PRELIMINARY AND INCOMPLETE: Please do not cite or quote.

20170115

v.1

# Risks, Returns, and the Supply and Demand of Bank Deposits

Gabrielle Wanzenried[1] and James A. Wilcox[2]

## Abstract

Questions remain about the importance of various risks on banks' deposit volumes and deposit interest rates. Unsettled issues include how much risks inside, or even outside, banks have been reflected in deposit rates and flows. Our empirical procedures allowed bank deposit rates and flows to be determined simultaneously and for some predetermined factors to affect both demands and supplies for deposits. To separately estimate deposit demands and supplies over 1998-2010, along with several indicators of bank and broader conditions and risks, we used bank-level deposit rates and flows. We found that banks' demands for deposits were reliably downward-sloping and that they faced equally reliable upward-sloping deposit supplies. We also detected strong inflows of deposits to banks in response to greater external risks. The slopes and risk sensitivities of depositors implied that deposit rates would rise if external risks abated or internal risks rose. Our results contribute some explanation for two ongoing puzzles. By showing banks' demand responses, they demonstrate that greater risks to bank deposits should not be expected to raise deposit rates by as much. They also show how sluggish adjustments of deposit rates helps explain the tendency for tighter monetary policies to boost bank lending. To uncover similarities and differences, we also estimated deposit demands and supplies across bank sizes, across financial conditions, and across types of bank deposits.

*key words*: Deposits; Nontransactions; Deposit interest rates; Bank risk; Competition for deposits; Market discipline.

*JEL Codes*: G21; E41; E44; C23; C26; G32; L13

[1] Gabrielle Wanzenried, Institute of Financial Services IFZ, School of Business, Lucerne University of Applied Sciences and Arts, Grafenauweg 10, 6304 Zug, Switzerland, email: gabrielle.wanzenried@hslu.ch.

[2]James A. Wilcox, Haas School of Business, University of California, Berkeley, 545 Student Services Building Berkeley, CA 94720-1900, United States. email: jwilcox@haas.berkeley.edu.

We thank Willie Fuchs, Ross Levine, and participants at the Berkeley Finance Group internal seminar for helpful comments and suggestions. We thank Devin D'Angelo Sara Soltanizadeh for research assistance. We thank the Fisher Center for Real Estate and Urban Economics at Berkeley for financial support. The views expressed here and any errors are solely those of the authors.

# I. Introduction

The financial crisis revived academics and bankers' concerns about deposit flow, especially outflows. As the speed and intensity of the crisis grew and then waned, the perceived risks of real and financial assets, including bank deposits, also waxed and waned. Perceptions about the relative risks of residential and commercial real estate, stocks and bonds, money-market mutual funds and uninsured deposits shifted back and forth, sometimes abruptly. Shifts in perceptions of risks sprang from pertinent shifts of economic and financial conditions and from responses of public policies.

Shifting perceptions of risks, as well as of actual conditions, led to vast volumes of deposits flowing into, out of, and then back into banks, across banks, and across categories of deposits. As perceptions of risks and conditions, both inside and outside of banks, shifted, banks changed the interest rates that they offered on deposits. Sometimes banks raised deposit rates to deter deposit outflows; sometimes they altered rates to attract more of their typically-lower-cost deposits.

We analyzed the relationship between deposit rates and flows before and during the recent financial crisis. To do so, we used rates and flows of deposits that were either explicitly or likely to be covered by deposit insurance throughout 1998-2010. Hence, we focused on individual nontransactions deposit accounts and the "posted" rates each bank offered on new, certificates of deposit (CDs) that had a maturity of six months and opening balances of $10,000 or more.

We used this data to estimate bank-level deposit demand and supply equations and the slopes of banks' demand and supply curves. Then we estimated the changes in demand and supply curves in response to changes in not only bank's deposit rate but also this rate in compare to its local competitors' rate. Our empirical procedures allowed bank deposit rates and flows to be determined simultaneously and for some predetermined factors to affect both demands and supplies for deposits.

We found that banks' demands for deposits were reliably downward-sloping and that they faced equally reliable upward-sloping deposit supplies. We also detected strong inflows of deposits to banks in response to greater external risks. The slopes and risk sensitivities of depositors implied that deposit rates would rise if external risks abated or internal risks rose.

Our results contribute some explanation for two ongoing puzzles. By showing banks' demand responses, they demonstrate that greater risks to bank deposits should not be expected to raise deposit rates by as much. They also show how sluggish adjustments of deposit rates helps explain the tendency for tighter monetary policies to boost bank lending.

Our review of relevant prior studies in section II turned up rather conventional factors as determinants of the prices and quantities of bank deposits. To delineate relevant factors and mechanisms and to preview our estimated specifications, Section III provides a straightforward model of the supply of deposits to a bank and of a bank's demand for those deposits and sections IV and V specify demand and supply of deposits respectively. Section VI describes the data and the econometric approach that we used. Section VII provides quantitative descriptions of our data. Section VIII presents our estimated responses of deposit demand and supply. In section IX and X we look at determinants of nontransactions deposits by bank size and economic conditions respectively. In section XI we present the reduced form analysis result. Section XII shows the result of bank deposit demand and supply determinants by deposit categories and section XIII concludes.

## II. Review of the literature

We discuss the findings of a number of pertinent, especially the more recent, studies about bank deposits. We attempt to review enough of the most recent and most pertinent empirical studies of the supply of deposits to banks and the demand for deposits by banks to fairly portray the fertile aspects of the field. Although any study may, and often does, consider both supply and demand factors, below we tried to separate our discussion of the two sides of the market for bank deposits, just as we later lay out a model first of the demand and then of the supply of (safe) bank deposits.

In academic research and in industry analysis, concepts are often clearly, or even consistently, aligned with terminology. We refer to depositors, such as households or firms, as suppliers of deposits to banks and banks as demanders of deposits. (Banks, in turn, may supply loans to households and to firms.) One clear advantage of the pairings of these concepts and terms is that the resulting market for deposits has upward-sloping supply and downward-sloping demand curves when the deposit interest rate (or "price)" is on the vertical axis and the dollar amount of

deposits is on the horizontal axis. Like their slopes, the supply and demand curves shift in the familiar directions in response to changes in exogenous factors.

Later, our task will be to provide analysis of default-risk-free, or safe, deposits and of the interest rates paid on them. Nonetheless, risk figures prominently in our analysis. Risk figured even more prominently in several, recent, pertinent studies. The reason is that they focused on the riskiness and risk premiums of deposits that might incur losses. In contrast, for our safe deposits and rates, it is the risks associated with other assets (and even of other, uninsured deposits) that are germane.

Deposits have long been (commercial) banks' primary source of funds. Deposits have constituted even larger shares of the liabilities of savings banks and other nonbank depositories, such as credit unions and savings and loan institutions. Deposits have also been the primary component and primary source of variation in the money supply.

As events and public policies that affected banking ebbed and flowed, so too did research on bank deposits. The combination of (1) strong correlations between the money supply and inflation and output and (2) binding regulations on cash reserves and on deposit rates and on deposit features (such as whether they were "checkable") promoted considerable research on bank deposits. In large part due to binding rate regulations, studies then focused on the quantities of deposits, rather than on their prices (or the interest rates they earned). Thus, studies of aggregate and of bank-level deposits were common before the 1990s.

The financial sectors in large macroeconometric models often had modeled effects on deposit flows and, in turn, the effects of deposits, especially on mortgage and housing markets. Representative of bank-level studies of that time is the analysis by Hughes (1970), who concluded that banks controlled two factors that affected their deposits: (1) the interest rate that they paid on deposits and (2) advertising expenditures that were designed to attract deposits. He also concluded that three other important factors were not controlled by banks: (1) income per household, (2) dividend rates on common stock, and (3) banks' earnings.

By the latter 1980s, however, much of the impetus to deposit studies was gone. Ceilings on deposit rates were virtually non-existent, required reserves shrank to much smaller fractions of banks' total deposits and assets, the money supply no longer seemed reliably related to inflation or output, and the Fed implicitly and then explicitly targeted, not the money supply, but the fed funds rate. The numbers of studies of bank deposits shrank commensurately.

The crisis changed all that. Suddenly, research on bank deposits revived. Banks were both villains and victims in the financial crisis that erupted in 2007 in the United States. Some banks contributed considerably to the crisis. Many more were damaged considerably by the crisis and the Great Recession that followed. The precarious positions after 2006 of many, even the largest, U.S. commercial banks raised the specter of large and widespread losses on (uninsured) liabilities, including uninsured deposits. After many years of virtually no bank failures in the U.S., the few years after 2006 saw several hundred formal or informal bank failures.

Estimating perceived risks of bank deposits is difficult. It is likely to be even more difficult during a crisis, and especially difficult when *de facto* deposit insurance coverage is uncertain. Not only is it difficult for analysts *ex post*; it was also difficult for depositors *ex ante*. Bennett, et al. (2012) suggested that uninsured creditors of failed banks faced substantial uncertainty regarding both amount and timing of their losses recovery during the recent financial crisis.

Nonetheless, several recent studies provided empirical evidence that the supplies of deposits to individual commercial banks have been sensitive to (default) risk. Acharya and Mora (2015), Egan, et al. (2015), and Delis and Kouretas (2011) focused on the responses of deposit volumes to the perceived "own-risk" of owning deposits in the periods before and during the financial crisis. Less central to their analysis, but still sometimes included, were the effects of risks of real estate, stocks, and bonds, which competed with deposits in asset portfolios. These studies each showed that deposit volumes shrank in response to greater perceived risks that deposit balances would not be available on time and in full.

Acharya and Mora (2015), for example, argued that banks tried to prevent or at least tame deposit outflows in the face of heightened perceptions of deposit risk during the financial crisis by raising deposit interest rates crisis. They concluded that banks didn't raise rates enough to preclude deposit shortfalls, thereby forcing banks to reduce their lending. At the height of the financial crisis, additional government guarantees were applied to deposit and non-deposit liabilities, especially those of larger banks. So, just when the accelerating crisis scared off supplies of funds to other assets, bank deposits suddenly became very much safer relatively, and enormous flows poured into bank deposits.

Similarly, the reductions in deposit supply due to deposit risks showed up in Europe recently. Brown, et al. (2013) used data for retail deposits at large European commercial banks to establish that, in the wake of the financial crisis, withdrawals were higher at more distressed banks.

Egan, et al. (2015) pointed out the cross-currents in deposit flows during periods of financial distress. When deposits come to be regarded as risky, banks may choose deposit rates that lead to lower volumes of uninsured deposits and sufficiently higher volumes of insured deposits.

While the recent crisis directed attention to risks of deposits and of other assets, factors other than risk also have long been recognized as affecting deposit supplies. The Hughes (1970) study that we discussed above, for example, concluded that deposit supplies were affected by individual banks' marketing efforts, as well as by income per household. Becker (2006) showed that larger local supplies of bank deposits raised banks' local lending, which in turn raised boosted local economies' manufacturing firms, small businesses and new businesses. That finding apparently reflects larger local deposit supplies' driving down the cost and driving up the availability of bank credit for local businesses.

Whether deposit risk premiums rose sufficiently in the period before or even during the crisis to provide effective market discipline on risky banks has been questioned. Based on branch-level deposit rate data, Ben-David, et al. (2015) found that deposit rates were correlated with loan growth in the states where branches were located. By contrast, they saw little evidence that shifts in the supplies of deposits drove deposit rates, in that banks' capital positions had no detectable effects on the interest rates that banks paid their depositors. Taken together, these results led them to conclude that, rather than depositors' supplies of funds, it was banks' demands for funds determined their deposit rates.

The individual effects of bank capital on deposit rates might not be easy to ascertain. Banks may gravitate toward given capital-to-asset ratios, such as some buffer amounts above the regulatory minimums for those ratios. If so, having more capital would increase the demand for deposits by capital-conscious banks. For such banks, having more capital would permit them to hold more assets, and banks' assets are funded overwhelmingly (e.g., 90%) by deposits. On the supply side, however, having more capital may reduce depositors' perceptions of the risks of bank deposits, particularly during periods of financial stresses. If so, higher-capital banks would attract larger supplies of deposits, as argued by Berger and Bouwman (2012). Although both the supply-side and the demand-side effects of having more capital would raise banks' deposit volumes, the net effect of more bank capital on deposit rates is not foreordained.

Bank failure probabilities and the risks of deposits might be reasonably well inferred from a whole collection of bank variables. In addition to bank capital, the lengthy empirical literature had identified any number of variables that help forecast bank failures and losses: delinquent loans, non-accruing loans, loan loss provisions and allowances, ROA, local economic conditions, real estate prices, and so on. These findings suggest that using only accounting measures of bank capital to assess the risks of banks' deposits is debatable.

In addition to bank capital, other factors, such as the interest yields that banks expect from holding loans or bonds and such as economic and financial conditions and prospects that would affect credit risks and returns are likely to drive banks' demands for deposits. Ben-David et. al (2015), for example, concluded that state-level loan growth was among the factors that affected banks' demands for deposits.

## III. Deposit demand and deposit supply

A straightforward model of the supply and demand for bank deposits motivated the variables that we considered for our empirical specifications. Because of their numbers and importance, and for expositional and empirical convenience, we consider only commercial banks, rather than holding companies or thrift institutions.

We begin with banks having only uninsured, nontransactions deposits. We soon delineate the characteristics, relative risks, and returns of several types of deposits. But, then our attention and empirical evidence focuses primarily, though not entirely, on the interest rates and volumes of insured, nontransactions deposits at commercial banks.

Banks' demands for deposits primarily stems from their desire to use leverage to acquire loans, bonds, and other assets that dwarf their equity capital. Indeed, even before the advent of deposit insurance, banking was always among the most highly levered of all industries. In addition to deposits and capital, banks also have other non-deposit liabilities, such as commercial paper and bonds. Because we excluded the largest banks from our sample, non-deposit liabilities of this sort were typically negligible relative to banks' total assets.

Like that of any input, the cost of deposits affects the quantities demanded: The higher the interest rate that a bank pays for its deposits, the smaller the quantity demanded. Banks' demands

for deposits also vary with bank-specific conditions and opportunities, as well as with national and local financial and economic conditions. These and other factors affect the risks and expected returns on banks' assets, and thus banks' demands for deposits. In addition, as we noted above, banks are typically conscious of their capital ratios, whether because of their independent business judgments or because of pressures of various sorts that stem from regulations or from regulators. As such, having more capital may stimulate banks' demands for deposits, which together can fund additional holdings of assets and generate additional earnings.

On the other side of the market for a bank's deposits, households and businesses supply deposits to banks.[3] The higher the deposit rate that a bank offers, especially relative to its competitors, the more deposits it garners. Thus, as a function of the deposit interest rate, Figure 1 shows that the demand for and supply of deposits to a bank have the usual downward and upward slopes.

Consider an increase in deposit demand due to higher loan rates. That higher output (i.e., loan) price leads the demand curve for the input (deposits) to shift rightward, say from $D_0$ to $D_1$. Absent changes in other exogenous factors, banks then offer higher deposit rates, raising them from $i_0$ to $i_1$. The higher deposit rate at this bank attracts more deposits, presumably from depositors' other banks, their other assets, and their deferring spending on goods and services. At the same time, the higher interest rate on deposits reduces the quantity of deposits demanded, with the net effect on the quantity of deposits shown by the horizontal amount of the move from A to B.

Analogously, consider a decline in the perceived riskiness of bank deposits relative to depositors' other assets. Deposits would become relatively less risky either if there were an increase in the effective amount of deposit insurance coverage or if other assets became riskier. Starting from point A, the supply of deposits could shift to $S_1$: More insurance reduced the risks of deposits, shifting the amount supplied at the initial deposit rate of $i_0$. The increase in deposit supply naturally lowers the resulting deposit rate and raises the volume of deposits, as shown at

[3] The public sector also supplies deposits to banks. Some of the same forces, such as household and business incomes, that affect private-sector supplies likely affect those of the public sector. Modeling other forces that drive public supplies of deposits is beyond our scope.

point C. As deposit rates fall relative to loan rates, for example, banks willingly gather more deposits so that they can fund more loans, while taking account of any effects on their capital ratios.

If incoming news foretold weaker banking conditions and greater deposit risks, by contrast, initially the supply of deposits would shift upward, raising deposit rates and reducing the volumes of deposits and loans. In Figure 1, the market equilibrium would slide, for example, from D to B (or C to A).

## IV. Specifying a bank's demand for deposits

Our model in the previous section justified banks' downward-sloping demands for deposits: banks' quantities of deposits demanded fall, *cet. par.*, as the interest rates that they pay on deposits rise. In addition, the model justified banks' demanding more deposits when they expect higher risk-adjusted returns on the assets funded by their deposits. Our model also implied that deposit interest rates and dollar amounts would be determined simultaneously. We chose, our econometric specification and estimation methods to allow for that simultaneity.

We chose variables to reflect the economic and financial conditions of the bank, its locality, and the nation that, in turn, affected banks' assets' risks and expected returns. To do so, we estimated the specification for the demand by bank *b* at time *t* for nontransactions deposits in equation (1):

(1) $$\text{g1nontransdeposits}_{bt} = \beta_0 + \beta_1 * \text{CD interest rate}_{bt} + \beta_2 * \text{g1capital ratio}_{bt} + \beta_3 * \text{mortgage interest rate}_{t} + \beta_4 * \text{credit spread}_{t} + \beta_5 * \text{leading indicator state}_{t} + \beta_6 * \text{leading indicator region}_{t} + \beta_7 * \text{home vacancy rate state}_{t} + \mu_b + v_{bt}$$

where subscripts b = banks 1, …, B and t = quarters 1, …, T.

## A. Nontransactions-accounts balances

The left-hand-side variable in equation (1), $g1nontransactiondeposit_{bt}$, denotes the growth rate over one quarter (in percent, not annualized) total nontransactions deposits at bank b over quarter t. After our main analysis of nontransactions deposits, below we show estimates of our baseline specifications for deposit demand and deposit supply for other types of deposits. So that they can be compared with the results for nontransactions deposits, there we show results for five other types of deposits: transactions, total, (estimated) insured, uninsured, insured CDs, and uninsured CDs.

A bank's total deposits are the sum of its nontransactions deposits plus its transactions deposits. The dollar amounts of nontransactions deposits consist of the balances in savings accounts, money-market deposit accounts (MMDAs), plus certificates of deposit (CDs). Of the three components of nontransactions deposits, only CDs, or time deposits, had contractual maturities and interest rates. Transactions deposits consist of the amounts in demand deposit, NOW, ATS, and telephone-and-pre-authorized-transfer accounts. As their name suggests, turnover rates, calculated as the ratios of debits and credits per period to average balances, for transaction accounts are huge compared with those for nontransaction accounts. Indeed, the disparities in turnover rates across types of accounts provide information about which types of accounts depositors use primarily for transactions and which are nontransactions ones, supplied primarily as stores of value., e.g. as one component in portfolios of financial assets.

Figure 2 shows the dollar amounts of nontransaction and transaction deposits of our sample banks for quarter-ends for our 1998Q1-2010Q1 sample period. In the late 1990s, there were over $500 billion in nontransactions deposits; by the end of our sample, a dozen years later, there were nearly $2 trillion in nontransactions deposits. Figure 2 also shows strong net flows of nontransactions deposits into banks at the beginning of the financial crisis. Then, when banks also seemed to be jeopardy in 2008, nontransactions deposits reversed course, only to re-reverse toward the end of 2008, after additional guarantees were provided for bank deposits. By the end of our sample in early 2010, the volume of nontransactions deposits was about the same as it had been before the crisis, in 2006.

Before the recent financial crisis, up to $100,000 of deposits per account name, per bank, were covered by FDIC deposit insurance. When the financial crisis intensified in late 2008, the ceiling on coverage rose to $250,000, where it remained at least until 2017.

Most of the nontransactions deposits at banks in our sample were covered by deposit insurance. Figure 3 shows that about two thirds of all deposits at the banks in our sample were covered by deposit insurance. Figure 4 shows that by the end of our sample in early 2010 nearly three fourth of our sample were covered by deposit insurance. Even larger portions of CDs were insured; Figures 5 and 6 show the dollar amount and percent of total deposits for insured and uninsured CDs. Those figures show that upwards of ninety percent of balances in CDs were insured at our sample banks.

Figures 3 and 4 show the estimated amounts of insured and uninsured total deposits, in billions of dollars and as percents of (sample) banks' total deposits. From 1998, dollars of deposits nearly tripled by 2006 with only modest fluctuations. Insured and uninsured deposits generally moved together, leaving their relative shares little changed. With the onset of the financial crisis after 2006, the share of uninsured deposits rose, but as the economy and the financial sector recovered over the years since the crisis, the share of uninsured deposits also recovered.

Figures 5 and 6 show the dollar amounts and percents of total deposits accounted for by insured and uninsured CDs over our 1998Q1-2010Q1 sample period. The dollar volume of uninsured CDs on banks' balance sheets increased only slightly over the entire period, while insured CDs grew substantially, more than doubling from a bit more than $300 billion in 1998q1 to more than $800 billion by early 2006. As the financial crisis took hold after 2006, the volume of uninsured CDs outstanding declined sharply.

We would expect relatively of more CDs in our sample banks to be insure compare to all banks. The reasons are that our sample excluded data for any bank that had more than $100 billion of assets. The largest banks generally had the individual nontransactions accounts with the largest balances, the largest transactions deposits totals and the largest shares of total deposits in accounts with balances larger than the explicit ceiling on deposit insurance coverage. In addition, the larger were balances in business accounts, the more that those balances typically were held in transactions accounts, rather than in nontransactions accounts.

Checking, savings, and MMDA accounts apparently had relatively more uninsured balances than CDs did. Neither checking nor saving accounts have explicit maturities. Thus,

depositors could withdraw from their checking or savings accounts any balance at any time without any penalties. Those accounts' liquidity likely meant that some large holders of deposits reduced their balances if they raised their assessments of expected losses on those accounts associated with bank failures. If holders of checking and savings account with balances above the deposit insurance ceiling judged the probabilities of their banks failing to remain very low and if those depositors thought the probabilities were very high that they would have enough advance warning of bank failures to withdraw their balances, we would not expect changes in depositors perceived expected losses to account for much of the changes in deposit amounts or in interest rates on checking and savings accounts. Nonetheless, some depositors may have perceived enough changes in the expected losses on those accounts that their balances and interest rates did respond somewhat. Thus, the savings accounts and MMDA balances may have quite sensitive to deposit risks, regardless of whether the interest rate of on deposit are sensitive or not.

### B. Interest rate on CDs

As our primary measure of the interest rate on nontransactions deposits (***CD interest rate***$_{bt}$) we used the interest rate on new, 6-month CDs that had a minimum-balance requirement of $10,000. Almost all banks almost always offered new CDs with maturities of six months and minimum balances of $10,000. Indeed, the $10,000-minimum, 6-month-maturity CD was the most-commonly offered CD.

We obtained contemporaneously-collected data for the interest rates offered on various categories of deposit accounts in commercial banks from RateWatch. RateWatch is an independent company that collects financial data for institutions located throughout the United States. RateWatch describes its data collection process as follows: "RateWatch works with institutions to determine the schedule upon which rates/fees are updated. For deposit information, RateWatch tracks the day of the week when rates reviewed and obtains the rate information on or after that day, prior to a report's scheduled delivery.

Figures 7 and 8 contain histograms drawn on the same scales for CD interest rates for 2006q1 and for 2009q1, respectively. The histograms show that, even during the same quarter, the rates offered on the same CDs vary considerably across banks. With an average rate of about 3 percent in early 2006, Figure 7 shows that upwards of half of the banks were offering rates that were either 50 basis points below or above the average rate. By 2009, the crisis and Fed easing led

to lower interest rates across the board. Figure 8 shows that rates offered had fallen below 2 percent. Figure 8 also shows that the distribution of CD rates had narrowed, with the ZLB apparently snipping off the skewed rates that we saw in Figure 7. Nonetheless, even these lower rates were dispersed noticeably across banks.

Because the balances in these CD accounts were covered almost entirely by deposit insurance, we consider the deposit interest rate on these CDs to be a risk-free-deposit interest rate. The balances in CDs with $10,000 minimums were very likely to be virtually-entirely-covered by FDIC deposit insurance. The deposit insurance ceiling was $100,000 per account name at a bank at the beginning of for our sample period. The $100,000 ceiling rose to $250,000 in October 2008 when the financial crisis erupted. Nearly always, banks offered higher deposit rates for CD accounts with higher minimum balances: Accounts that required at least $100,000, $50,000, or even $25,000 paid higher rates than accounts that required balances only of $10,000. Thus, depositors who chose to forego higher rates on still-insured CD accounts (e.g., those with minimums of $25,000 or $50,000) and instead accepted the lower interest rates that came with CD accounts with lower, e.g. $10,000, minimum balances, seem very likely to have had balances that were comfortably below the deposit insurance ceilings of $100,000 or of $250,000.

Our six-month CD interest rate was also representative of the interest rates paid on all nontransactions deposits. In a pooled sample of banks across quarters, the interest rates on those CDs at a bank were very strongly correlated with the average of interest rates at a bank weighted each quarter by balances in savings, MMDA, and CD accounts. The main cause of strong correlation was relatively small variation, both across quarters and across banks, in interest rates on savings accounts and MMDAs relative to the variation in CD rates. The result, for the pooled bank-quarter sample, was a correlation between rates on the benchmark CD and the weighted average of nontransactions accounts of 0.97. Thus, we regarded our CD interest rate as an appropriate measure indicator of the interest rates paid on all nontransactions deposit.

### C. Bank capital

The bank capital ratio (***g1capital ratio***$_{bt}$) in equation 1 is the growth rate over one quarter of the ratio of capital to total risk-weighted assets of bank b over quarter t. We calculated bank capital for each bank as the difference between total assets and total liabilities.

Banks' capital conditions can also affect their deposit demands. Banks, particularly smaller banks, which have less access to equity capital markets, either choose not to or just cannot completely control their capital over shorter periods. When their capital changes, for example due to changes in after-tax income, banks can alter the amounts of their assets and liabilities. A bank may have its own target for leverage ratio that reflects a combination of regulatory considerations and purely business considerations. Because capital changes can have repercussions on assets and liabilities, including deposits, we included a measure of each bank capital as a determinant of its demand for deposits. We expected that declines in capital would reduce banks' holdings of assets and demand for deposits.

### D. Mortgage interest rates and home vacancy rates

Commercial banks devote considerable shares of their loans outstanding to residential mortgages and other housing-related loans. These assets have importantly affected banks' earnings and capital during our 1998-2010 sample period. We included two housing-related variables in the demand for deposits. The national-average interest rate on prime-quality mortgages (***mortgage interest rate***$_t$) serves as an indicator of the interest rate a bank can expect from new mortgages. In addition, we included the home vacancy rate at the state level (***home vacancy rate state***$_t$). The home vacancy rate is likely correlated with both the current conditions of banks and with bank' views about the prospects for housing and mortgage lending. High current vacancy rates likely indicate large losses on banks' mortgage lending period. High vacancy rates also likely signal weaker future house prices and mortgage delinquencies and defaults. To generate quarterly data for state-level home vacancy rates, we linearly interpolated the annual data, after setting the second quarter value for each year equal to the annual value for that state.

While we allowed for bank's demand for deposits to respond to the interest rate it could earn on its loans or bonds, we assumed that a bank's demand for deposits would not be a function of the deposit rates at other banks. We did, naturally, allow for the supply of deposits to a bank to decline when other banks in the locality raised their deposit rates.

## E. Credit spread

While we included a straightforward measure of a bond yield spread (***credit spread***$_t$), the effects of that spread on banks' demands for deposits is not nearly as straightforward. We calculated the spread as the difference between the yield on Moody's seasoned Baa corporate bonds and the yield on 10-year Treasurys.

Credit spreads reflect the combination of risk and the reward to taking on risk. Increase in spread due to perception of increased risk will likely reduce bank supplies of credit and therefore reduce their demand for deposit. We would expect similar reaction by banks if higher credit spreads stumped from reductions in banks' risk appetite period. In contrast, increases in the credit spreads that did not arise from increased risk aversion at banks would likely lead them to increase their supply of credit and thus their demand for deposit. Gilchrist and Zakrajsek (2010) found that credit spreads predicted future economic growth periods. They concluded that contraction in supply of credit as a result of reduction in risk appetite of financial sector results in adverse consequences for macroeconomy and increases the bond premium.

## F. Leading economic indicators

We included both state-level (for the state where a bank was headquartered) and multi-state region-level indices of leading economic indicators. Banks' supplies of credit, both to businesses and to households, likely rise with the economic prospects of their business locales. Forecasting the economic outcome is the purpose for leading economic indicators are designed.

Federal Reserve Bank of Philadelphia construct the state level-leading indicators (***leading indicator state***$_t$). These indicators were design to predict the six-month-ahead growth rate of each states' economy. The indexes are based on state-level housing permits (1 to 4 units), state initial unemployment insurance claims, delivery times from the Institute for Supply Management (ISM) manufacturing survey, and the difference between the 10-year treasury bond yield and the 3-month treasury bill yield (Crone, 2000). We linearly interpolated annual data to generate quarterly observations.

We used the state level indicators to create a population-weighted region-level indicator (***leading indicator region***$_t$) for each of the nine multi-states Census division level. We used the region level indicators for banks that operated in more than one state.

## V. Specifying the supply of bank deposits

Our model posited an upward-sloped supply of deposits: the volume of deposits supplied by households and businesses to a bank would rise with the interest rate that a bank offered on deposits. Below, in our specification for the supply of deposits to a bank, we also allow for competition for deposits from local banks. Presumably, the supply of deposits to a bank is lower when its competing banks offer higher deposit rates. We also allow for economic conditions in households' localities, as well as national financial and economic conditions and risks. More specifically, our baseline equation for supply of nontransaction deposits to a bank is shown in equation (2):

(2) $$\begin{aligned} \text{g1nontransdeposits}_{bt} = \\ & \gamma_0 + \gamma_1 * \text{CD interest rate}_{bt} + \\ & \gamma_2 * \text{own} - \text{competitor CD interest rate}_{bt} + \\ & \sum_{k=2}^{4} \theta_k * q_k + \gamma_3 * \Delta\text{NASDAQ100}_{t-1} + \\ & \gamma_4 * \text{financial conditions}_t + \gamma_5 * \text{recession}_t + \\ & \gamma_6 * \text{household distress state}_t + \\ & \gamma_7 * \text{home vacancy rate state}_t + \xi_b + \rho_{bt} \end{aligned}$$

Subscripts b = banks 1..., *B* and *t* = quarters 1..., *T.* As with the demand for deposits, in the supply of deposits to a bank, we allowed for unobserved, bank-specific, fixed effects ($\xi_b$) and included a standard idiosyncratic disturbance term ($\rho_{bt}$).[4] The supply of deposits in equation (2) uses the same deposit and interest rate variables that we used in the demand for deposit in equation (1).

### A. Competitor interest rates

In addition to the interest rate that a bank paid on its own CDs (***CD interest rate**$_{bt}$*), we included the difference between a bank's own deposit rate and the rate offered by its local

[4] We applied the Hausman (1978) specification test (Greene 2008) in order to decide between the random effects and the fixed effects specification. The results of Hausman specification tests (Greene 2008) indicated that fixed effects were superior to random effects for our demand and supply functions.

competitors (***own-competitor CD interest rate***$_{bt}$). To calculate competing interest rates, we weighted the interest rate offered by each bank's competitors by the total assets of each competing bank. Each bank's competitors were the banks in its local area. We considered each individual bank's local area to be all the areas that had the same first three numbers in their ZIP codes as the bank had. Thus, for example, all the banks headquartered in ZIP codes that began with the digits 144 were considered to be the local competitors for a bank in Canandaigua, NY whose ZIP code was 14424.

### B. Seasonal effects

Neither interest rate nor deposit data were seasonally adjusted. Although we not detect, or expect, seasonality in any of the interest rate time series, we did find, and expect, large seasonal variations in various series that were not officially seasonally adjusted. We allowed for seasonal effects, regardless of where they occurred, simply by including a dummy variable for calendar quarters two through four ($\boldsymbol{q_k}$). Having included a constant term in equation (2), we therefore omitted a seasonal dummy variable for the first quarter of the year. Seasons likely affected the supply of deposits in various ways. GDP itself is seasonal, generally being higher in the second and fourth quarters of the year. Holidays account for its rise toward the end of the year. The weather warms enough for construction in the frozen-winter states to revive by the second quarter. In addition to more construction of new homes during the second quarter, typically there are considerably more sales of new, and especially of existing homes during the second and third quarters. Further, total activity slows during the third quarter of the year, when more employees are on vacation. These seasonal factors affect incomes, outlays, and thus deposit supplies. All of these factors probably don't affect deposit supplies in the same direction, but their individual, seasonal effects are likely large enough that, even if partially offsetting, they are unlikely to cancel each other out completely.

### C. National financial and economic conditions

We included variables to reflect some of the substantial gyrations in national economic and financial conditions and in risks during our 1998-2010 sample period. We allowed the supplies of deposits to banks to reflect risks and expected returns on non-deposit assets. For example, when

the bubble in high-tech stock prices popped around 2000 and again when financial markets were roiled by the recent financial crisis, deposits surged into banks. As an indicator of the relative attractiveness as assets of equities to bank deposits, we used the one-quarter-lagged, first-difference of the end-of-quarter value of the NASDAQ100 stock price index ($\Delta NASDAQ100_{t-1}$).

During our sample period, financial markets showed unprecedented ease and equally unprecedented tightness. Not only were there gyrations associated with the boom and bust in mortgage markets in the second half of our sample period. In the first half, the Asian financial crisis and the 2001 recession were followed by historically low interest rates under Fed Chair Greenspan. As an indicator of the ease and stresses in financial markets, we included the National Financial Conditions Index (***financial conditions***$_t$). The Federal Reserve Bank of Chicago calculated its National Financial Conditions Index (NCFI) from variables that signal conditions in money markets, in debt and equity markets, and in traditional and "shadow" banking. We also included a dummy variable that indicated whether the national economy was in an NBER-determined recession (***recession***$_t$).

### D. Household distress and home vacancy rates

Depositors move funds not only across banks, but also in and out of the banking system. We included measures that likely both affected and reflected depositors' incomes and wealth, and thus their desire to hold deposits. We included a variable that measured the financial health and distress of households in particular (***household distress state***$_t$). We chose to include the CredAbility Consumer Distress Index, which was based on several dozen measures of households' conditions regarding their employment, mortgages, credit, budgets, and net worth. As another indicator of households' condition, we included the same, state-level home vacancy rate (***home vacancy rate***$_t$) that we included in the specification for a bank's demand for deposits.

## VI. Data and methods

### A. Estimation period

Our sample period extended from 1998q1 through 2010q1. The beginning date was determined by the availability of deposit interest rate data from RateWatch. Before then, there

were many fewer banks in the RateWatch database. We chose to end the sample in early 2010 because interest rates on very many types of short-term, low-risk paper and deposits were approximately at a zero lower bound (ZLB). During and after the Great Recession, demand for bank loans remained weak, deposit inflows remained strong afterwards, and the Fed keep its target for the fed funds interest rate at virtually zero. As a result, by 2010, banks lowered the rates that they offered on many types of deposits essentially to zero. Bank of America, for example, paid 1 basis point (0.01% annually) on huge volumes of savings and interest-bearing checking balances for many years after the financial crisis, and still did so as of early 2017. But, even essentially zero deposit rates weren't low enough for banks to accumulate well over $1 trillion of (regulatory) excess reserves. Why nominal, short-term, low-risk interest rates were apparently bound from below at zero is an open question. Plenty of reasons could be offered for why they might have, or perhaps should have, gone negative. But, that is beyond our reach here. The effective ZLB in the U.S. very likely meant that deposit rates were not then being determined by the intersection of the same supply and demand functions that operated before rates hit the ZLB. For example, Delis and Kouretas (2011) concluded that individual Eurozone banks took on more risks, *cet. par.*, in the period even before the financial crisis when nominal market interest rates were lower. By excluding the U.S. ZLB period, we sought to avoid mixing in a period when banks might be "reaching for yield", which is akin to a shift downward in banks' risk aversion.

Figure 9 plots the unweighted average across banks of the interest rate that we focus on, the rate offered on new, 6-month CDs that had a minimum balance of $10,000. Over our 1998q1-2010q1 sample period, that deposit rate fluctuated impressively. After cresting above 5% in 2001, it plummeted to a historical low of about 1% by 2004. The deposit rate then reversed as the Fed raised the its funds rate target, rising to nearly 4% during 2007. The onset of the financial crisis and Fed easings then produced a CD interest rate of about 1% by early 2010. From then on, the CD interest rate was even lower after that.

### B. Sample banks

We excluded from our sample bank-quarters for U.S. commercial banks that had fewer than $10 million or more than $100 billion in assets. Thus, we excluded considerable numbers of very small banks, as well as the small numbers of very-large banks. We omitted both the very

small and the very large banks because their business models were fundamentally different in scope and scale from the vast majority of other banks. Further, for the largest U.S. banks, deposit rates and volumes were likely to have large, volatile, unmeasurable shifts due to public policies, such as too-big-to-fail, during our sample period. Big too-big-to-fail discounts have been reported by Jacewitz and Pogach (2013). We do recognize, however, that most deposits were in those few, very-large banks: Whereas our thousands of sample banks had total deposits at the end of 2009 of about $2 trillion in the aggregate, total deposits of all U.S. commercial banks taken together were about $7 trillion.

Over the course of our sample period, some banks entered or exited during the sample period. Some banks moved in or out temporarily because of their size or their being winsorized; some banks moved in or out of our sample permanently due to their being de novo banks or their having merged or failed. In addition, for some bank-quarters, our RateWatch database did not have deposit rate data. To reduce the impact on our analysis of very atypical growth rates of deposits or of other variables, we also excluded bank-quarters when their data seemed so extreme that they might inordinately affect our results. Thus, we excluded bank-quarters if their nontransactions deposits (in dollars) shrank by more than 10 percent or grew by more than 20 percent, either over the current quarter or over the prior quarter. We also excluded bank-quarters if their bank capital (in dollars) either shrank or grew by more than 20 percent over the current quarter.

### C. Instrumental Variables and Estimation

Our model suggests that deposit rates and volumes would be determined simultaneously. Therefore, we estimated the deposit supply and demand functions with an instrumental variable method throughout. Because the relative attractiveness of banks' competitors' interest rates was based on banks' own deposit rates, we also treated the competing interest variable as being endogenous.

We treated all of the other supply and demand variables as being predetermined. Consider the estimates that included all of the variables shown in equations (1) and (2). In that case, when estimating deposit supply functions like the one shown in equation (2), in addition to the 8 exogenous variables in the supply function itself, we also included the 6 predetermined variables from the deposit demand function like the one shown in equation (2). And, in turn, when we

estimated deposit demand functions, we used the same 14 predetermined variables as instruments. When we estimated fewer parameters than in equation (1) or (2), we still used all of the predetermined variables from the other side of the deposit market as instruments, but we did not use the predetermined variables that were omitted as instruments. As noted above, our estimation method also allowed for bank-specific fixed effects.

## VII. Summary statistics

Table 2 presents descriptive statistics for each of our variables: means, standard deviations, and medians, as well as lower and upper quartiles, for the bank-quarters that remained in our pooled, 1998q1-2010q1 sample after we excluded outliers.

The average quarterly growth rate of nontransaction deposits was 1.67% (6.7% annualized). Deposits grew at noticeably different rates across banks and across time. They grew fastest, on average, during 2001q1, when both the economy and stock prices were in retreat. Banks offered an interest rate of 2.93% on average for new, 6-month CDs with a $10,000 minimum balance. Of course, the highest rates tended to be just before the 2001 recession and the lowest after the financial crisis. The difference between the interest rates that banks and their competitors offered, naturally, averaged near zero. Of more interest, so to speak, was the inter-quartile range, which showed that, for about half of our bank-quarters, the average of local competitors' deposit rates was more than ¼ of 1 percentage point higher or lower than a bank's own deposit rate. The size of that range moved up and down quite consistently with the overall level of deposit rates, tightening when rates were low, perhaps due to a ZLB, and stretching out when rates were higher.

## VIII. Estimated deposit demands and deposit supplies

Our estimates provide strong support for the presumed slopes of bank deposit demand and supply functions. They also provide strong support for several other factors importantly influencing the deposit market.

Starting with Table 3, we present estimated deposit demand and supply functions. In Tables 3 and 4, we provide some information about how much point estimates and (statistical) significance changed when we included more variables in our specifications. In order to see the effects of the bank- and market-specific variables, and consider truncated versions of our model,

we begin by showing results based only on deposits and interest rates. Successive columns show the results when we introduce additional variables.

### A. The demand by banks for nontransactions deposits

The first column in Table 3 shows the results for the minimal specification. The second column adds bank capital. Rather than negative, the estimated coefficient on the interest rate is strongly positive. Column 3 adds variables for two interest rates that banks can earn: mortgage interest rates and credit spreads. In columns 3 and 4, these rates always turned up positive. Adding these two, significantly-positive-coefficient variables carries the CD interest rate upward from strongly positive, to about zero. The positive sign of the mortgage interest rate indicates that a bank demands more deposits when it can loan those deposits out at higher interest rates. In other words, the coefficient of this variable indicates that a bank is willing to take on a greater amount of liabilities (i.e. deposits) when it has the opportunity to create more valuable assets (i.e. loans with higher interest rates).

For each specification in Table 3, bank capital is estimated to have strong, positive effects on deposit demand, as we expected. The positive coefficient indicates growth of bank capital leads to more demand for deposits, which banks then lend out. This result is not surprising, as it follows from banks' gravitating toward target capital ratios.

However, the estimated coefficient on the CD interest rate becomes significantly negative when we add the state-level and the region-level leading economic indicators, both of which themselves carry strongly positive coefficients. As expected, a better economic climate as reflected by a higher value of the leading index and lower home vacancy rate, respectively, have a positive effect on the growth rate of nontransactions deposits on the demand side. Column 4 also included the state-level home vacancy rate, which was estimated to significantly negative.

Taken together, these results suggest that bank's demands for deposits did slope downward. They also suggest that our other, predetermined variables significantly shifted deposit demands.

Our results also shed light on another notable feature of bank deposit and loan markets: the tendency of loan volumes initially to rise in the wake of tighter monetary policy, before later declining. Our results may help explain that "J-Curve" in bank deposit and loan amounts. Tighter monetary policies have tended to raise longer-term interest rates and shorter-term rates even more;

yield curves for open-market rates, such as those on Treasurys, typically flattened in response to higher fed funds interest rates. In contrast, prior studies concluded the opposite for loan and deposit rates: typically, posted spreads between banks' loan and deposit rates tended to rise by significant amounts and for extended periods of time in response to increases in the Fed's target for the federal funds rate (Nishiyama 2010, Delis and Kouretas 2011, Lee, et al. 2013, and Drechsler, et al 2016). The results in Table 3 imply that, even if mortgage and deposit rates rise by the same amounts, the quantity of deposits demanded by banks would rise. To the extent that deposit rates respond less or slower than loan rates to tighter monetary policies, the resulting higher interest rate spreads would further stimulate banks demands for deposits. Either way, these estimates help account for loan volumes initially rising when the fed funds rate rises.

### B. The supply to banks of nontransactions deposits

Our estimated deposit supply functions begin in Table 4. As will the deposit demand estimates, we start with truncated and move toward more complete specifications. To allow for the effects of competition for bank deposits on the supply of deposits to each bank, we included the difference between deposit interest rate offered by each bank and by its local competitors. As noted above, we treated banks' own and relative deposit rates as endogenous. Column 1 included only banks' deposits, their own deposit interest rates, and the difference between banks' own and their local competitors' deposit interest rates. (We included constant terms in all specifications.) The estimated coefficients on both banks' own deposit rates and their rates relative to their competitors' rates were positive and strongly significant.

As we would expect, the quantities of deposits supplied rose with own and relative rates. Also, as we would expect, the magnitude of the effect of relative rates was much larger than that of own rates. It would seem to be relatively easy to reallocate funds across banks for the same type of account within the same locality. Doing so would not alter depositors' portfolios, except by bank name. By comparison, shifting funds from other types of bank accounts or assets or altering spending would be more difficult and more consequential.

The estimates in column 2 included the three quarterly seasonal dummy variables, each of which proved to have negative and highly significant coefficients. The estimated coefficient was especially large for the second quarter, perhaps due to households and businesses having made

income tax payments during April. The implied positive coefficient for the first calendar quarter may have resulted from businesses having received payments after New Year's Day for strong holiday retail sales just before then.

The lower returns and high volatility of the NASDAQ100 from about the middle of 2000 through 2002 coincided with enormous inflows of deposits into banks, a pattern that was repeated during the recent financial crisis. In column (3), we added the lagged value of the quarterly change in the NASDAQ100 stock price index. The coefficient of the NASDAQ variable is significantly negative, as expected: The larger were recent stock price gains, the lower that supplies of nontransactions deposits were estimated to be.

We also added the current value of the NCFI, which was constructed to rise and fall with tightness in financial conditions broadly, to the specification used for columns 3 and 4. Contrary to our expectations, column 3 shows strongly negative estimated effects. But, column 4 shows that once we included three more significant variables, the sign turns around. There we see that when financial conditions deteriorated (and thus the NFCI rose), depositors supplied more funds to banks, presumably funding those flows with sales of their stocks, bonds, and other assets. This is another example of where our estimates for some factors were affected substantially by whether or not we included other, statistically-significant factors.

The three, statistically-significant factors that we introduced in column 4 were the NBER recession dummy, the household distress index, and the home vacancy rate. The five factors introduced after column 2 reflected similar, but somewhat different, aspects of the real and the financial sectors of the economy. They also differed in timing. For example, household distress grew noticeably before the economy tipped into recessions. In this case, the indictor of, household distress apparently picked up symptoms before the economy became seriously ill. But, the similarities were significant enough that interpreting the effects of one of these five factors, while controlling for the effects of the others, requires more than the usual amounts of care.

While recessions might be associated with more difficulties and uncertainties, our estimates implied that recessions, cet. par., reduced deposit supplies. One source of the negative effect might have been that recessions were better indicators of reduced labor and business incomes. We also estimated the effects of household distress and of home vacancy rates to negative. Tied to households, and to housing in particular, increases in these two variables may well have signaled reduced household wealth, which could have reduced deposit supplies. Taken together, the results

in column 4 provide solid evidence about many of the factors which significantly affected supplies of nontransactions deposits.

## IX. Effects of bank sizes on deposit demands and supplies

Despite our having excluded the many, very-smallest (under $10 million in assets) banks and the few, very-largest (over $100 billion in assets) banks from our analysis, the assets of the remaining banks span a wide range. Even within this restricted range, banks may still differ in ways beyond what fixed effects capture (Jacewitz and Pogach, 2013).

To assess size-related differences across the banks that remained in our sample, we constructed three sub-samples by asset size. The group of "small banks" included banks that had less than $300 million in assets; the group of "medium-sized banks" had between $300 million and $1 billion in assets; the group of "large banks" had between $1 billion and $100 billion in assets. Table 5 shows the distributions of banks and of bank-quarters by bank sizes. Of our 7,189 banks, 80 percent were small, 15 percent were medium-sized, and 5 percent (384 banks) were large. After rounding to the nearest percent, the distribution of individual, bank-quarter observations was the same as that of banks.

Tables 6 and 7 show the estimates for the same specifications for demand and supply used for column 4 in Tables 3 and 4. The columns in Table 6 repeat the full-sample estimates in column 4 of Table 3 and show the estimates for sub-samples of small, medium, and large banks.

The deposit demand estimates were generally quite similar across bank sizes. Some of the discernible differences were to be expected. The estimated demand slopes were similar in magnitude and significance across sizes. The exception was that they were much weaker for our largest banks. While significant for all sizes, capital effects were estimated to be the largest for our largest banks. We estimated that both mortgage rates and credit spreads had effects that differed little across bank sizes.

As we would expect, and as shown in rows 5 and 6 of Table 6, the state-level leading indicators were most pertinent to deposit demands of small banks, while multi-state, region-level leading indicators were most strongly related, by magnitude and by significance, to deposit demands of medium-size and large banks. We found state-level leading indicators to have significant effects only on deposit demands for small banks. The large banks' coefficient estimate,

0.223, was more than quadruple that for small banks. Row 7 shows that state-level home vacancy rates affect demands of each group of banks, with the small banks being affected the least.

Results by bank size for deposit supplies are shown in Table 7. As we found for deposit demands, for deposit supplies slope estimates were large and significant for small and medium-size banks, but noticeably smaller and insignificant for our largest banks. On balance, nonetheless, we estimated deposit supplies to be upward-sloping.

In Table 7, for larger banks we used larger areas to calculate the deposit rates of banks' competitors. Before this we used each bank's local, 3-digit ZIP code to circumscribe the area of its local competitors. We still use that rule for small banks. For medium-sized banks, however, here we used two-digit ZIP codes; for large banks, we used one-digit ZIP codes. Thus, the area of local competition for a bank that had $500 million in assets and was headquartered in Chestnut Hill, MA 02467 would have been the Greater Boston Area and mostly areas in Massachusetts that were south and east of Boston. A bank headquartered in Boston that had $50 billion in assets would have had a local area that covered Maine to New Jersey but omitted the state of New York. We detected large, significant effects on deposit supplies to small and medium-sized banks; the effects at medium-sized banks were even larger than at small banks. But, like the own-rate effects for our largest banks, the effects of banks' own deposit rates relative to competitors' rates were not significant.

The estimated effects of the five economic and financial variables in rows 8 through 12 tended to be the same sign and significance by bank size as they were for our full sample of banks. One pattern that did emerge was that the estimated effects of these five variables tended to rise with bank size. For example, in row 9, tightening of financial conditions boosted supplies of deposits by (proportionally) more for medium-sized and large banks than for small banks.

## X. Effects of financial stress and crisis on deposits

We also considered whether the same deposit demand and supply functions prevailed during periods of financial stress, or even during financial crises, as prevailed during other, more-typical periods. To pursue this question, we formed three sub-samples on the basis of the readings of the National Financial Conditions Index, our financial conditions variable. We designated "regular" quarters as those with NFCI values 0.25, "stress " quarters as those with NFCI values between -0.25, and "crisis" quarters as those with NFCI values above zero. The data in Table 8

shows that nearly two-thirds (64%) of our sample consisted of bank-quarter observations when financial conditions were quite typical. 19 and 17 percent of our full sample came from stress and crisis quarters.

The results that we obtained from the full samples and samples delineated by financial conditions are shown in Table 9 for deposit demands and in Table 10 for deposit supplies. For both tables, we used the same, full list of variables that we used for prior tables. Perhaps reassuringly, column 2 of Table 9 shows that the results were not much different when the sample excluded the 1/3 of bank-quarter observations that occurred during periods of national financial stress or crisis. Including the periods of financial stress and of crisis, as shown in column 1, tended to produce coefficient magnitudes that were somewhat larger, but not dramatically larger. The largest difference between columns 1 and 2 was in the CD interest rate coefficient, which was less than 0.1 (in absolute value) during regular periods, but was nearly 3 during crisis periods. Comparing columns 3 and 4 to column 2 suggests that deposit demands during stress periods were more like those that prevailed during regular periods than they were like those that prevailed during crisis periods. At the same time, the estimated coefficients from the crisis sub-sample that were of the same sign as those from the regular sample. The basic difference between the regular and crisis estimates was that the magnitudes in column 4 tended to be noticeably larger (in absolute value) than they were in column 4. Thus, for crisis periods, our estimates imply that banks responded much more vigorously to the same stimuli.

In Table 9, we estimated significantly positive effects of credit spreads on banks' demands for deposits. The magnitudes of those effects was higher during stress periods and highest during crisis periods. In stress and in crisis periods, credit spreads are typically larger, due to some combination of larger expected losses and larger rewards per unit of loss risk (or "price of risk"). One possible explanation for larger credit-spread coefficients the variations during stress and crisis periods in the (national) credit spreads are due disproportionately increases in the rewards to risk-taking. Higher spreads then signal greater opportunities for banks to lend, therefore boosting their demands for deposits. The much-larger coefficient on the mortgage interest rate during crisis periods would be consistent with this interpretation of the credit spread coefficients.

Table 10 reveals that the supplies of deposits followed many of the same patterns. The results that we obtained when stress and crisis periods were included in our sample were quite similar to those we obtained when we omitted those periods. And, similar to demands, supplies

were much more sensitive to national economic and financial variables, financial conditions and recession, as shown in rows 7 and of Table 10. On the other hand, estimated responses of deposit supplies to state-level household distress and home vacancy rates were about the same for each period.

The crisis-periods results also present some puzzles. The coefficient related to competitors' deposit rates suddenly became negative, instead of positive, as did the NASDAQ100 variable. And, even the seasonal dummies' coefficients changed a lot. Thus, our specification is unlikely to have included and have correctly measured all the factors that affected deposit supplies then.

## XI. Reduced forms for deposit volumes and deposit interest rates

Our specifications of deposit demands and supplies in equations 1 and 2 imply reduced forms for our three endogenous variables: deposit volumes, deposit interest rates, and the difference between banks' own and their competitors' deposit interest rates, and deposit volumes. The three columns in Table 11 present the OLS estimates that allowed for bank-specific fixed effects of the implied reduced forms for our endogenous variables. Each reduced form included any exogenous variable that appeared in either deposit demand or deposit supply.

The signs of the reduced-form coefficient estimates in Table 11 are generally the same as those implied by the point estimates in column 4 of Table 3 and of Table 4. There are also some notable exceptions. Of course, the magnitudes, and thus the signs, of each of the estimated coefficients in Tables 3, 4, and 11 are random variables. So, too, are the reduced-form coefficient estimates implied by Tables 3 and 4. Although we discuss the reduced form estimates in Table 11 and how they compare with the point estimates implied by Tables 3 and 4, we don't have any way readily available to test statistically whether the directly-estimated differ from the implied reduced-form coefficients.

Column 1 of Table 11 contains the directly-estimated reduced form for the growth rate of nontransactions deposits. The significantly-positive capital estimate in row 1 comports with the positive effect on deposit demands in Table 3. While we would expect the demand increase to raise deposit rates, column 2 shows a negative response to an increase in our bank capital variables. The estimated capital coefficient for the difference between banks' own and their local competitors' deposit interest rates was very small and insignificant.

As we would expect, the estimated positive effect on deposit demand shown in Table 3 carried over to the reduced form estimates in Table 11, where both deposit volumes and interest rates rose with mortgage rates. The same conforming pattern held for the credit spread variable. We would generally expect relatively little, if any, effects on the cross-bank differences of deposit rates due to changes in the mortgage interest rate and in the credit spread because they were national measures. To varying degrees, the same considerations apply to the state-level and region-level variables. Therefore, we focus less on the results in column 3.

In column 1, we see that the home vacancy rate, the NASDAQ100 variable, the dummy for national economic recession quarters, and household distress had significant coefficients of the same sign implied by the supply and demand estimates in Table 3 and 4. On the other hand, the sign on financial conditions was negative whereas it was estimated to be positive in Table 4, and both leading indicator variables had insignificant effects in the reduced form for deposit volumes.

Similarly mixed signals came from the reduced form for banks' own CD interest rates in column 2. The leading indicators were now significant, but only one of the two had the expected, positive sign. The recession and household distress variables had the expected positive and significant effects on deposit rates, but financial conditions and the NASDAQ variable had significantly positive effects on deposit rates, which we didn't expect, either *a priori* or based on our estimates in Table 4.

## XII. Demands for and supplies of other types of deposits

Up to this point, we have focused on results for nontransactions deposits. Although sometimes only for shorter time periods, we also had data for other types of bank deposits: transactions, total, (estimated) insured, (estimated) uninsured, insured CDs, and uninsured CDs. Tables 12 and 13 show the results of applying the same demand and supply specifications that we used for Tables 3 and 4 (and elsewhere) to each of these six additional types of deposits. Column 1 repeats the results for nontransactions deposits shown in column 4 of Table 3 and of Table 4. Rather using approximations to the rates that pertained to each type of deposit, we used the same CD interest rate that we used earlier. Using the same CD interest rate facilitates comparison with earlier tables. There is the very real possibility, however, that the interest rates on particular types of deposits moved less or later than CD rates. They may also have declined more when CD rates declined than they rose when CD rates rose (Lee, et al., 2013).

Deposit demands were generally downward-sloping. The estimated deposit demands in Table 12 show higher CD interest rates were associated with declines in deposit volumes for each type of deposit, except that higher rates had an insignificant estimated effect on (total) uninsured deposits and had a significantly positive effect on (total) insured deposits. Columns 6 and 7 shows that the estimated effects of CD interest rates were the largest for the volumes of the two, CDs-only categories.

Having more capital generally strengthened deposit demands. Except for transactions deposits, each type of deposits was estimated to rise significantly when capital rose. And, the coefficient magnitudes were also quite similar across deposit types. Almost entirely, the effects of the aggregate-level variables in rows 3 through 7 were the same sign for the other types as they were for nontransactions deposits. And, two-thirds of the estimated coefficients for types other than nontransactions deposits were statistically significant as well. Thus, we generally found that similar forces affected the other types of deposits as affected nontransactions deposits.

Table 13 shows estimated supplies for each of the seven types of deposits. Like the demand estimates, many of the supply-side-coefficient estimates had the same signs and significance for the other types of deposits that they had for nontransactions deposits. When banks paid higher rates on their own CDs, they garnered more deposits. Other types of deposits also responded similarly to changes in broader factors, such as financial conditions, the NASDAQ100, recessions, and home vacancy rates. Table 13 indicates that most similar to the estimated supplies of nontransactions deposits were insured deposits. The similarities of columns 1 and 4 bolster our confidence in having regarded (total) nontransactions deposits and the CD interest rate as being predominately default-risk free.

Most notably different than those of nontransactions deposits, however, were the responses of transactions deposits. Whereas their demands were very similar, estimated supplies of transactions deposits looked more like complements to nontransactions deposits. The significant signs for transactions deposits were the opposite of those for nontransactions deposits, except for rows 2 and 10. While higher CD rates and the problems and stresses indicated by rows 6 through 8 each boosted nontransactions, they each reduced transactions deposits. Even the seasonal dummies reversed signs from column 1 to column 2. Thus, Table 12 suggests, not all that surprisingly, that households and businesses, and perhaps the public sector as well, moved funds

back and forth between their transactions and nontransactions accounts rather systematically in response to rates, broader real and financial conditions, and even the seasons.

## XIII. Conclusions

We addressed some of the questions that remain about the importance of various risks on banks' deposit volumes and deposit interest rates. In part because of our interest in the effects of greater risks to bank deposits, we addressed how much risks outside of banks have affected demands and supplies of deposits and thus have been reflected in deposit rates and flows.

We used instrumental variables methods to estimate separately bank deposit demand and supply functions. We estimated them for our full sample of banks over 1998-2010. We also estimated them by bank size, by aggregate financial conditions, and by types of bank deposits.

We found that banks' demands for deposits were reliably downward-sloping and that they faced equally-reliable, upward-sloping deposit supplies. We also detected strong inflows of deposits to banks in response to greater external risks. The slopes and risk sensitivities of depositors implied that deposit rates would rise if external risks abated or internal risks rose.

These result results contribute some explanation for two ongoing puzzles. By showing banks' demand responses, they demonstrate that greater risks to bank deposits should not be expected to raise deposit rates by as much. They also show how sluggish adjustments of deposit rates helps explain the tendency for tighter monetary policies to boost bank lending.

## References


Acharya, Viral V. and Nada Mora. (2015), "A Crisis of Banks as Liquidity Providers." *Journal of Finance*, 70.1: 1-43.

Becker, Bo (2007), "Geographical Segmentation of US Capital Markets", *Journal of Financial Economics*, *85*(1), 151-178.

Ben-David, Itzhak, Ajay Palvia, and Chetser Spatt. (2015), "Banks' Internal Capital Markets and Deposit Rates." *Fisher College of Business Working Paper Series,* August 2015: 1-53.

Bennett, Rosalind L, Hwa, Vivian, & Kwast, Myron L. Bank Failures During the Crisis: Who Was Expected to Lose and What Does This Mean for Market Discipline?

Berger, Allen N, & Bouwman, Christa HS. (2009). Bank liquidity creation. Review of Financial Studies, 22(9), 3779-3837.

Brown, Martin, Morkötter, Stefan, & Guin, Benjamin. (2014). Deposit Withdrawals from Distressed Commercial Banks: The Importance of Switching Costs.

Crone, Theodore M. (2000), "A New Look at Economic Indexes for the States in the Third District." *Business Review,* Federal Reserve Bank of Philadelphia. November-December 2000.

Delis, Manthos D. and Georgios P. Kouretas. (2011), "Interest Rates and Bank Risk-Taking." *Journal of Banking and Finance*. 35: 840-855.

Drechsler, Itamar, Alexi Savov, and Philipp Schnabl. (2016), "The Deposits Channel of Monetary Policy." *Social Science Research Network*, March 18, 2016: 1-58.

Egan, Mark, Ali Hortacsu, and Gregor Matvos. (2015), "Deposit Competition and Financial Fragility: Evidence from the US Banking Sector." *Chicago Booth Research Paper 15-33, Fama-Miller Working Paper*, March 11: 1-51.

Gilchrist, Simon and Egon Zakrajšek. (2012), "Credit Spreads and Business Cycle Fluctuations." *American Economic Review*, 102.4: 1692-1720.

Greene, William H. (2008), *Econometric Analysis*, 6th ed. Upper Saddle River, NJ: Prentice Hall.

Hausman, Jerry A. (1978), "Specification Tests in Econometrics." *Econometrica*, 46.6: 1251-1271.

Hughes, David G. (1970), "Predicting Bank Deposits and Loans." *Journal of Marketing Research*, 7.1:95-100.

Jacewitz, Stefan and Jonathan Pogach. (2014), "Deposit Rate Advantages at the Largest Banks." *Center for Financial Research, FDIC Working Paper Series, 2014-02*: 1-42.

Lee, Junsoo, Strazicich, Mark C, & Yu, Byung Chul. (2013). Asymmetric adjustments in the spread of lending and deposit rates: Evidence from extended threshold unit root tests. Review of Financial Economics, 22(4), 187-193.

Nishiyama, Yasuo. (2011). The term structure of CD rates and monetary policy transmission. Journal of Banking & Finance, 35(1), 82-94.

**Table 1 : Variable mnemonics, definitions, calculations, and sources**

| Variables | Definitions and Calculations | Sources |
|---|---|---|
| $nontransdeposits_{bt}$ | Nontransactions deposits at bank b at end of quarter t, percent change over previous quarter | Call Report item RCON2385. |
| $transdeposits_{bt}$ | Transactions deposits at bank b at end of quarter t, percent change over previous quarter | Call Report item RCON2215 |
| $totaldeposits_{bt}$ | Total (nontransaction and transaction) deposits at bank b at end of quarter t, percent change over previous quarter | Call Report items [RCON 2215 + RCON 2385] |
| $insdeposits_{bt}$ | Estimated insured deposits [= totaldeposits - noninsdeposits] at bank b at end of quarter t, percent change over previous quarter | - |
| $noninsdeposits_{bt}$ | Estimated uninsured deposits | Call Report items [RCON 2710 - (100 * RCON 2722)] |
| $insCDs_{bt}$ | Insured CDs at bank b at end of quarter t, percent change over previous quarter of quarter t, percent change over previous quarter | Call Report items [RCON6648 + (0.80) * RCON2604] |
| $uninsCDs_{bt}$ | Uninsured CDs at bank b at end of quarter t, percent change over previous quarter | Call Report items [(RCON 6648+ RCON 2604) - insCDs] |
| CD interest $rate_{bt}$ | Interest rate on new CDs that had a 6-month term to maturity and a minimum balance of $10,000 at bank b in quarter t | RateWatch |
| own-competitor CD interest $rate_{bt}$ | CD interest rate at bank b minus deposit rate of local-competitor banks in quarter t | RateWatch |
| mortgage interest $rate_{bt}$ | Interest rate on 30-year, fixed-rate, conventional home mortgages, National average, percent | Freddie Mac |
| credit $spread_t$ | Seasoned Baa corporate bond yield minus yield on 10-year Treasury debt, national, percent | Moody's |
| home vacancy rate $state_t$ | Home vacancy rate, by state, quarterly, percent | U.S. Census Bureau |
| household $distress_t$ | Index of household distress, by state | Credability |

**Table 1: Variable mnemonics, definitions, calculations, and sources (continued)**

| Variables | Definitions and Calculations | Sources |
|---|---|---|
| leading indicator state$_t$ | Index of leading economic indicators by state(1997q1=100) | Federal Reserve Bank of Philadelphia |
| leading indicator region$_t$ | Index of leading economic indicators by multi-state region (1997q1=100) | Federal Reserve Bank of Philadelphia |
| g1NASDAQ100$_{t-1}$ | NASDAQ100 stock price index, percent change over previous quarter, annualized, lagged one quarter | NASDAQ |
| recession$_t$ | Dummy variable = 1 if quarter contained a month during an NBER-dated, U.S. recession; = 0 otherwise | NBER |
| NFCI | National Financial Conditions Index<br>Positive (or negative) values of the NFCI were intended to signal that U.S. financial conditions were more (or less) restrictive than average. | Federal Reserve Bank of Chicago |
| q1, q2, q3, q4 | Dummy variables for calendar quarters | |
| total assets$_{bt}$ | Total assets of bank b at end of quarter t | Call Report item RCDF2170 |
| total risk-weighted assets$_{bt}$ | Total assets with 100% risk-weight | Call Report item RCDF5340 |
| total liabilities$_{bt}$ | Total liabilities of bank b at end of quarter t | Call Report item RCDF2950 |
| Capital $_{bt}$ | Bank capital = total assets – total liabilities | Call Report items [RCDF2170- RCDF2950] |
| g1capital ratio$_{bt}$ | Ratio of capital to total risk-weighted asset of bank b at end of quarter t, percent change over previous quarter | Call Report items [(RCDF2170-RCDF2950)//RCDF5340] |
| bank size$_{bt}$ | Small: Assets < $300 million<br>Medium-sized: $300 million ≤ Assets < $1 billion<br>Large: $1 billion ≤ Assets < $100 billion | Call Report item RCDF2170 |
| financial conditions$_t$ | | Federal Reserve Bank of Chicago |
| regular periods | Quarters when NCFI<-0.25 | |
| stress periods | Quarters when -0.25<=NCFI<= 0 | |
| crisis periods | Quarters when NCFI>0 | |

**Table 2 : Summary statistics for regression variables**

| | Regression Variable | Mean | Std. Dev. | 25% Quantile | Median | 75% Quantile |
|---|---|---|---|---|---|---|
| 1 | $g1nontransdeposit_t$ | 1.672 | 4.653 | -1.227 | 1.144 | 3.980 |
| 2 | CD interest $rate_{bt}$ | 2.932 | 1.456 | 1.617 | 2.667 | 4.250 |
| 3 | own-competitor CD interest $rate_{bt}$ | 0.106 | 0.476 | -0.138 | 0.107 | 0.362 |
| 4 | $g1capital\ ratio_{bt}$ | 0.095 | 82.082 | -3.772 | -0.203 | 3.260 |
| 5 | q1 | 0.265 | 0.441 | 0.000 | 0.000 | 1.000 |
| 6 | q2 | 0.244 | 0.429 | 0.000 | 0.000 | 0.000 |
| 7 | q3 | 0.246 | 0.431 | 0.000 | 0.000 | 0.000 |
| 8 | q4 | 0.245 | 0.430 | 0.000 | 0.000 | 0.000 |
| 9 | mortgage interest $rate_t$ | 6.374 | 0.820 | 5.840 | 6.240 | 6.880 |
| 10 | credit $spread_t$ | 2.585 | 0.915 | 1.820 | 2.470 | 2.880 |
| 11 | leading indicator $state_t$ | 98.477 | 1.487 | 97.799 | 98.743 | 99.459 |
| 12 | leading indicator $region_t$ | 98.390 | 1.321 | 97.844 | 98.744 | 99.319 |
| 13 | home vacancy rate $state_t$ | 2.042 | 0.689 | 1.600 | 2.000 | 2.500 |
| 14 | $g11NASDAQ100_{t-1}$ | 2.480 | 17.258 | -7.538 | 3.553 | 12.596 |
| 15 | financial $conditions_t$ | -0.250 | 0.677 | -0.707 | -0.390 | -0.170 |
| 16 | $recession_t$ | 0.186 | 0.389 | 0.000 | 0.000 | 0.000 |
| 17 | household distress $state_t$ | 77.496 | 5.666 | 74.349 | 78.152 | 81.801 |
| | Bank-quarters | 237,879 | | | | |
| | Banks | 7,189 | | | | |

This table reports the means, standard deviations, medians, and first and third quantiles of the regression variables, which were calculated over 1998q3-2010q1. The deposit rate was the interest rate each bank offered on its new CD accounts that had a 6-month term to maturity and a required minimum balance of $10,000. Local, state, and national data came from the FRED database, which we accessed via a website maintained by the Federal Reserve Bank of St. Louis.

**Table 3 : Estimated demand functions by banks for deposits**

**Dependent variable: g1nontransdeposit$_{bt}$**

| | **Independent Variables** | **(1)** | **(2)** | **(3)** | **(4)** |
|---|---|---|---|---|---|
| 1 | CD interest rate$_{bt}$ | 0.240*** (0.007) | 0.222*** (0.007) | -0.002 (0.035) | - 0.260*** (0.038) |
| 2 | g1capital ratio$_{bt}$ | | 0.070*** (0.003) | 0.065*** (0.003) | 0.060*** (0.003) |
| 3 | mortgage interest rate$_{t}$ | | | 0.202*** (0.026) | 0.388*** (0.029) |
| 4 | credit spread$_{t}$ | | | 0.295*** (0.016) | 0.549*** (0.025) |
| 5 | leading indicator state$_{t}$ | | | | 0.058*** (0.017) |
| 6 | leading indicator region$_{t}$ | | | | 0.079*** (0.020) |
| 7 | home vacancy rate state$_{t}$ | | | | - 0.219*** (0.020) |
| 8 | constant | 0.968*** (0.022) | 0.919*** (0.022) | -0.436*** (0.102) | -14.562*** (1.450) |
| | Prob. > F($\xi b = 0$) | 0.000 | 0.000 | 0.000 | 0.000 |
| | Bank-quarters | 237,879 | 237,879 | 237,879 | 237,879 |
| | Banks | 7,189 | 7,189 | 7,189 | 7,189 |

The table reports bank-fixed-effect, IV estimates of the effects of bank, local, state-level, and national variables on the flow of nontransactions deposits to banks. The dependent variable is quarterly percent change in each bank's nontransactions deposits. Robust standard errors are shown in parentheses. ***, **, and * indicate p-value<0.01, p-value<0.05, and p-value<0.10 respectively.

**Table 4 : Estimated supply functions to banks of deposits**

**Dependent variable: g1nontransdeposit$_{bt}$**

| | Independent Variable | (1) | (2) | (3) | (4) |
|---|---|---|---|---|---|
| 1 | CD interest rate$_{bt}$ | 0.361*** (0.009) | 0.347*** (0.009) | 0.315*** (0.009) | 0.308*** (0.012) |
| 2 | own-competitor CD interest rate$_{bt}$ | 5.152*** (0.280) | 4.377*** (0.272) | 2.811*** (0.252) | 2.682*** (0.266) |
| 3 | q2 | | -1.361*** (0.027) | -1.488*** (0.027) | -1.476*** (0.027) |
| 4 | q3 | | -0.694*** (0.027) | -0.776*** (0.027) | -0.798*** (0.027) |
| 5 | q4 | | -0.990*** (0.027) | -1.129*** (0.027) | -1.194*** (0.028) |
| 6 | g1NASDAQ100$_{t-1}$ | | | -0.012*** (0.001) | -0.013*** (0.001) |
| 7 | financial conditions$_t$ | | | -0.046*** (0.016) | 0.085*** (0.022) |
| 8 | recession$_t$ | | | | -0.256*** (0.039) |
| 9 | household distress state$_t$ | | | | -0.011*** (0.004) |
| 10 | home vacancy rate state$_t$ | | | | -0.311*** (0.022) |
| 11 | constant | 0.070 (0.052) | 0.937*** (0.054) | 1.298*** (0.053) | 2.902*** (0.298) |
| | Prob. > F($\xi b = 0$) | 0.000 | 0.000 | 0.000 | 0.000 |
| | Bank-quarters<br>Banks | 237,879<br>7,189 | 237,879<br>7,189 | 237,879<br>7,189 | 237,879<br>7,189 |

The table reports bank-fixed-effect, IV estimates of the effects of bank, local, state-level, and national variables on the flow of nontransactions deposits to banks. The dependent variable is quarterly percent change in each bank's nontransactions deposits. Robust standard errors are shown in parentheses. ***, **, and * indicate p-value<0.01, p-value<0.05, and p-value<0.10 respectively.

**Table 5 : Size distribution of sample banks**

| | Size | Assets | Banks | Percent | Bank-quarters | Percent |
|---|---|---|---|---|---|---|
| 1 | Small | $10 million - $300 million | 5,715 | 80 | 190,399 | 80 |
| 2 | Medium | $300 million - $1 billion | 1,090 | 15 | 35,140 | 15 |
| 3 | Large | $1 billion - $100 billion | 384 | 5 | 12,340 | 5 |
| 4 | All | $10 million - $100 billion | 7,189 | 100 | 237,879 | 100 |

**Table 6 : Estimated demand functions by banks for deposits, by bank size**

**Dependent variable: g1nontransdeposit$_{bt}$**

| | | Bank Size | | | |
|---|---|---|---|---|---|
| | | All | Small | Medium | Large |
| | **Independent variables** | **(1)** | **(2)** | **(3)** | **(4)** |
| 1 | CD interest rate$_{bt}$ | - 0.260*** | - 0.234*** | - 0.320*** | - 0.116 |
| | | (0.038) | (0.043) | (0.109) | (0.150) |
| 2 | g1capital ratio$_{bt}$ | 0.060*** | 0.040*** | 0.098*** | 0.142*** |
| | | (0.003) | (0.003) | (0.007) | (0.010) |
| 3 | mortgage interest rate$_{t}$ | 0.388*** | 0.380*** | 0.475*** | 0.229** |
| | | (0.029) | (0.032) | (0.078) | (0.110) |
| 4 | credit spread$_{t}$ | 0.549*** | 0.531*** | 0.597*** | 0.703*** |
| | | (0.025) | (0.028) | (0.062) | (0.102) |
| 5 | leading indicator state$_{t}$ | 0.058*** | 0.064*** | 0.004 | 0.059 |
| | | (0.017) | (0.019) | (0.044) | (0.076) |
| 6 | leading indicator region$_{t}$ | 0.079*** | 0.052** | 0.154*** | 0.223** |
| | | (0.020) | (0.023) | (0.053) | (0.092) |
| 7 | home vacancy rate state$_{t}$ | - 0.219*** | - 0.120*** | - 0.526*** | - 0.477*** |
| | | (0.020) | (0.024) | (0.057) | (0.093) |
| 8 | Constant | -14.562*** | -12.639*** | -16.156*** | -27.795*** |
| | | (1.445) | (1.645) | (3.784) | (6.386) |
| | Prob. > F($\xi b = 0$) | 0.000 | 0.000 | 0.000 | 0.000 |
| | Bank-quarters | 237,879 | 190,399 | 35,140 | 12,340 |
| | Banks | 7,189 | 6,401 | 1,883 | 615 |

The table reports bank-fixed-effect, IV estimates of the effects of bank, local, and national variables on flows of bank deposits, by bank size. Dependent variables were quarterly, percent changes in deposits. Table 1 describes the variables. Robust standard errors are shown in parentheses. ***, **, and * indicate p-value<0.01, p-value<0.05, and p-value<0.10 respectively.

**Table 7 : Estimated supply functions to banks of deposits, by bank size**

**Dependent variable: g1nontransdeposit$_{bt}$**

| | | Bank Size | | | |
|---|---|---|---|---|---|
| | | All | Small | Medium | Large |
| | **Independent variables** | **(1)** | **(2)** | **(3)** | **(4)** |
| 1 | CD interest rate$_{bt}$ | 0.308*** | 0.341*** | 0.198*** | 0.0099 |
| | | (0.012) | (0.014) | (0.031) | (0.062) |
| 2 | own-competitor CD interest rate$_{bt}$ | 2.682*** | 2.106*** | | |
| | | (0.266) | (0.259) | | |
| 3 | own-competitor CD interest rate$_{bt}$ 2-digit ZIP code | | | 5.395*** | |
| | | | | (1.103) | |
| 4 | own-competitor CD interest rate$_{bt}$, 1-digit ZIP code | | | | -1.211 |
| | | | | | (5.670) |
| 5 | q2 | -1.476*** | -1.583*** | -1.097*** | -0.910*** |
| | | (0.027) | (0.030) | (0.076) | (0.130) |
| 6 | q3 | -0.798*** | -0.902*** | -0.449*** | -0.165 |
| | | (0.027) | (0.029) | (0.073) | (0.140) |
| 7 | q4 | -1.194*** | -1.247*** | -1.098*** | -0.762*** |
| | | (0.028) | (0.030) | (0.076) | (0.120) |
| 8 | g1NASDAQ100$_{t-1}$ | -0.013*** | -0.013*** | -0.015*** | -0.013*** |
| | | (0.001) | (0.001) | (0.002) | (0.003) |
| 9 | financial conditions$_t$ | 0.085*** | 0.048** | 0.310*** | 0.431*** |
| | | (0.022) | (0.024) | (0.060) | (0.114) |
| 10 | recession$_t$ | -0.256*** | -0.178*** | -0.492*** | -0.424** |
| | | (0.039) | (0.043) | (0.106) | (0.286) |
| 11 | household distress state$_t$ | -0.011*** | -0.018*** | 0.027*** | 0.040** |
| | | (0.004) | (0.004) | (0.010) | (0.023) |
| 12 | home vacancy rate state$_t$ | -0.311*** | -0.188*** | -0.755*** | -0.669*** |
| | | (0.022) | (0.025) | (0.080) | (0.104) |
| 13 | constant | 2.902*** | 3.122*** | 1.248 | 0.843 |
| | | (0.298) | (0.339) | (0.805) | (2.040) |
| | Prob. > F($\xi$b = 0) | 0.000 | 0.000 | 0.000 | 0.000 |
| | Bank-quarters | 237,879 | 190,399 | 35,140 | 12,340 |
| | Banks | 7,189 | 6,401 | 1,883 | 615 |

The table reports bank-fixed-effect, IV estimates of the effects of bank, local, and national variables on flows of bank deposits, by bank size. Dependent variables were quarterly, percent changes in deposits. Table 1 describes the variables. Robust standard errors are shown in parentheses. ***, **, and * indicate p-value<0.01, p-value<0.05, and p-value<0.10 respectively.

**Table 8 : Distribution of bank-quarter observations, by U.S. financial conditions**

| | Financial conditions | Bank-quarters | Percent |
|---|---|---|---|
| 1 | Regular | 151,749 | 64 |
| 2 | Stress | 45,899 | 19 |
| 3 | Crisis | 40,231 | 17 |
| 4 | All | 237,879 | 100 |

This table reports the numbers of bank-quarter observations and their percent of all observations, by U.S. financial conditions. Regular U.S. financial conditions were the quarters when the NCFI had values below -0.25, stress quarters had values between -0.25 and 0.00 for the NCFI. Crisis quarters had values of the NCFI greater than 0.00.

**Table 9 : Estimated demand functions by banks for deposits, by U.S. financial conditions**

**Dependent variable: g1nontransdeposit$_{bt}$**

| | | U.S. Financial Condition | | | |
|---|---|---|---|---|---|
| | | All | Regular | Stress | Crisis |
| | **Independent variables** | **(1)** | **(2)** | **(3)** | **(4)** |
| 1 | CD interest rate$_{bt}$ | - 0.260*** | - 0.083* | 0.632*** | - 2.803*** |
| | | (0.04) | (0.046) | (0.163) | (0.302) |
| 2 | g1capital ratio$_{it}$ | 0.060*** | 0.053*** | 0.025*** | 0.032*** |
| | | (0.003) | (0.003) | (0.006) | (0.006) |
| 3 | mortgage interest rate$_{t}$ | 0.388*** | 0.283*** | -0.206* | 1.673*** |
| | | (0.029) | (0.036) | (0.111) | (0.175) |
| 4 | credit spread$_{t}$ | 0.549*** | 0.417*** | 1.083*** | 1.281*** |
| | | (0.025) | (0.039) | (0.110) | (0.061) |
| 5 | leading indicator state$_{t}$ | 0.058*** | 0.094*** | 0.098* | 0.005 |
| | | (0.017) | (0.023) | (0.050) | (0.045) |
| 6 | leading indicator region$_{t}$ | 0.079*** | 0.092*** | -0.129** | 0.333*** |
| | | (0.020) | (0.028) | (0.066) | (0.068) |
| 7 | home vacancy rate$_{st}$ | - 0.219*** | - 0.110*** | 0.134** | - 0.768*** |
| | | (0.02) | (0.028) | (0.058) | (0.091) |
| 8 | constant | -14.562*** | -19.106*** | 0.777 | -35.724*** |
| | | (1.450) | (2.030) | (4.882) | (5.307) |
| | Prob. > F($\xi b = 0$) | 0.000 | 0.000 | 0.000 | 0.000 |
| | Bank-quarters | 237,879 | 151,749 | 45899 | 40,231 |
| | Banks | 7,189 | 7,031 | 6,647 | 6,077 |

The table reports fixed-bank-effects, instrumental variables (IV) estimates of the effects of bank-specific, market-specific, and national variables on nontransactions deposits flows, by U.S. financial conditions on the demand by banks for deposits. The dependent variable is the quarterly percent change in each bank's nontransactions deposits. The variables are described in Table 1. Robust standard errors are shown in parentheses. ***, **, and * indicate p-value<0.01, p-value<0.05, and p-value<0.10 respectively.

**Table 10 : Estimated supply functions to banks of deposits, by U.S. financial conditions**

**Dependent variable: g1nontransdeposit$_{bt}$**

| | | U.S. Financial Condition | | | |
|---|---|---|---|---|---|
| | | All | Regular | Stress | Crisis |
| | **Independent variables** | **(1)** | **(2)** | **(3)** | **(4)** |
| 1 | CD interest rate$_{bt}$ | 0.308*** | 0.439*** | 0.609*** | 4.285*** |
| | | (0.012) | (0.019) | (0.086) | (1.575) |
| 2 | own-competitor CD interest rate$_{bt}$ | 2.682*** | 3.370*** | 6.001*** | -3.562** |
| | | (0.266) | (0.374) | (2.257) | (1.622) |
| 3 | q2 | -1.476*** | -1.397*** | -2.193*** | 1.5331 |
| | | (0.027) | (0.034) | (0.322) | (1.407) |
| 4 | q3 | -0.798*** | -0.505*** | -1.029*** | -2.527*** |
| | | (0.027) | (0.034) | (0.158) | (0.406) |
| 5 | q4 | -1.194*** | -0.980*** | -1.358*** | -11.610*** |
| | | (0.028) | (0.038) | (0.196) | (4.014) |
| 6 | g1NASDAQ100$_{t-1}$ | -0.013*** | -0.008*** | -0.011*** | 0.129*** |
| | | (0.001) | (0.001) | (0.003) | (0.048) |
| 7 | financial conditions$_{t}$ | 0.085*** | -1.350*** | 4.128*** | 6.921*** |
| | | (0.022) | (0.156) | (1.449) | (2.642) |
| 8 | recession$_{t}$ | -0.256*** | -0.349*** | - | -7.064** |
| | | (0.039) | (0.055) | | (2.915) |
| 9 | household distress state$_{t}$ | -0.011*** | -0.040*** | -0.023 | -0.023 |
| | | (0.004) | (0.006) | (0.015) | (0.043) |
| 10 | home vacancy rate state$_{t}$ | -0.311*** | -0.426*** | -0.314*** | -0.494*** |
| | | (0.022) | (0.036) | (0.078) | (0.092) |
| 11 | constant | 2.902*** | 4.076*** | 2.900** | -2.158 |
| | | (0.298) | (0.446) | (1.258) | (5.436) |
| | Prob. > F($\xi$b = 0) | 0.000 | 0.000 | 0.000 | 0.000 |
| | Bank-quarters | 237,879 | 151,749 | 45,899 | 40,231 |
| | Banks | 7,189 | 7,031 | 6,647 | 6,077 |

The table reports results from fixed-effects instrumental variables estimations of the effects of bank- and market-specific characteristics on nontransactions deposits deposit flows by economic condition on both the supply and the demand side. The dependent variable is the quarterly change in nontransactions deposits (in %). For the notation of the variables see Table 1. Robust standard errors are shown in parentheses. ***, **, and * indicate p-value<0.01, p-value<0.05, and p-value<0.10 respectively.

**Table 11 : Estimated reduced forms for banks' deposit amounts and deposit interest rates**

| | | Dependent variable: | | |
|---|---|---|---|---|
| | | **g1nontransdeposits$_{it}$** | **Own CD interest rate$_{bt}$** | **own-minus-competitor CD interest rate$_{bt}$** |
| | **Independent variables** | **(1)** | **(2)** | **(3)** |
| 1 | g1capital ratio$_{it}$ | 0.051*** | -0.002*** | 0.000 |
| | | (0.003) | (0.000) | (0.000) |
| 2 | mortgage interest rate$_t$ | 0.204*** | 0.716*** | -0.005** |
| | | (0.009) | (0.001) | (0.001) |
| 3 | credit spread$_t$ | 0.327*** | 0.340*** | 0.078*** |
| | | (0.031) | (0.004) | (0.004) |
| 4 | leading indicator state$_t$ | -0.058 | -0.052*** | -0.010*** |
| | | (0.018) | (0.003) | (0.003) |
| 5 | leading indicator region$_t$ | -0.029 | 0.123*** | -0.001 |
| | | (0.022) | (0.005) | (0.004) |
| 6 | home vacancy rate state$_t$ | -0.279*** | -0.146*** | 0.021*** |
| | | (0.026) | (0.005) | (0.005) |
| 7 | q2 | -1.412*** | 0.086*** | 0.000 |
| | | (0.037) | (0.002) | (0.001) |
| 8 | q3 | 0.895*** | 0.040*** | -0.010*** |
| | | (0.034) | (0.001) | (0.001) |
| 9 | q4 | -1.118*** | -0.023*** | 0.011** |
| | | (0.041) | (0.002) | (0.001) |
| 10 | g1NASDAQ100$_{t-1}$ | -0.011*** | 0.002*** | 0.000*** |
| | | (0.001) | (0.000) | (0.000) |
| 11 | financial conditions$_t$ | -0.129** | 0.116*** | -0.091*** |
| | | (0.036) | (0.004) | (0.004) |
| 12 | recession$_t$ | -0.071*** | 0.100*** | 0.028*** |
| | | (0.037) | (0.004) | (0.004) |
| 13 | household distress state$_t$ | -0.009** | 0.009*** | -0.001** |
| | | (0.004) | (0.001) | (0.001) |
| 14 | constant | -1.228 | -9.751*** | 0.919*** |
| | | (1.653) | (0.310) | (0.278) |
| | Prob. > F($\xi$b = 0) | 0.000 | 0.000 | 0.000 |
| | Bank-quarters | 237,879 | 237,879 | 237,879 |

The table reports results of OLS estimates (with bank fixed effects) with the three endogenous variables as dependent variables and all exogenous variables included as regressors. Robust standard errors in brackets. For the notation of the variables see Table 1. Robust standard errors are shown in parentheses. ***, **, and * indicate p-value<0.01, p-value<0.05, and p-value<0.10 respectively.

**Table 12 : Estimated demand functions by banks for deposits, by category of deposits**

| | | Dependent variable: | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **g1nontrans-depositsbt** | **g1trans-depositsbt** | **g1total-depositsbt** | **g1insdepositsbt** | **g1unins-depositsbt** | **g1insCDsbt** | **g1uninsCDsbt** |
| | **Independent variables** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| 1 | CD interest ratebt | -0.260*** | -0.119** | -0.317*** | 0.444*** | 0.042 | -0.903*** | -0.430*** |
| | | (0.043) | (0.060) | (0.038) | (0.036) | (0.087) | (0.049) | (0.068) |
| 2 | g1capital ratiobt | 0.060*** | -0.086*** | 0.013*** | 0.037*** | 0.000 | 0.069*** | 0.065*** |
| | | (0.003) | (0.006) | (0.004) | (0.003) | (0.006) | (0.003) | (0.005) |
| 3 | mortgage interest ratet | 0.388*** | 0.014 | 0.331*** | -0.298*** | -0.016 | 1.083*** | 0.653*** |
| | | (0.032) | (0.045) | (0.028) | (0.026) | (0.066) | (0.037) | (0.051) |
| 4 | credit spreadt | 0.549*** | 0.716*** | 0.722*** | 0.119*** | 0.446*** | 0.420*** | 0.386*** |
| | | (0.026) | (0.041) | (0.024) | (0.022) | (0.057) | (0.030) | (0.043) |
| 5 | leading indicator statet | 0.058*** | 0.104*** | 0.099*** | 0.060*** | 0.011 | -0.051** | -0.022 |
| | | (0.018) | (0.027) | (0.016) | (0.016) | (0.037) | (0.022) | (0.030) |
| 6 | leading indicator regiont | 0.079*** | 0.310*** | 0.190*** | -0.013 | 0.267*** | -0.037 | 0.008 |
| | | (0.021) | (0.031) | (0.019) | (0.019) | (0.044) | (0.026) | (0.035) |
| 7 | home vacancy rate statet | -0.219*** | -0.391*** | -0.363*** | -0.014 | -0.515*** | 0.014 | -0.106*** |
| | | (0.024) | (0.032) | (0.021) | (0.019) | (0.046) | (0.027) | (0.037) |
| | Prob. > F(ξb = 0) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Bank-quarters | 237,714 | 194,905 | 236,287 | 232,802 | 141,195 | 230,407 | 190,910 |
| | Banks | 7,024 | 6,861 | 7,008 | 6,995 | 6,791 | 6,975 | 6,910 |

This tables report bank-fixed-effect, IV estimates of the effects of bank, local, and national variables on flows of bank deposit demand, by deposit category. Dependent variables were quarterly, percent changes in deposits. Table 1 describes the variables. Robust standard errors are shown in parentheses. ***, **, and * indicate p-value<0.01, p-value<0.05, and p-value<0.10 respectively.

**Table 13 : Estimated supply functions to banks of deposits, by category of deposits**

| | | Dependent variable: | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | g1nontrans-deposits$_{bt}$ | g1trans deposits$_{bt}$ | g1total deposits$_{bt}$ | g1ins deposits$_{bt}$ | g1unins deposits$_{bt}$ | g1insCDs$_{bt}$ | g1uninsCDs$_{bt}$ |
| | **Independent variables** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| 1 | CD interest rate$_{bt}$ | 0.308*** | -0.118*** | 0.142*** | 0.152*** | -0.044* | 0.595*** | 0.475*** |
| | | (0.013) | (0.018) | (0.012) | (0.010) | (0.025) | (0.015) | (0.020) |
| 2 | own-competitor deposit rate$_{bt}$ | 2.682*** | 3.961*** | 3.127*** | 1.095*** | 3.468*** | -2.170*** | -1.101** |
| | | (0.285) | (0.391) | (0.261) | (0.231) | (0.598) | (0.317) | (0.448) |
| 3 | q2 | -1.476*** | 0.466*** | -0.663*** | -0.861*** | -0.137* | -0.914*** | -1.060*** |
| | | (0.036) | (0.069) | (0.041) | (0.030) | (0.076) | (0.031) | (0.048) |
| 4 | q3 | -0.798*** | 0.308*** | -0.216*** | -0.085*** | 0.084 | -0.410*** | -0.454*** |
| | | (0.034) | (0.065) | (0.038) | (0.029) | (0.072) | (0.032) | (0.047) |
| 5 | q4 | -1.194*** | 4.040*** | 1.115*** | 0.197*** | 0.856*** | -1.040*** | -1.014*** |
| | | (0.040) | (0.086) | (0.053) | (0.035) | (0.081) | (0.032) | (0.050) |
| 6 | g1NASDAQ100$_{t-1}$ | -0.013*** | 0.000 | -0.011*** | -0.001*** | -0.010*** | -0.023*** | -0.020*** |
| | | (0.001) | (0.001) | (0.001) | (0.000) | (0.001) | (0.001) | (0.001) |
| 7 | financial conditions$_t$ | 0.085*** | -0.452*** | -0.075*** | 0.122*** | 0.017 | 0.177*** | 0.298*** |
| | | (0.023) | (0.034) | (0.020) | (0.019) | (0.049) | (0.026) | (0.038) |
| 8 | recession$_t$ | -0.256*** | 0.907*** | 0.101*** | -0.219*** | -0.220** | -0.659*** | -0.754*** |
| | | (0.037) | (0.056) | (0.033) | (0.031) | (0.086) | (0.043) | (0.064) |
| 9 | household distress state$_t$ | -0.011** | 0.020*** | 0.002 | -0.072*** | 0.035*** | -0.033*** | -0.026*** |
| | | (0.004) | (0.006) | (0.004) | (0.003) | (0.009) | (0.005) | (0.007) |
| 10 | home vacancy rate state$_t$ | -0.311*** | -0.497*** | -0.464*** | -0.406*** | -0.565*** | 0.188*** | -0.073* |
| | | (0.029) | (0.039) | (0.027) | (0.021) | (0.053) | (0.030) | (0.040) |
| | Prob. > F($\xi b = 0$) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Bank-quarters | 237,714 | 194,905 | 236,287 | 232,802 | 141,195 | 230,407 | 190,910 |
| | Banks | 7,024 | 6,861 | 7,008 | 6,995 | 6,791 | 6,975 | 6,910 |

This table report bank-fixed-effect, IV estimates of the effects of bank, local, and national variables on flows of bank deposit supply, by deposit category. Dependent variables were quarterly, percent changes in deposits. Table 1 describes the variables. Robust standard errors are shown in parentheses. ***, **, and * indicate p-value<0.01, p-value<0.05, and p-value<0.10 respectively.

**Figure 1. Supply of and Demand for Bank Deposits**

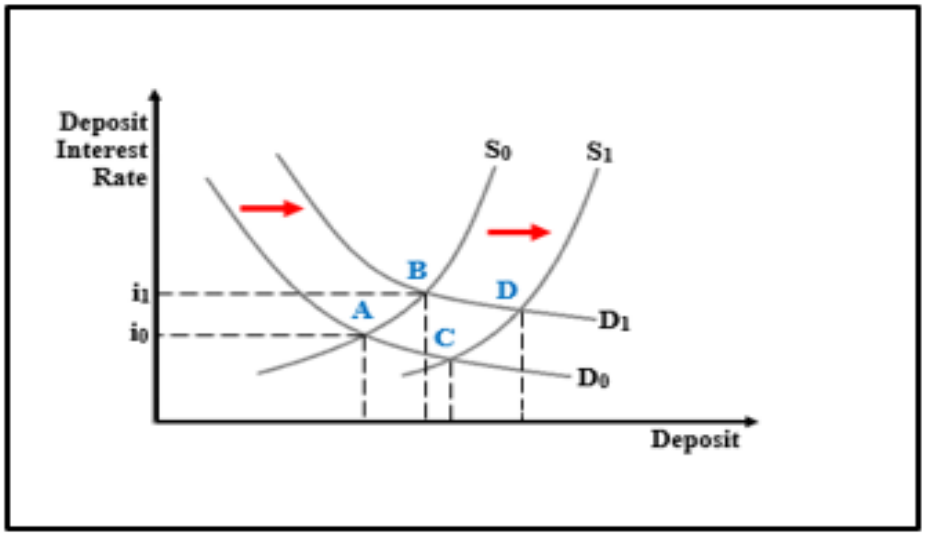


**Figure 2. Nontransaction and transaction accounts (deposit dollar amounts)**

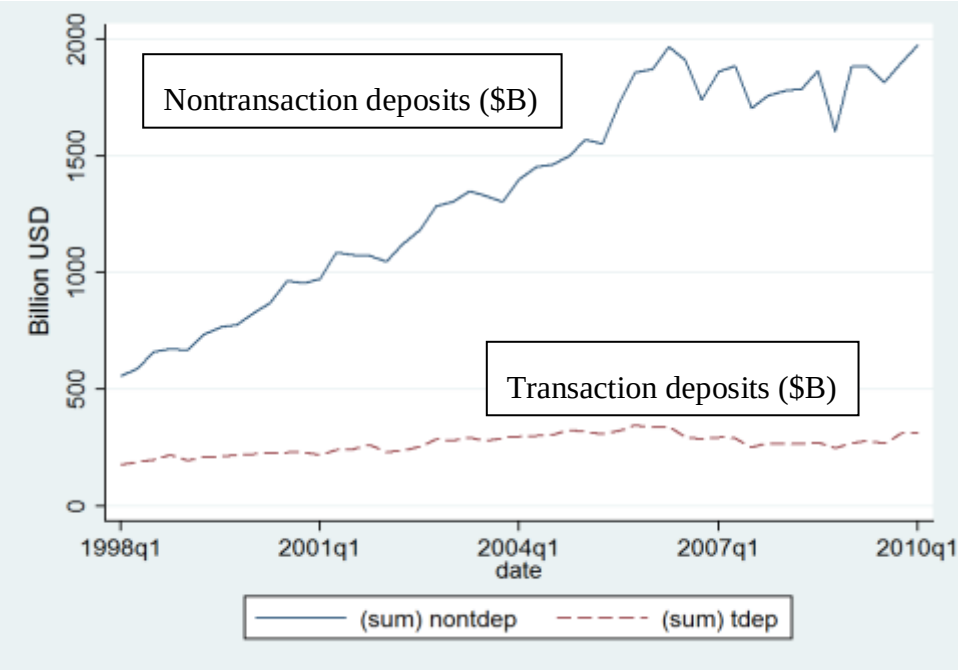



**Figure 3. Estimated insured and total uninsured total deposit (deposit amounts)**

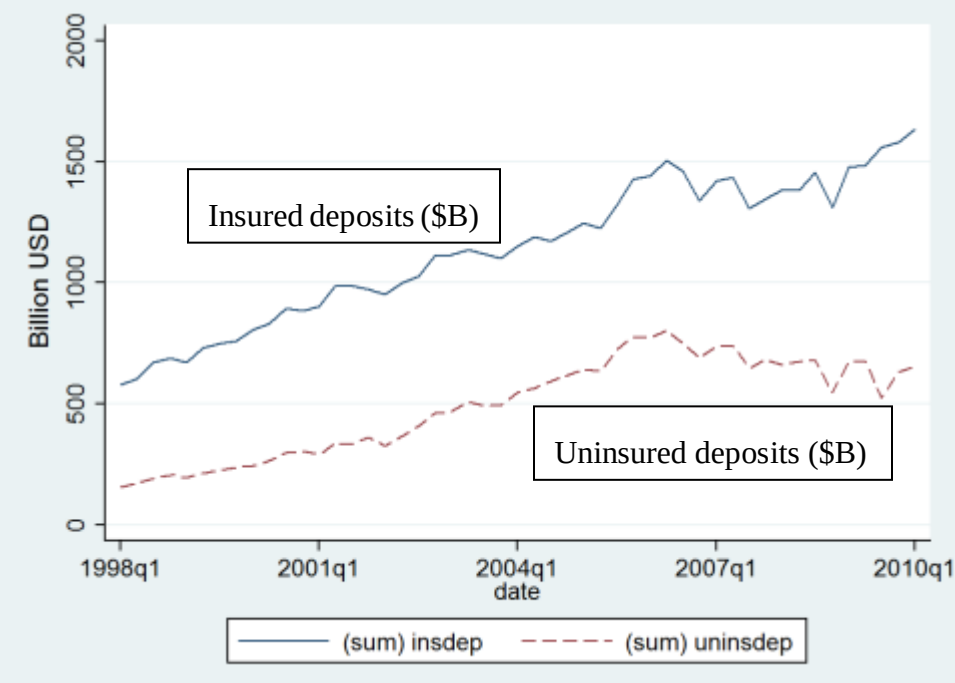


**Figure 4. Insured and uninsured total deposits (percent of total deposits)**

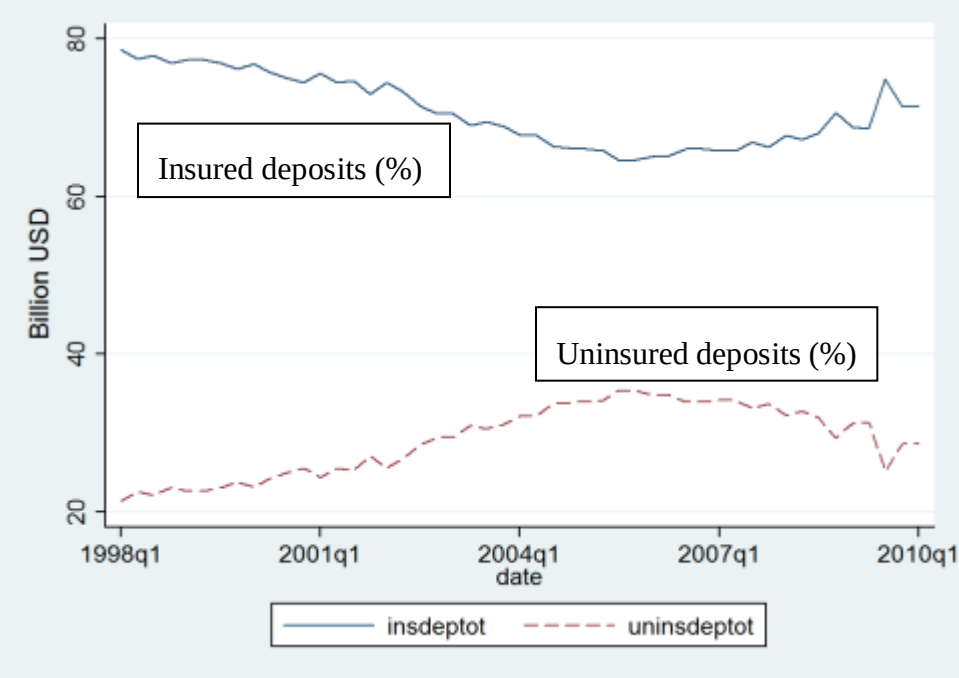



**Figure 5. Total insured CDs and total uninsured CDs (deposit amounts)**

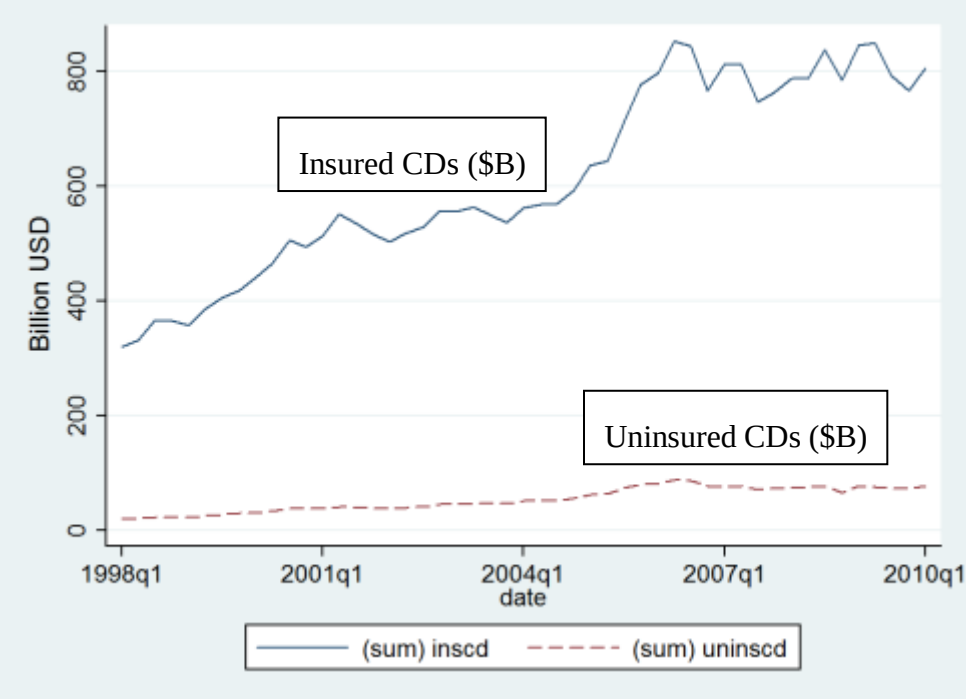


**Figure 6. Insured and uninsured CDs (percent of total deposits)**

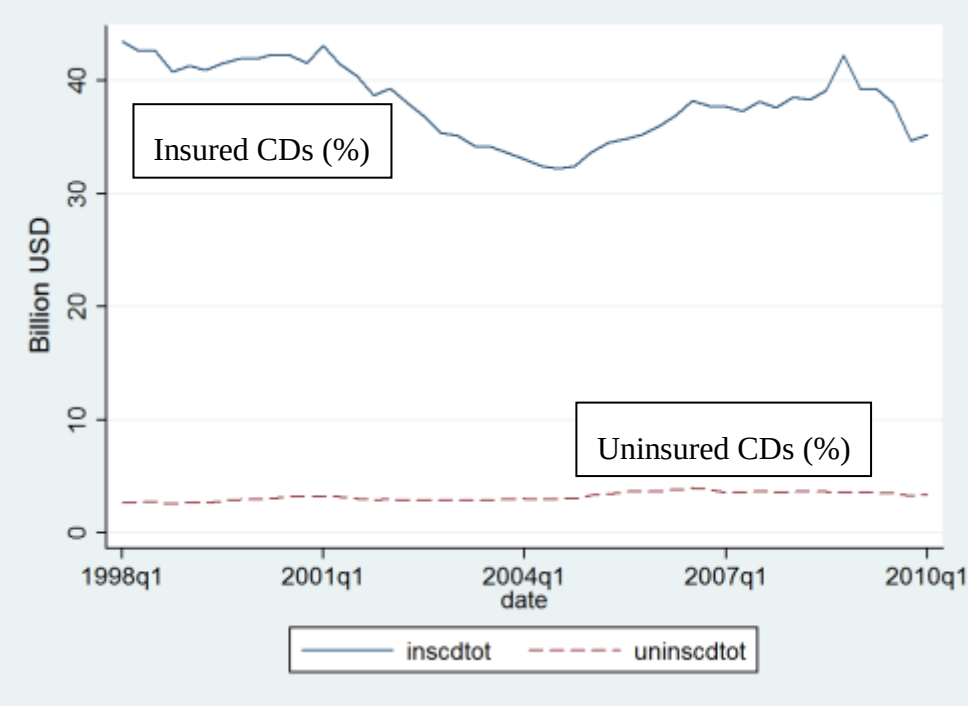
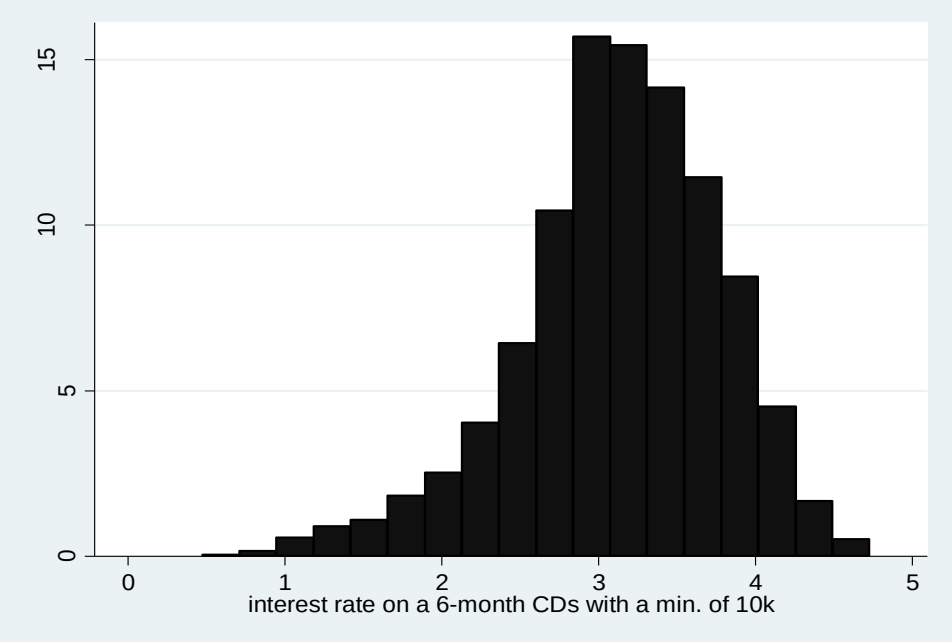


**Figure 7. Distribution of interest rates on new CDs that had 6-month terms to maturity and required minimum balances of $10,000: 2006Q1**




\

**Figure 8. Distribution of interest rates on new CDs that had 6-month terms to maturity and required minimum balances of $10,000: 2009Q1**

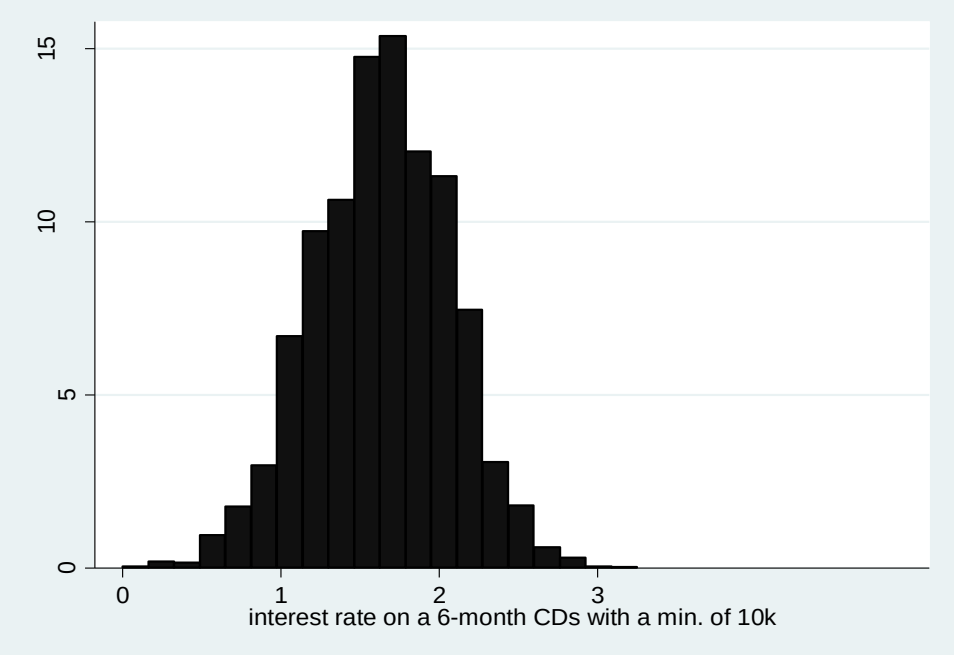


**Figure 9. Deposit rates on new, 6-month CDs that had minimum balances of $10,000**

**(Average across sample banks, end-of-quarter months, 1998Q1– 2010Q1)**