from a low of 1.02% in 3rd quarter 2012 to a high of 1.98% in 2nd quarter of 2009.[7] The results are presented in Table 2, Panel E, Column (2). We observe that the correlation of CD rates with equity-to-asset ratio remains positive and even statistically significant for the post-2008/Q4 period. Hence, our results are not driven by the rate caps imposed by regulators.

Third, the Troubled Asset Relief program (TARP) could have affected banks' operating strategies (see Duchin and Sosyura (2013)). The program was launched in 2008 to counter the effects of the subprime increase and allowed for the US government to purchase "troubled"

[7] The FDIC sets rate caps for jumbo and non-jumbo CDs at 75 basis points above the national rate, which is the simple average of CD rates for commercial banks using RateWatch data. The caps for jumbo and non-jumbo CDs are almost identical in both quarters and un-reported robustness tests confirm our results are not sensitive to which one is used.

assets from banks that were deemed illiquid or difficult to value. The goal was largely to increase banks' financial flexibility and allow for the potential for greater lending growth. To the extent, banks receiving TARP were under regulatory scrutiny and in addition received capital discipline, both bank capitalization and the relation between capitalization and demand for loans (i.e., CD rates) might be different for TARP banks.

To explore the potential for TARP banks to impact our findings, we conduct additional tests where all banks receiving initial TARP funding within the prior two years are removed from the sample. We find that 620 banks in our sample received TARP funding or were subsidiaries of bank holding companies receiving initial TARP funding between 2008/Q4 and 2009/Q4. About 3.8% of bank observations are from banks receiving TARP funding in the previous two-years (4,530 bank-quarter observations). We report results without these bank-observations in Table 2, Panel E, Column (3). The results are similar to our core results.

In Column (4) of Table 2, Panel E, we exclude all potentially affected banks. Our results remain positive and statistically significant, meaning that well-capitalized banks pay higher CD rates.

3.3 Deposit Rates and Bank Failure

We conduct an additional test for the market discipline hypothesis. Specifically, this theory suggests that deposit rates should be reflective of bank default risk, therefore, ex post bank failure likelihood should be positively associated with higher ex ante deposit rates. We follow the FDIC definition of failure, and flag bank-quarters as failure according to the FDIC's publicly available list. The logit regression that we run is:

$$Failure\ within\ Q\ quarters_{i,q} = \alpha + \beta_1 Deposit\ rate_{i,q-1} + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (2)$$

where $Failure\ within\ Q\ quarters_{i,q}$ is an indicator to whether the bank failed within Q quarters from quarter q; we estimate these specifications for two different horizons – Q = 4 and Q = 8 using robust standard errors clustered by bank. $Deposit\ rate_{i,q-1}$ is the deposit rate of bank i at quarter $q - 1$. $B_{i,q-1}$ is a set of bank-quarter controls. T_q is a set of time (quarter) fixed effects.

We present the regression results in Table 3, Columns (1) and (2). The regressions show that the relation is negative for both horizons and statistically significant for the four-quarter horizon. This result is in contrast to the prediction that the relation between the variables should be positive.

Next, we limit the sample to banks that failed ex post, and ask whether the time to failure is correlated with the current deposit rates:

$$Time - to - failure_{i,q} = \alpha + \beta_1 Deposit\ rate_{i,q-1} + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (3)$$

where $Time - to - failure_{i,q}$ is measured in years. The results are estimated using OLS regressions with robust standard errors clustered at the bank level; they show that time-to-failure is positively correlated with deposit rates, in contradiction to the prediction of the market discipline hypothesis.

In sum, we do not find any evidence that indicates that the market discipline hypothesis describes the data of deposit rates in the U.S. for the years 2007 to 2012.

4 Deposit Rates and Internal Capital Markets

4.1 Deposit Flows

Our main hypothesis is that banks use time deposits to fund lending activity, and therefore we should expect a correlation between deposit growth (i.e., flows) and both loan growth and deposit rates. When loan growth is high, banks seek deposits and therefore increase rates in order to attract them. Important predictions of this mechanism are, therefore, that the flow of deposits is positively correlated with loan growth, and that banks that offer higher deposit rates indeed attract more deposits.

These are important predictions since they differentiate the market discipline story from the internal capital market story. The market discipline story suggests that deposit rates reflect risk: banks that are riskier offer higher deposit rates; therefore, there is no reason for depositors to favor banks that offer high deposit rates, since the risk-reward tradeoff is the same across all banks. Also, deposit flows should not necessarily be positively correlated with loan growth. In contrast, the internal capital market hypothesis suggests that flows of deposits increase with deposit rates, and that flows are positively correlated with loan growth.

We test these predictions in Table 4. The regressions are estimated using OLS regressions with robust standard errors clustered by bank and take the following form:

$$\begin{aligned} Deposit\ growth_{i,q} &= \alpha + \beta_1 Loan\ growth_{i,q-1} + \beta_2 Loan\ growth_{i,q-1} \times I(q \geq 2008/Q4) \\ &+ \beta_3 Deposit\ rate_{i,q-1} + \beta_4 Deposit\ rate_{i,q-1} \times I(q \geq 2008/Q4) \\ &+ \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \end{aligned} \quad (4)$$

where $Deposit\ growth_{i,q}$ is defined as the quarter-on-quarter net growth in total deposits for the bank. In Table 4, Column (1), we include loan growth on the right-hand-side but exclude the deposit rate. The results show that deposit growth is very strongly correlated with loan growth, where the correlation declines during the financial crisis. This result is qualitatively similar to the findings of Jayaratne and Morgan (2000), that banks' loan growth is strongly correlated with insured deposit growth. Our results show that prior to the financial crisis, a one standard deviation change in loan growth is associated with a change of 9.5% in the same direction in deposit growth (Column (1)).[8]

We examine the relation between deposit growth and deposit rates in Columns (2) to (4), where in Columns (3) and (4) we split the sample by capitalization level. Low-capital banks are defined as the bottom 10% of capitalization within each quarter. The results show that the deposit flows are correlated with deposit rates, and that this correlation increased following the financial crisis. In addition, we find that the correlations are strong for both weakly and strongly capitalized banks which we interpret to suggest that having lower capital does not qualitatively alter the relations between loan-growth and deposit-growth or CD-rates and deposit-growth.

These findings can be explained with the changing economic environment following the financial crisis. The financial crisis was characterized by a freeze in the lending activity, thus an imbalance was created in the amount of the lending and deposits. This imbalance is plotted in Figure 4: prior to 2008/Q4 the aggregate deposit amount surpassed the aggregate loan amount by less than one trillion dollars. Following the financial crisis, however, the gap widens and the difference between aggregate deposits to aggregate loans reaches two trillion dollars in 2012.

[8] $0.142 \times 0.047 / 0.070 = 0.095$.

The fact that more funds were deposited in banks than banks were willing to lend created two effects. First, internal capital markets were not critical for growth, since banks were flushed with cash. Hence, the association between deposit growth and loan growth declined significantly. Second, as more deposits were available in a low interest rate environment, deposits were more sensitive to deposit rates. Therefore, the coefficient on the interaction of deposit rates and the crisis indicator in Columns (2) to (4) is positive, i.e., deposit flows are more sensitive to deposit rates during the financial crisis. Prior to the financial crisis, one standard deviation change in deposit rates is associated with change in the same direction of 0.044 standard deviations in deposit flows; following the crisis, the effect grows to 0.139 standard deviations (Column (2)).[9]

4.2 Deposit Rates and Growth of Banks' Loan Portfolios

Next, we turn to assessing the relation between deposit rates and loan growth. The internal capital markets mechanism suggests that loan growth determines deposit rates. We begin with examining the endogenous relation between deposit rates and loan growth by regressing the 12-month deposit rate (for $10k accounts) on lagged loan growth, controlling for bank characteristics and fixed effects. As before our models are estimated with robust standard errors clustered by bank:

$$\begin{aligned} Deposit\ rate_{i,q} \\ &= \alpha + \beta_1 Loan\ growth_{i,q-1} + \beta_2 Loan\ growth_{i,q-1} \times I(q \geq 2008/Q4) \\ &+ \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q}. \end{aligned} \tag{5}$$

[9] 0.008 × 0.389 / 0.070 = 0.044; (0.008 + 0.017) × 0.389 / 0.070 = 0.139.

The prediction of the internal capital market mechanism is that deposit rates are positively correlated with loan growth. The results are presented in Table 5. In Columns (1) and (2) we use the lagged loan growth of the bank as the independent variable of interest. Lagged loan growth has a positive and significant coefficient, meaning that CD rates move in the same direction of loan growth. The sensitivity of CD rates to loan growth is significantly higher in the pre-crisis period and almost completely muted in the post-2008/Q4 period. To demonstrate the economic magnitude, consider the coefficient on lagged loan growth in Column (2), which measures the sensitivity of deposit rates to lagged loan growth in the pre-crisis period. It indicates that one standard deviation shift in lagged loan growth is associated with a shift in the same direction of about 4.2% of a standard deviation.[10] In Figure 3 we present the coefficients from a similar regression, based on lagged loan growth decile indicator (instead of the continuous lagged loan growth variable).

The relation of deposit rates and loan growth is however endogenous. A positive relation may result from high loan growth causing an increase in deposit rates, high deposit rates leading to high loan growth, or a third factor that is not controlled for driving both variables up. To discern the drivers of the correlation and test the causal relation between loan growth and deposit rates we proceed with two empirical methodologies. First, we replace banks' loan growth rate with loan growth rate of other banks within the same state. Second, we exploit the branching structure of banks and examine the internal capital market across states. In addition, we test another prediction of the internal capital markets mechanism that correlations between banks that operate should be stronger for single state than for those that operate in multiple states.

[10] $0.366 \times 0.047 / 0.413 = 0.042$.

4.3 Deposit Rates and State-Level Loan Growth

As a first attempt towards unlocking the endogenous relation between bank loan growth and deposit rates, we replace bank loan growth with an instrument for bank loan growth – the loan growth of the median bank in the state. Arguably, this variable reflects the common component of loan growth across banks within the state, however, does not reflect idiosyncratic variation at the bank level that may induce endogeneity. We present the analysis in Table 5, Columns (3) and (4), where we use a state-level loan growth instead of own-bank growth. We calculate the state-level loan growth as follows: we limit the sample to banks that operate in one state only. For each state-quarter, we compute the median loan growth of the single-state banks that operate in this state. Then, for each bank in the sample, we compute the average state-level loan growth across all the states in which the bank operates. The state-level loan growth variable essentially measures the state-level common component in loan growth, independent of the bank's idiosyncratic loan growth. We replace therefore the bank-level loan growth variable with the state-level loan growth variable and run the following regression:

$$Deposit\ rate_{i,q} = \alpha + \beta_1 State - level\ loan\ growth_{i,q-1} + \beta_2 State - level\ loan\ growth_{i,q-1} \times I(q \geq 2008/Q4) + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q}. \quad (6)$$

The results are estimated using OLS regressions with robust standard errors clustered at the bank level and are presented in Table 5, Columns (3) and (4). The coefficients reflect a strong correlation between loan growth and deposit rates. Pre-crisis, the coefficient is 2.6 (Column (4)) and the standard deviation of the market loan growth 0.014, therefore one standard deviation of the market loan growth is associated with 8.9% standard deviations in the adjusted

12-month CD rate.[11] We also interact loan growth with a crisis dummy (2008/Q4 onwards). The interaction shows that the association between CD rates and loan growth is declines during the crisis roughly to zero (Column (4)).

Overall, these results show that loan growth and CD rates are correlated in the pre-crisis period, and have a weaker or no correlation once the crisis began.

4.4 Exploiting the Branching Structure

Another way to trade down the causal relationship between loan growth and deposit rates is to exploit the branching structure. In particular, in the absence of internal capital markets, deposit rates in one branch would be independent of the loan growth that other branches, that are geographically distant, experience. Since our data includes deposit rate information at the branch level, it allows us to exploit the branching structure to show that loan growth actually drives deposit rates and thereby provide a stronger test of causality. To understand how the branching structure can be useful for testing causality, consider the following thought experiment. Suppose a bank has branches in locations that have low loan growth (State A) and other branches in locations that have relatively high loan growth (State B). Given that the bank is interested to fulfill the high demand for loans in State A, the bank may use its State B branches to raise deposit funding. Thus, we should observe that the deposit rates in the State A branches are correlated with the loan growth experienced by the State B branches. Hence, our test measures the correlation between the deposit rate in a particular location and loan growth experienced in a different location in which the bank has some presence.

[11] $2.6 \times 0.014 / 0.409 = 0.089$.

For the purpose of this test, we transform our data to be a bank-state-quarter level dataset and limit the sample to banks that have presence in more than one state. For each bank-state-quarter, we calculate the average deposit rates across all branches within the state. Also, for each state-quarter we compute the state-level growth rate (see previous sections), as the median loan growth of all single-state banks. Our final dataset includes 25,284 bank-state-quarter observations (524 unique banks).

Our empirical test seeks to compute the sensitivity of deposit rates to out-of-state loan growth, while controlling for in-state loan growth. Therefore, for each bank-state-quarter we compute two variables: *out-of-state loan growth* and *in-state loan growth*. The *out-of-state loan growth* is the average state-level loan growth of all states in which the bank-quarter has presence, excluding the specific state-quarter. The complementary variable is the *in-state loan-growth*, which is calculated as simply the state-level loan growth for the state of the bank-state-quarter. The regression that we run is:

$$
\begin{aligned}
Deposit\ rate_{i,s,q} \quad & (7)\\
&= \alpha + \beta_1 Out-of-state\ loan\ growth_{i,s,q-1} + \beta_2 Out-of\\
&- state\ loan\ growth \times I(q \geq 2008/Q4)\\
&+ \beta_3 In-state\ loan\ growth_{i,s,q-1} + \beta_4 In-state\ loan\ growth\\
&\times I(q \geq 2008/Q4) + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q}
\end{aligned}
$$

where the index *isq* relates to a bank-state-quarter observation, and *out-of-state loan growth* and *in-state loan growth* are both lagged by one quarter. As before, we include bank-quarter controls and time dummies. The results are estimated using OLS regressions estimated with robust standard errors clustered at the bank-state level.

The results of the analysis are presented in Table 6. Panel A presents the results for the entire universe of bank-state-quarter. The panel shows that both out-of-state and in-state loan growth variables determine CD rates. The effect is weaker for the post-2008/Q4 period. During the pre-2008/Q4 period, the economic magnitude of the effect can be estimated as follows (Column (4)). A one standard deviation increase in other states' loan growth (0.014) increases CD rates by 0.045% (10.6% standard deviations).[12]

To sharpen the test, we split the sample by non-brokered deposits ratio (calculated as the fraction of total non-brokered deposits scaled by total liabilities). Banks with high non-brokered deposits ratio are more sensitive to economic conditions in the locations in which they are present, as they rely on local deposits as opposed to deposits from the national market (brokered deposits). The analysis is presented in Table 6, Panel B. We use the following breakpoints for the non-brokered deposits ratio variable: bottom 25 percentiles (low dependence on local deposits), the middle 50 percentiles (medium dependence on local deposits), and the top 25 percentiles (high dependence on local deposits), based on the bank sample as cutoffs.

The results in Table 6, Panel B, show that the deposit rates of banks with high dependence on local deposits had a high sensitivity to out-of state loan growth prior to the financial crisis (Columns (2), (4), and (6)). Also consistent with the internal capital markets mechanism, the results show that the sensitivity of deposit rates to out-state-loan growth declined the least for banks that rely more heavily on brokered deposits. The reason is that these banks do not use their internal capital markets heavily in the first place, hence, a sharp decline in lending activity in out-of-state locations (as happened during the financial crisis) is not affecting the local deposit rates that much.

[12] $3.2 \times 0.014 / 0.424 = 0.106$.

4.5 Single vs. Multi-State Banks

Another test that aims to identify the causal effect of loan growth on deposit rates relates to the geographical spread of banks' presence. The prediction is that banks that operate in different geographical environments (proxied by multi-state operations) have lower sensitivity to local loan growth, as it can smooth the shocks to internal demand for deposit funding over a greater network of branches.

To test this prediction, we return to the bank-quarter sample, where both deposit rates and state-level loan growth variables are averaged across branches and states of presence, respectively. We split the sample to branches that have presence in more than one state (7,960 bank-quarter observations and 518 unique banks), and bank-quarters that have presence only in one state (111,655 bank-quarter observations and 6145 unique banks).[13] We regress the 12-month CD rate for $10k accounts at the bank-quarter level on the state-level loan growth. The results are presented in Table 7. The results show that both single and multi-state banks are sensitive to market loan growth but that the positive relation between market loan growth and CD rates is driven by the pre-crisis period. After the inclusion of the interaction terms (columns 2 and 4), the results show that indeed the sensitivity of deposit rates is about greater for banks that operate in one state relative to multi-state banks for the pre-crisis period.

[13] For the multi-state sub- sample we require banks operate in more than one state and we have CD rate data for more than one state. For the single-state sub-sample we require that each bank operate in one state and therefore implicitly exclude banks that have CD rate data for only 1 state but operate in more than one state. As a result the total number of observations in the two sub-samples does not exactly equal the full sample observations.

In summary, our causality test shows that loan growth has a first-order economic effect on CD rates in the pre-crisis period, and virtually zero effect afterwards. The effect is particularly strong for banks that rely on deposit funding to finance their loan portfolio growth.

5 Conclusion

The study presents new evidence in a novel setting showing that deposit rates in the United States for the period 2007 to 2012 were determined by internal capital markets rather than determined by market discipline. Our first set of tests finds no evidence for the effects of market discipline. Specifically, deposit rates are not negatively correlated with banks' equity, as the theory predicts. Furthermore, deposit rates do not predict bank failure.

In contrast, we find strong evidence that deposit rates are determined by internal capital markets. Consistent with a significant role of internal capital markets we show that deposit flows are correlated with lagged deposit rates and with loan growth. In addition, we exploit the branching structure to show that there is a causal relationship between loan growth and deposit rates: deposit rates in one state are associated with loan growth in other states in which the bank operates. Furthermore, this relation is stronger for banks that rely heavily on deposits from the states in which the bank operates (as opposed to deposits from the national market). Also, the relation between deposit rates and loan growth is stronger for banks that have smaller geographical presence. For these banks, the internal capital market is small, hence demand shocks for loans translate to stronger effects on deposit rates.

The message to policymakers coming from our paper is that market discipline is not a tool to rely on to assess bank riskiness. Deposit rates are not indicative of the quality of the bank, but rather reflect bank loan growth.

References

Aggrawal, Raj and Kevin T. Jacques, 2001, The impact of FDICIA and prompt corrective action on bank capital and risk: Estimates using a simultaneous equations model, *Journal of Banking & Finance* 25(6), 1139–1160.

Berger, Allen N., and Christa H. S. Bouwman, 2009, Bank liquidity creation, *Review of Financial Studies* 22(9), 3779–3837.

Berger, Allen N., and Christa H. S. Bouwman, 2013, How does capital affect bank performance during financial crises? *Journal of Financial Economics* 109, 146–176.

Berger, Allen N., and Christa H. S. Bouwman, Thomas Kick, and Klaus Schaeck, 2012, Bank risk taking and liquidity creation following regulatory interventions and capital support, Working Paper, University of South Carolina.

Berger, Allen N., and Robert DeYoung, 2001, The effects of geographic expansion on bank efficiency, *Journal of Financial Services Research* 19(2/3), 163–184.

Berger, Allen N., and Rima Turk-Ariss, 2012, Do depositors discipline banks and did government actions during the recent crisis reduce this discipline? An international perspective, Working Paper, University of South Carolina.

Bouwman, Christa H. S., 2013, Liquidity: How banks create it and how it should be regulated, in: Allen Berger, Phil Molyneux, and John Wilson (eds.), *The Oxford Handbook of Banking* (2nd edition), Oxford University Press.

Brown, Craig O., and Serdar Dinc, 2011, Too many to fail? Evidence of regulatory reluctance in bank failures when the banking sector is weak, *Review of Financial Studies* 24(4), 1378–1405.

Cetorelli, Nicola, and Linda Goldberg, 2012, Liquidity management of U.S. global banks: Internal capital markets in the great recession, Working Paper, Federal Reserve Bank of New York.

Diamond, Douglas, and Raghuram G. Rajan, 2000, A Theory of Bank Capital, *Journal of Finance* 55(6), 2431–2465.

Duchin, Ran, and Denis Sosyura, 2013, Safer ratios, riskier portfolios: Banks' response to government aid, Working Paper, University of Michigan.

Esty, Benjamin C., 1997, Organizational form and risk taking in the savings and loan industry, *Journal of Financial Economics* 44, 25–55.

Gatev, Evan, and Philip E. Strahan, 2006, Banks' advantage in hedging liquidity risk: Theory and evidence from the commercial paper market, *Journal of Finance* 61(2), 867–892.

Gatev, Evan, Til Schuermann, and Philip E. Strahan, 2009, Managing bank liquidity risk: How deposit-loan synergies vary with market conditions, *Review of Financial Studies* 22(3), 995–1020.

Gilje, Erik, Loutskina, Elena, and Philip E. Strahan, 2013, Exporting liquidity: Branch banking and financial integration, Working Paper, Boston College.

Jayaratne, Jith, and Donald P. Morgan, 2000, Capital market frictions and deposit constraints at banks, *Journal of Money, Credit and Banking* 32 (1), 74–92.

Keeley, Michael C., 1990, Deposit insurance, risk, and market power in banking, *American Economic Review* 80(5), 1183–1200.

Park, Sangkyun, and Stavros Peristiani, 1998, Market discipline by thrift depositors, *Journal of Money, Credit, and Banking* 30(3), 347–364.

Peria, Maria Soledad Martinez, and Sergio L. Schmukler, 2001, Do depositors punish banks for bad behavior? Market discipline, deposit insurance, and banking crises, *Journal of Finance* 56(3), 1029–1051.

Shoven, John B., Scott B. Smart, and Joel Waldfogel, 1992, Real interest rates and the savings and loan crises: The moral hazard premium, *Journal of Economic Perspectives* 6(1), 155–167.

Appendix

Variable	Definition	Data Source
Deposit rate for x-month horizon and $Y account	The average of X-month deposit rate for $Y account, averaged across the branches of the bank	RateWatch
Asset quality	Total performing loans & leases / Total assets	Call Report
Average loan growth in other states	The average of state-level loan growth in other states in which the bank operates in	Call Report
Charge-off ratio	Total charge offs / Total loans	Call Report
Commercial and industrial loans-to-assets	Total commercial and industrial loans / Total assets	Call Report
Deposit growth (1-qtr change)	log (total deposits(t)) – log(total deposits (t-1))	Call Report
Deposits-to-liabilities ratio	Total deposits / Liabilities	Call Report
Equity-to-assets	Equity / Total assets	Call Report
Failure within Q quarters	An indicator to whether the bank failed according to the FDIC (http://www.fdic.gov/bank/individual/failed/banklist.html)	FDIC
Large deposits ratio	Total deposits of $100k or more / Total deposits	Call Report
Loan growth (1-qtr change)	log (total loans(t)) – log(total loans(t-1))	Call Report
Loan growth in other states	The average state-level loan growth of the states in which the bank has presence, excluding the state in which the bank-state relates to.	Call Report
Loan growth in own state	State-level loan growth of the bank-state's own state	Call Report
Loans-to-assets	Total loans / Total assets	Call Report
Log # offices	log (# branches)	Call Report
Log assets ($ Thousands)	log (total assets ($ Thousands))	Call Report
Multi-bank holding company indicator	Indicator to whether the bank affiliated with Multi-Bank-Holding Company (MBHC)	Call Report
New bank indicator	Indicator to whether the bank was chartered in previous 5 years	Call Report
Non-brokered deposits-to-total liabilities	Non-brokered deposit liabilities / Total liabilities	Call Report

Table 1. Summary Statistics

The table presents summary statistics for the variables used in the analysis. The sample period is 2006/Q4 to 2012/Q3. Panel A shows summary statistics for the analysis for the main sample, based on 12-month deposit rates for $10k accounts. Panel B shows summary statistics for the sample that includes deposit rates for variety of maturities and account sizes. Panel C presents summary statistics for the sample used for the bank branching analysis. Variable definitions are in the Appendix.

Panel A: Summary Statistics of Main Sample (unit of observation: bank-quarter)

	N	Mean	Std Dev	p5	p25	p50	p75	p95
Asset quality	122,347	0.985	0.021	0.95	0.98	0.99	1.00	1.00
Charge-off ratio	122,347	0.004	0.009	0.00	0.00	0.00	0.00	0.02
Commercial and industrial loans-to-assets	122,344	0.146	0.093	0.03	0.08	0.13	0.19	0.32
Deposit growth (1-qtr change)	122,347	0.002	0.070	-0.10	-0.03	0.00	0.03	0.12
Deposits-to-liabilities ratio	122,347	0.933	0.069	0.80	0.90	0.95	0.99	1.00
Equity-to-assets	122,346	0.106	0.033	0.07	0.09	0.10	0.12	0.17
Failure within 4 quarters	122,347	0.009	0.095	0.00	0.00	0.00	0.00	0.00
Failure within 8 quarters	122,347	0.019	0.135	0.00	0.00	0.00	0.00	0.00
Large deposits ratio	122,347	0.421	0.157	0.19	0.31	0.41	0.52	0.71
Loan growth (1-qtr change)	122,347	0.007	0.047	-0.06	-0.02	0.00	0.03	0.08
Loans-to-assets	122,347	0.645	0.145	0.37	0.56	0.67	0.75	0.85
Log # offices	122,347	1.374	1.078	0.00	0.69	1.39	1.95	3.22
Log assets ($ Thousands)	122,347	12.078	1.267	10.33	11.26	11.95	12.71	14.25
Multi-bank holding company	122,347	0.190	0.392	0.00	0.00	0.00	0.00	1.00
New bank indicator	122,347	0.055	0.229	0.00	0.00	0.00	0.00	1.00
Non-brokered deposits-to-total deposits	122,347	0.897	0.109	0.68	0.85	0.93	0.98	1.00
Real-estate loans-to-assets	121,574	0.702	0.173	0.36	0.60	0.74	0.83	0.93
State-level loan growth	122,347	0.006	0.014	-0.02	0.00	0.01	0.01	0.03
Time deposits-to-total deposits ratio	122,347	0.435	0.138	0.21	0.34	0.44	0.53	0.66
Time to failure (years)	3,918	1.883	1.254	0.25	0.85	1.69	2.67	4.32

Panel B: Summary Statistics of Deposit Rates (unit of observation: bank-quarter)

Deposit rate (%) of …	N	Mean	Std Dev	p5	p25	p50	p75	p95
Money market, $10k accounts	117,397	-0.011	0.475	-0.71	-0.25	-0.06	0.19	0.85
12-month CD rate, $10k accounts	122,092	0.000	0.389	-0.67	-0.22	0.01	0.24	0.63
24-month CD rate, $10k accounts	116,188	0.000	0.383	-0.67	-0.23	0.02	0.25	0.60
48-month CD rate, $10k accounts	93,099	0.002	0.411	-0.74	-0.24	0.04	0.28	0.61
60-month CD rate, $10k accounts	93,557	0.002	0.433	-0.80	-0.25	0.05	0.31	0.63
12-month CD rate, $100k accounts	79,366	0.000	0.352	-0.54	-0.19	0.01	0.21	0.53
12-month CD rate, $250k accounts	34,936	0.000	0.239	-0.36	-0.16	-0.01	0.16	0.39
12-month CD rate, $500k accounts	34,984	0.000	0.246	-0.37	-0.16	-0.01	0.16	0.39
12-month CD rate, $1m accounts	34,624	0.000	0.233	-0.36	-0.16	-0.01	0.16	0.39
Call report imputed CD rate (all deposits)	122,347	0.000	0.005	-0.01	0.00	0.00	0.00	0.01
Call report imputed CD rate (deposits ≥ $100k)	122,253	0.000	0.006	-0.01	0.00	0.00	0.00	0.01

Table 1. Summary Statistics (Cont.)

Panel C: Summary Statistics of Branching Structure Analysis (unit of observation: bank-state-quarter)

	N	Mean	Std Dev	p5	p25	p50	p75	p95
Adjusted 12-month CD rate ($100k) (%)	20,332	0.113	0.382	-0.50	-0.15	0.11	0.37	0.76
Adjusted 12-month CD rate ($10k) (%)	25,451	0.125	0.424	-0.56	-0.16	0.11	0.40	0.86
Asset quality	25,588	0.979	0.022	0.94	0.97	0.99	0.99	1.00
Non-brokered deposits-to-total liabilities	25,588	0.826	0.112	0.63	0.75	0.84	0.91	0.98
Charge-off ratio	25,588	0.008	0.012	0.00	0.00	0.00	0.01	0.03
Commercial and industrial loans-to-assets	25,580	0.169	0.090	0.05	0.10	0.16	0.21	0.32
Deposits-to-liabilities	25,588	0.866	0.092	0.68	0.81	0.88	0.94	0.99
Equity-to-assets	25,585	0.105	0.031	0.07	0.09	0.10	0.12	0.16
In-state loan growth	25,596	0.006	0.014	-0.01	0.00	0.00	0.01	0.03
Large deposit ratio	25,588	0.448	0.141	0.24	0.35	0.43	0.53	0.72
Loans-to-assets	25,584	0.650	0.122	0.41	0.59	0.66	0.73	0.83
Log # offices	25,588	4.331	2.207	1.61	2.56	3.76	6.13	8.59
Log assets ($ Thousands)	25,588	15.450	2.693	12.16	13.30	14.65	17.79	20.91
Multi-bank holding company	25,588	0.433	0.496	0.00	0.00	0.00	1.00	1.00
New bank indicator	25,588	0.021	0.144	0.00	0.00	0.00	0.00	0.00
Out-of-state loan growth	25,604	0.006	0.016	-0.02	0.00	0.00	0.01	0.03
Real-estate loans-to-assets	25,454	0.701	0.147	0.43	0.60	0.72	0.81	0.92
Time deposits-to-total deposits ratio	25,588	0.317	0.157	0.09	0.19	0.31	0.43	0.58

Table 2. Deposit Rates and Bank Capitalization

The table presents regression of adjusted 12-month CD rates on lagged equity-to-assets interacted with period dummy. Control variables include loan growth, deposits-to-liabilities, logged assets, log # offices, large deposit ratio, time deposits to total deposits, loans to assets, brokered deposits to total deposits, multi-bank holding company indicator, new bank indicator, charge-off ratio, and asset quality. All control variables are lagged by one quarter. All regressions are OLS regressions. Variable definitions are in the Appendix. *t*-statistics are presented in parentheses. ***, **, * represent statistical significance at the 1%, 5%, or 10% levels, respectively.

Panel A: Deposit Rates and Bank Capitalization, by Maturity

Dependent variable:	Adjusted deposit rate, $10k accounts (%) of …					
	Money market	6-month CD	12-month CD	24-month CD	48-month CD	60-month CD
	(1)	(2)	(3)	(4)	(5)	(6)
Equity-to-Assets (q-1) × I(pre-2008/Q4)	1.219 ***	0.131	0.228	0.087	0.248	0.063
	(4.76)	(0.73)	(1.46)	(0.59)	(1.61)	(0.40)
Equity-to-Assets (q-1) × I(2008/Q4 onward)	0.345 ***	0.433 ***	0.437 ***	0.177 *	0.108	-0.173
	(3.17)	(4.42)	(4.58)	(1.72)	(0.75)	(-1.11)
Bank characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	116,637	121,083	121,322	115,432	92,506	92,861
Adj R^2	0.067	0.091	0.121	0.126	0.120	0.099

Panel B: Deposit Rates and Bank Capitalization, by Account Size

Dependent variable:	Adjusted 12-month CD rate (%) of …				
	$10k accounts	$100k accounts	$250k accounts	$500k accounts	$1m accounts
	(1)	(2)	(3)	(4)	(5)
Equity-to-Assets (q-1) × I(pre-2008/Q4)	0.228	-0.280			
	(1.46)	(-0.84)			
Equity-to-Assets (q-1) × I(2008/Q4 onward)	0.437 ***	0.432 ***	0.378 ***	0.398 ***	0.398 ***
	(4.58)	(4.67)	(4.22)	(4.43)	(4.40)
Bank characteristics	Yes	Yes	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes	Yes	Yes
Obs	121,322	78,833	34,580	34,404	34,353
Adj R^2	0.121	0.141	0.218	0.216	0.215

Table 2. CD Rates of Low-Capital Banks during Crisis (Cont.)

Panel C: Deposit Rates and Bank Capitalization, by Fraction of Large Deposits

Dependent variable:	Adjusted 12-month CD rate, $10k accounts (%)		
Sample broken by:	Large deposits / Total deposits		
	Low	Mid	High
	(1)	(2)	(3)
Equity-to-Assets (q-1) × I(pre-2008/Q4)	0.190	-0.131	0.650 ***
	(0.70)	(-0.53)	(2.84)
Equity-to-Assets (q-1) × I(2008/Q4 onward)	0.922 ***	0.460 ***	-0.079
	(5.64)	(3.32)	(-0.55)
Bank characteristics	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes
Obs	40,531	40,495	40,296
Adj R^2	0.119	0.119	0.147

Panel D: Deposit Rates and Bank Capitalization, by Bank Size and by Non-Brokered Deposits

Dependent variable:	Adjusted 12-month CD rate, $10k accounts (%)					
Sample broken by:	Bank assets			Non-brokered deposits ratio		
	Low	Mid	High	Low	Mid	High
	(1)	(2)	(3)	(4)	(5)	(6)
Equity-to-Assets (q-1) × I(pre-2008/Q4)	0.678 ***	0.400	-0.132	0.333	0.484 *	0.195
	(3.15)	(1.45)	(-0.34)	(1.04)	(1.94)	(0.91)
Equity-to-Assets (q-1) × I(2008/Q4 onward)	0.699 ***	0.498 ***	0.062	0.107	0.393 ***	0.736 ***
	(5.11)	(2.70)	(0.34)	(0.62)	(2.76)	(5.34)
Bank characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	40,480	40,411	40,431	40,333	40,522	40,467
Adj R^2	0.083	0.091	0.143	0.174	0.106	0.099

Table 2. CD Rates of Low-Capital Banks during Crisis (Cont.)

Panel E: Deposit Rates and Bank Capitalization, Robustness

Dependent variable:	Adjusted 12-month CD rate (%)			
Sample:	Exclude poorly-capitalized banks	Exclude rates above rate-cap ceiling	Exclude banks receiving TARP	Exclude all (1)-(3)
	(1)	(2)	(3)	(4)
Equity-to-Assets (q-1) × I(pre-2008/Q4)	0.214	0.278 *	0.239	0.268 *
	(1.37)	(1.78)	(1.53)	(1.71)
Equity-to-Assets (q-1) × I(2008/Q4 onward)	0.470 ***	0.340 ***	0.458 ***	0.339 ***
	(4.59)	(3.97)	(4.60)	(3.58)
Bank characteristics	Yes	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes	Yes
Obs	117,431	114,535	115,079	105,640
Adj R^2	0.122	0.118	0.112	0.108

Table 3. Bank Failure and CD Rates

The table presents regressions of failure indicator (Columns (1) and (2)), and time-to-fail (Column (3)). Bank is considered failed if it is included in the failed bank list of the FDIC. The sample in Column (3) is limited to banks that actually failed. The regressions in Columns (1) and (2) are logit regressions, where the marginal effect for the average bank-quarter is presented. The regression in Column (3) is an OLS regression. Control variables include change in deposits-to-liabilities, logged assets, log # offices, large deposit ratio, time deposits to total deposits, loans to assets, brokered deposits to total deposits, inter-bank holding company indicator, new bank indicator, charge-off ratio, and asset quality. All control variables are lagged by one quarter. All regressions are OLS regressions. Variable definitions are in the Appendix. *t*-statistics are presented in parentheses. ***, **, * represent statistical significance at the 1%, 5%, or 10% levels, respectively.

Dependent variable:	Failure within…		
Sample:	4 quarters	8 quarters	Time to fail
	(1)	(2)	(3)
Adjusted 12-month CD rate, $10k accounts (%)	-0.0016 **	-0.0011	0.182 **
	(-2.08)	(-0.75)	(2.06)
Bank characteristics	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes
Obs	121,157	121,157	3,787
Pseudo R^2 (Adj R^2)	0.517	0.421	0.476

Table 4. Deposit Growth, CD Rates, and Loan Growth

The table presents regressions of deposit quarter-on-quarter growth on lagged loan growth and 12-month CD rate and lagged loan growth. Columns (1) and (2) use the entire sample of bank-quarter. Columns (3) and (4) split the sample based on equity-to-assets ratio, where Column (3) uses the bottom decile and Column (4) uses the top nine deciles. Control variables include change in deposits-to-liabilities, logged assets, log # offices, large deposit ratio, time deposits to total deposits, loans to assets, brokered deposits to total deposits, inter-bank holding company indicator, new bank indicator, charge-off ratio, and asset quality. All control variables are lagged by one quarter. All regressions are OLS regressions. Variable definitions are in the Appendix. *t*-statistics are presented in parentheses. ***, **, * represent statistical significance at the 1%, 5%, or 10% levels, respectively.

Dependent variable:	Deposit growth			
Sample:	All	All	Low capital	High capital
	(1)	(2)	(3)	(4)
Adjusted 12-month CD rate, $10k accounts (%) (q-1)		0.008 ***	0.011 ***	0.008 ***
		(11.44)	(5.04)	(10.52)
× I(2008/Q4 onward)		0.017 ***	0.012 ***	0.017 ***
		(14.26)	(3.32)	(14.26)
Loan growth (q-1)	0.142 ***	0.141 ***	0.143 ***	0.139 ***
	(6.10)	(6.07)	(3.65)	(5.70)
× I(2008/Q4 onward)	-0.054 **	-0.056 **	-0.007	-0.062 **
	(-2.27)	(-2.33)	(-0.13)	(-2.48)
Bank characteristics	Yes	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes	Yes
Obs	121,571	121,158	12,133	109,024
Adj R^2	0.099	0.109	0.138	0.105

Table 5. Deposit Rates and Loan Growth

The table presents regressions of the adjusted 12-month CD rates on measures of loan growth. Columns (1) and (2) use lagged bank's loan growth as a proxy for current loan growth. Columns (3) and (4) use the lagged market loan growth as a proxy for current loan growth. Control variables include change in deposits-to-liabilities, logged assets, log # offices, large deposit ratio, time deposits to total deposits, loans to assets, brokered deposits to total deposits, inter-bank holding company indicator, new bank indicator, charge-off ratio, and asset quality. All control variables are lagged by one quarter. All regressions are OLS regressions. Variable definitions are in the Appendix. *t*-statistics are presented in parentheses. ***, **, * represent statistical significance at the 1%, 5%, or 10% levels, respectively.

Dependent variable:	Adjusted 12-month CD rate, $10k accounts (%)			
	(1)	(2)	(3)	(4)
Loan growth (q-1)	0.246 ***	0.366 ***		
	(8.98)	(4.72)		
× I(2008/Q4 onward)		-0.178 **		
		(-2.25)		
State-level loan growth (q-1)			0.891 ***	2.552 ***
			(4.64)	(6.65)
× I(2008/Q4 onward)				-2.710 ***
				(-6.50)
Bank characteristics	Yes	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes	Yes
Obs	121,322	121,322	121,322	121,322
Adj R^2	0.121	0.121	0.120	0.121

Table 6. Local CD Rates and Loan Growth in Other States

The table presents analysis of CD rates. Panels A and B show a regression of the adjusted 12-month CD rates on measures of loan growth. Panel A uses a sample of all inter-state bank-quarter. Panel B, Columns (1) to (4), restricts the sample to inter-state banks that rely on local deposits. Panel B, Columns (5) to (8), restricts the sample to low capital inter-state banks. These banks have below-median ratio of brokered deposits-to-total deposits. Control variables include change in deposits-to-liabilities, logged assets, log # offices, large deposit ratio, time deposits to total deposits, loans to assets, brokered deposits to total deposits, multi-bank holding company indicator, new bank indicator, charge-off ratio, and asset quality. All control variables are lagged by one quarter. All regressions are OLS regressions. Variable definitions are in the Appendix. *t*-statistics are presented in parentheses. ***, **, * represent statistical significance at the 1%, 5%, or 10% levels, respectively.

Panel A: All Inter-State Banks

Dependent variable:	Adjusted 12-month CD rate (%)			
Sample:	All inter-state bank-quarters			
	(1)	(2)	(3)	(4)
Out-of-state loan growth (q-1)	2.322 ***	3.105 ***	2.249 ***	3.154 ***
	(4.46)	(2.81)	(4.12)	(2.95)
× I(2008/Q4 onward)		-1.231		-1.423
		(-1.14)		(-1.44)
In-state loan growth (q-1)	0.886 *	1.259 ***	0.840 *	1.237 ***
	(1.87)	(2.82)	(1.73)	(2.83)
× I(2008/Q4 onward)		-0.593		-0.636
		(-1.43)		(-1.50)
Bank characteristics	Yes	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes	Yes
State × Bank FE	No	No	Yes	Yes
Obs	25,284	25,284	25,284	25,284
Adj R^2	0.331	0.332	0.326	0.326

Panel B: Inter-State Banks, by Dependence on Local Deposits

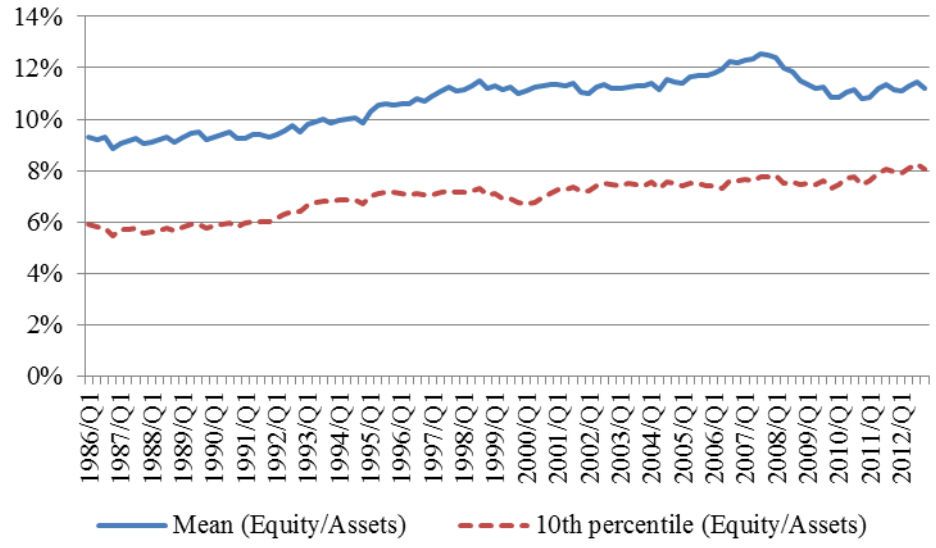
Dependent variable:	Adjusted 12-month CD rate (%)					
Sample: Non-brokered deposit ratio:	Low		Medium		High	
	(1)	(2)	(3)	(4)	(5)	(6)
Out-of-state loan growth (q-1)	2.281 ***	2.288	1.870 ***	3.058 ***	1.514	7.545 ***
	(2.74)	(1.43)	(5.48)	(4.81)	(1.50)	(2.63)
× I(2008/Q4 onward)		-0.000		-1.792 ***		-8.390 ***
		(-0.00)		(-2.57)		(-2.79)
In-state loan growth (q-1)	0.397	0.198	1.242 ***	2.928 ***	1.141	5.338
	(0.67)	(0.42)	(2.96)	(4.31)	(1.29)	(1.51)
× I(2008/Q4 onward)		0.332		-2.376 ***		-5.492
		(0.47)		(-4.09)		(-1.45)
Bank characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	13,363	13,363	10,847	10,847	1,074	1,074
Adj R^2	0.351	0.351	0.262	0.263	0.363	0.378

Table 7. CD Rates and Loan Growth: Single- vs. Multi-State Banks

The table presents regressions of the adjusted 12-month CD rates on measures of loan growth. Columns (1) and (2) use lagged bank's loan growth as a proxy for current loan growth. Columns (3) and (4) use the lagged market loan growth as a proxy for current loan growth. Control variables include change in deposits-to-liabilities, logged assets, log # offices, large deposit ratio, time deposits to total deposits, loans to assets, brokered deposits to total deposits, inter-bank holding company indicator, new bank indicator, charge-off ratio, and asset quality. All control variables are lagged by one quarter. All regressions are OLS regressions. Variable definitions are in the Appendix. *t*-statistics are presented in parentheses. ***, **, * represent statistical significance at the 1%, 5%, or 10% levels, respectively.

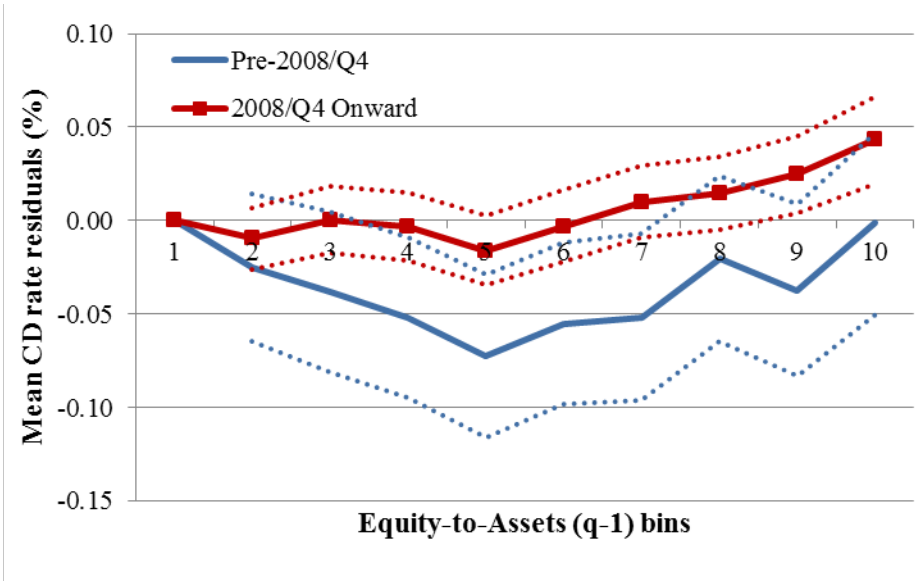
Dependent variable:	Adjusted 12-month CD rate, $10k accounts (%)			
Sample:	Multi-state banks		Single-state banks	
	(1)	(2)	(3)	(4)
State-level loan growth (q-1)	1.667 **	2.329	1.001 ***	2.935 ***
	(2.19)	(1.49)	(4.76)	(7.50)
× I(2008/Q4 onward)		-1.048		-3.298 ***
		(-0.62)		(-7.61)
Bank characteristics	Yes	Yes	Yes	Yes
Calendar quarter FE	Yes	Yes	Yes	Yes
Obs	7,960	7,960	111,655	111,655
Adj R^2	0.233	0.233	0.103	0.105

Figure 1. Equity Capital to Assets 1987-2012



The figure shows the average equity-to-assets and the 10th percentile of the distribution of equity-to-assets. Source: Call Report.

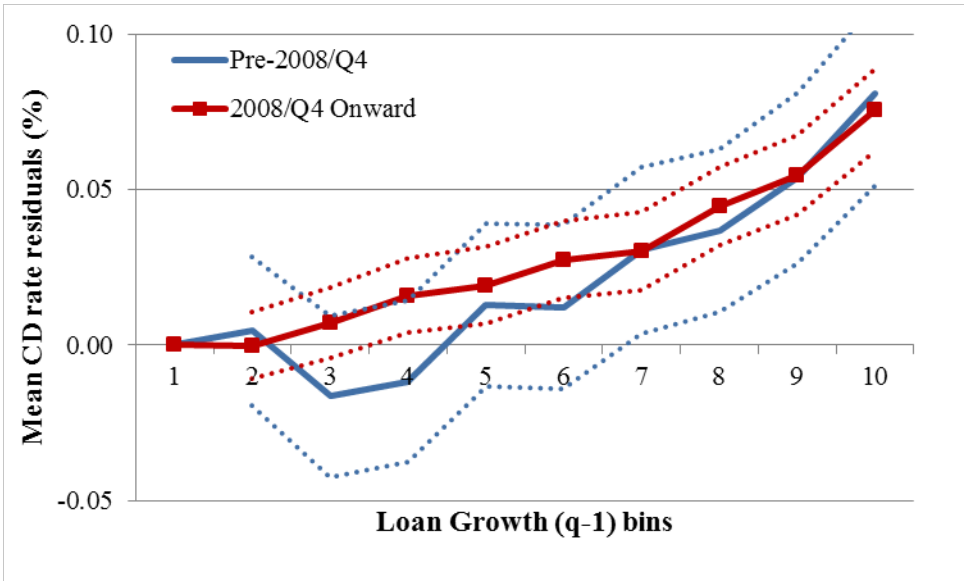
Figure 2. CD Rates and Equity-to-Assets



The figure shows the relation between deposit rates and lagged equity-to-assets. It presents the coefficients from regressions of CD rates (12-month duration for $10k accounts) on lagged equity-to-assets decile indicators, bank controls, and calendar fixed effects. The sample is split to two: pre-2008/Q4 and 2008/Q4 onward. The solid lines represent the point estimate of the coefficients. The dashed lines represent two standard errors around the point estimate of the coefficients.

Source: RateWatch and Call Report.

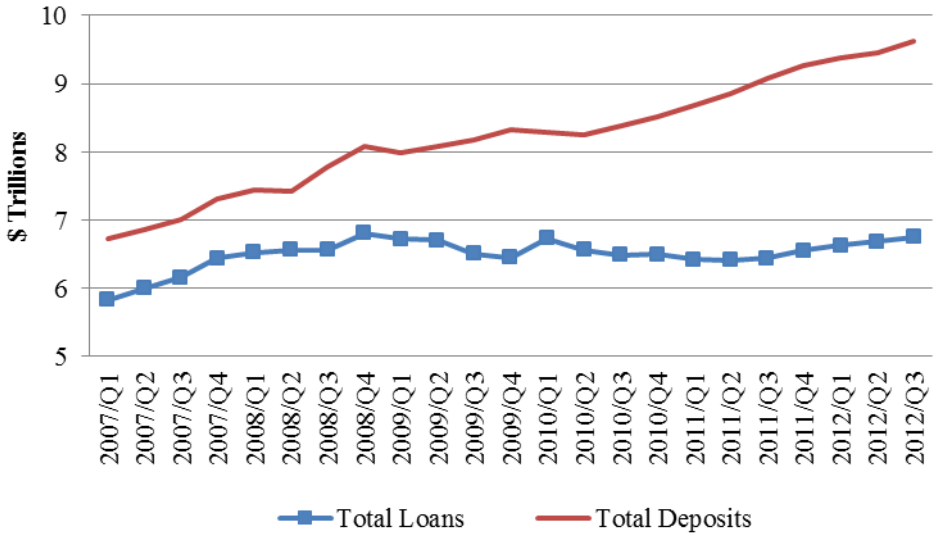
Figure 3. CD Rates and Equity-to-Assets



The figure shows the relation between deposit rates and lagged loan growth. It presents the coefficients from regressions of CD rates (12-month duration for $10k accounts) on lagged loan growth decile indicators, bank controls, and calendar fixed effects. The sample is split to two: pre-2008/Q4 and 2008/Q4 onward. The solid lines represent the point estimate of the coefficients. The dashed lines represent two standard errors around the point estimate of the coefficients.

Source: RateWatch and Call Report.

Figure 4. Aggregate Deposits and Loans



The figure shows the quarterly aggregate deposits and loans. Source: Call Report.