Dynamic Depositor Discipline in U.S. Banks

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Abstract

This paper investigates the presence of depositor discipline in the U.S. banking sector. We test whether depositors penalize (discipline) banks for poor performance by withdrawing their uninsured deposits. While focusing on the movements in uninsured deposits, we also account for the possibility that banks may be forced to pay a risk premium in the form of higher interest rates to induce depositors not to withdraw their uninsured deposits. Our results support the existence of depositor discipline: a weak bank may not necessarily be able to stop a deposit drain by raising its uninsured deposit interest rates.

I. INTRODUCTION

A. Motivation

Most countries deal with bank insolvencies on a relatively regular basis.[1] Generally speaking, most countries have their share of bad banks. If widespread, bank failures are typically very costly, ranging anywhere from a few percentage points of GDP to as high as 50 percent of GDP.[2] In an effort to minimize such costly occurrences, policymakers and regulators have turned their attention increasingly to market discipline as a tool to induce banks to conduct their business in a transparent, effective, and sound manner.[3] In the banking sector, one form of market discipline is depositor discipline—the ability of depositors to penalize (discipline) banks for poor performance by withdrawing deposits. Investors in bank liabilities, such as uninsured deposits or subordinated debt, actively reward or punish banks for their relative performance. In the case of excessive risk taking, depositors can demand higher yields on their liabilities or withdraw their funds. By making risk taking more costly for banks, depositor discipline should curb banks' incentives to take excessive risk and hence should contribute to the stability of the financial system.

Depositor discipline strengthens the banking system by making bank managers accountable for their performance and depositors responsible for their investment choices. It helps reduce the likelihood that depositors (or their insurers) will implicitly subsidize the risks taken by their banks and hence mitigates moral hazard. But an extreme form of depositor discipline can lead to bank runs, which, if widespread, carry costly consequences for the economy as a whole.[4] As a result, few countries have been willing to rely fully on depositor discipline as an instrument to curb excessive risk-taking behavior on the part of banks, at least not without

[1] In the United States., the 1986–95 savings and loan (S&L) crisis resulted in the closure of approximately 50 percent of all federally insured thrift institutions (Curry and Shibut, 2002). Outside the United States, since 1980 a number of systemically important countries, such as Canada, Sweden, Switzerland, and Japan, have been confronted with major problems involving significant numbers of bank failures (Bartholomew and Gup, 1999).

[2] The budgetary cost of the 1997 Thai and Korean banking crises are estimated to have reached 30 percent of GDP, while the cost of the Indonesian banking crisis in the same year is believed to have reached up to 50 percent of GDP (Caprio, 2001).

[3] In the third consultative paper of the New Basel Accord, the Basel Committee on Banking Supervision (2003) has designated market discipline as part of the third pillar of a sound financial architecture, after minimum capital requirements and supervisory review process.

[4] The U.S. banking crisis of the early 1930s showed the magnitude and degree of danger posed by the phenomenon of widespread bank runs.

offering some form of deposit protection.[5] In the United States, the Federal Deposit Insurance Corporation (FDIC) guarantees all deposits up to $100,000 per depositor. Deposit insurance, however, weakens depositors' monitoring incentives and undermines depositor discipline.[6] Demirgürç-Kunt and Detragiache (2002), for example, provide evidence that explicit deposit insurance tends to increase the likelihood of banking crises in a sample of 61 countries over the years 1980–1997.[7]

In this paper, we investigate the presence of depositor discipline in the U.S. banking sector. The main hypothesis is that depositors withdraw uninsured deposits when bank performance deteriorates. Using panel data on bank-specific information, we test whether depositor discipline (or withdrawal of deposits) is linked to bank performance. We also account for the dynamic relationship between the price and quantity of uninsured deposits by controlling for banks' ability to increase interest rates when facing a possible deposit drain. Our goal is to capture the dynamic interactions between price (interest rates) and quantity movements in uninsured deposits.

When the quality of a bank's fundamentals changes, both the demand and supply of uninsured deposits may be shifting simultaneously, obscuring the effect of depositor discipline. When bank fundamentals deteriorate, depositors withdraw their uninsured deposits, shifting the supply curve of uninsured deposits upward. As a result, the equilibrium moves upward along the bank's demand curve, raising the price of deposits and lowering their quantity. In response, banks may offer a higher deposit interest rate to induce depositors not to withdraw their uninsured deposits. This would shift the demand curve upward, raising both the price and quantity of uninsured deposits. In the new equilibrium, the price of uninsured deposits is higher, with an ambiguous effect on the quantity of uninsured deposits. Clearly, depositors' reaction and banks' response is a jointly determined process.

To account for these dynamic processes, we use the generalized-method-of-moments (GMM) estimators developed by Arellano and Bond (1991) for dynamic panel data. This generation of GMM models has the marked advantage that it is specifically designed to handle autoregressive properties in the dependent variable (uninsured deposits) and endogeneity issues between the dependent variable and an explanatory variable (the interest rate of uninsured deposits).

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[5] Demirgüç-Kunt and Sobaci (2001) provide a data set on the existence and extent of deposit insurance schemes across countries. For general reviews of deposit insurance systems around the world see also Demigürç-Kunt and Kane (2002) and Garcia (2000).

[6] Some people have argued that the U.S. deposit insurance plan is responsible for the relatively small number of bank failures that has occurred since the creation of the FDIC (see discussion in FDIC, 1998). See also U.S. Department of the Treasury (1991) and U.S. Congressional Budget Office (1991). Kane (1992) provides evidence of the role of deposit insurance in the S & L crisis, and Kaufman (1995) discusses the impact of deposit insurance on bank capital.

[7] In a related paper, Demirgüç-Kunt and Huizinga (1999) find that banks' funding costs tend to be lower and less sensitive to fluctuations in bank fundamentals in countries with explicit deposit insurance.

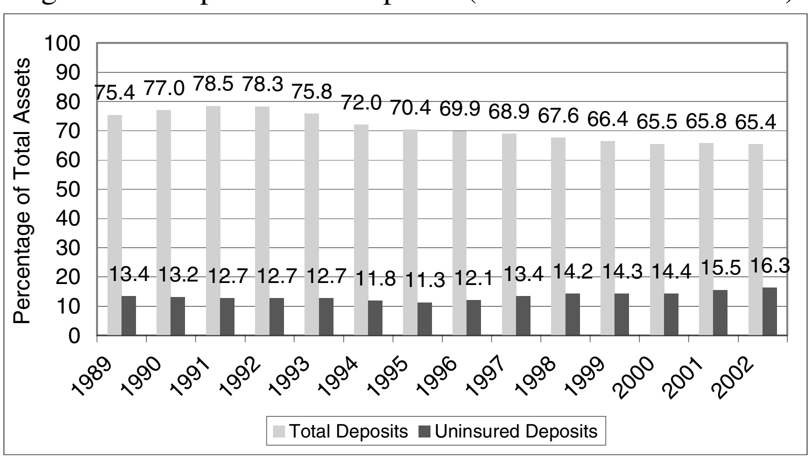
Overall, our results support our choice of modeling interest rates as an endogenous mechanism. We find that banks can raise their level of uninsured deposits (as a share of total deposits) by raising their interest rates, although they can do so only at a relatively high price. We also find that, for a given increase in the interest rate of uninsured deposits, good banks attract relatively more uninsured deposits than the average bank, whereas bad banks may not necessarily be able to raise uninsured deposits.

Note that while our empirical evidence supports the existence of depositor discipline (depositors recognize and penalize a bank's bad performance), our results do not allow us to say anything about the effectiveness of depositor discipline (that is, the degree to which depositor discipline manages to reduce bank managers' risk tolerance). This limitation, however, is a common feature of research in this area. We will return to this issue in Section I.C.

B. Deposit Structure in the U.S. Banking Sector

Deposits, including uninsured deposits, play an important role as a funding source for banks. In 2002, total deposits represented over 65 percent of U.S. banks' total assets.[8] This is shown in Figure 1. Although the share of total deposits to total assets has been falling progressively since 1992, this trend is primarily due to the substitution of insured deposits for non-deposit liabilities. The share of uninsured deposits to total assets, on the other hand, has been increasing sharply since 1995, rising from 11 percent in 1995 to 16 percent in 2002.

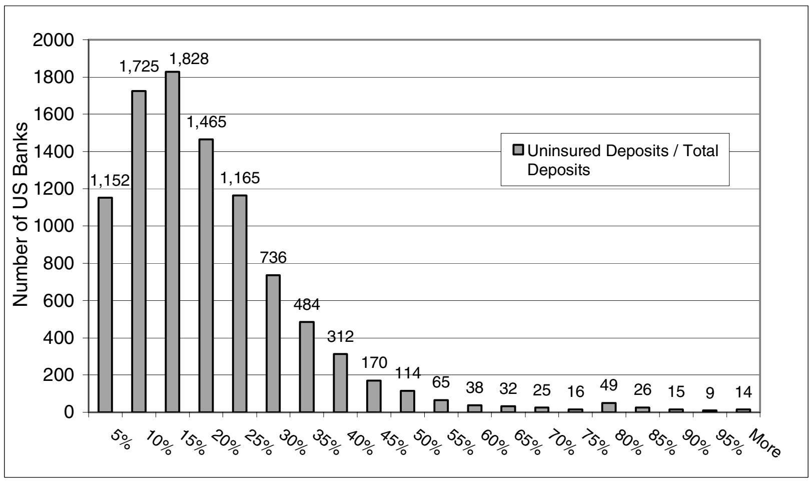
Figure 1. Composition of Deposits (as Share of Total Assets)



[8] Total deposits include domestic deposits (insured and uninsured) and foreign deposits if applicable. These data are published in the "Quarterly Condition and Income Reports," generally knows as "Call Reports." The estimate for uninsured deposits is taken from the banks' self-reported data published in the same source.

Despite the relatively large deposit insurance coverage, only 12.2 percent of all U.S. banks (1,152 banks) have less than 5 percent of their deposits that are uninsured; 22.3 percent of all banks (or 2,105 banks) hold more than 20 percent of uninsured deposits (as a share of total deposits); and 4 percent of all banks (or 403 banks) have more than 40 percent of their deposits in the form of uninsured deposits. At the far end of the spectrum, 25 banks hold more than 90 percent of their deposits in the form of uninsured deposits.[9] The distribution of uninsured deposits (as a share of total deposits) across the U.S. banking sector is illustrated in Figure 2.

Figure 2. Histogram of Uninsured Deposits, 2002



Most uninsured deposits are held by the largest banks in the United States. Over 73 percent of uninsured deposits are held by the 172 banks that hold more than $5 billion in assets. The smallest banks (4,893 banks with less than $100 million assets) hold only 3 percent of total uninsured deposits. The remaining 24 percent of uninsured deposits are held in 4,386 banks with assets between $100 million and $5 billion. The distribution of uninsured deposits by bank size is shown in Figure 3, while the frequency of banks by bank size is illustrated in Figure 4.

[9] These banks tend to be primarily commercial banks and, to a lesser extent, consumer banks and trust companies.

Figure 3. Uninsured Deposits (in U.S. dollars) by Bank Size

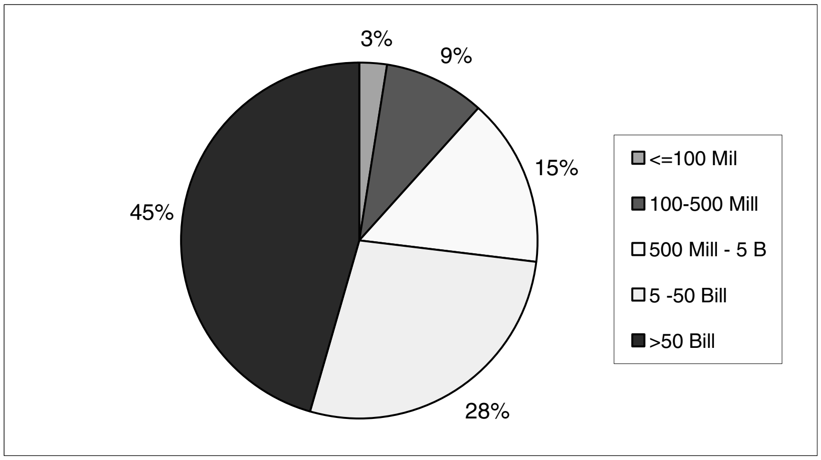
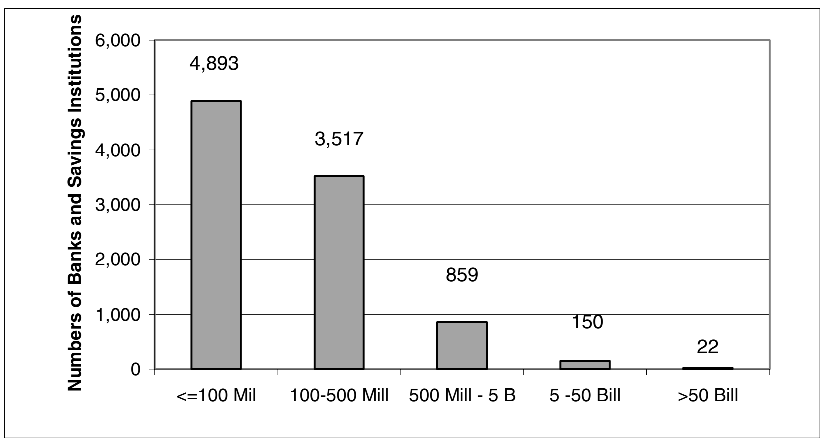
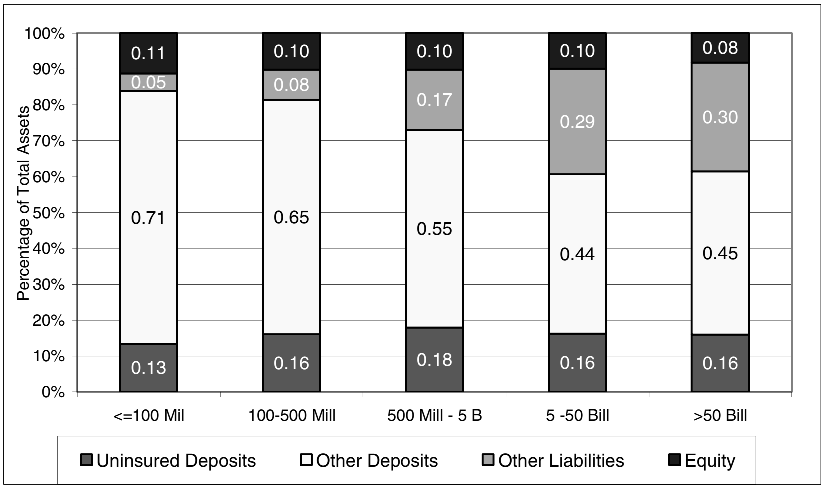


Figure 4. Number of U.S. Banks by Size Category



It is interesting to note that the size of the bank does not significantly alter its reliance on uninsured deposits for funding. According to Figure 5, small banks (with total assets up to $100 million) fund on average 13 percent of assets with uninsured deposits; banks with assets between $5 billion and $50 billion fund 16 percent of assets with uninsured deposits. However, the difference between small and large banks is slightly larger if we look at uninsured deposits as a share of total deposits because total deposits represent a small funding source for larger banks. Small banks hold 16 percent of uninsured deposits (as a share of total deposits), whereas large banks (with assets between $5 billion and $50 billion) hold as much as 26 percent of uninsured deposits (as a share of total deposits). Again, these figures support the view that uninsured deposits represent an important funding source for banks, regardless of size.

Figure 5. Balance Sheet (in U.S. dollars)



C. Related Literature

Researchers have expended considerable effort to measure depositor discipline. The most widely used approach is the price-based approach, which uses yield spreads (the difference between a market yield on bank debt and a market yield on a risk-free asset such as government debt) as a proxy for the market's perception of bank risk. This strand of the literature investigates whether depositors punish bad banks by demanding a higher yield spread for holding uninsured bank liabilities. For example, Flannery and Sorescu (1996) investigated the nonlinear relationship between yield spreads on large uninsured bank liabilities and various measures of risks and found that spreads were closely related to balance-sheet and market measure of bank risk. Since then, the ability of financial markets to discipline bank behavior by pricing banks' uninsured debt according to their risk has gathered significant attention (Evanoff and Wall, 2001, Morgan and Stiroh, 2001, Hancock and Kwast, 2001, and Sironi, 2003).[10]

Another approach, the quantity-based approach, examines whether depositors discipline their banks by withdrawing their uninsured deposits whenever the performance of their banks is no longer satisfactory. For example, Goldberg and Hudgins (1996, 2002) find that failed thrift institutions exhibit declining proportions of uninsured debt before failure. Jordan (2000) finds a similar result for New England banks in the 1990s.[11] Park and Peristiani

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[10] A good overview of this strand of literature is given in Board of Governors of the Federal Reserve System (1999) and Board of Governors of the Federal Reserve System and the U.S. Treasury (2000), and U.S. empirical evidence on private investors' abilities to assess the financial condition of banks can be found in Flannery (1998).

[11] Typically, in the literature on depositor discipline, risk measures are based on CAMEL indicators derived from balance sheets and income statements, such as non-accrual loans, past-due loans, other real estate ownership, equity ratios, leverage ratios, measure of profits, and loss ratios.

(1998) examine the effect of bank health on the quantity of uninsured deposits and the interest rate on these deposits. They find that riskier thrifts pay higher interest and attract smaller amounts of uninsured deposits. More recently, McDill and Maechler (2003) note that uninsured depositors are more responsive to movements in bank fundamentals in banks that already have low levels of equity. Similar evidence of depositor discipline has been found in countries other than the United States.[12]

From a slightly different perspective, Covitz, Hancock and Kwast (2000) find that relatively weak banks are unwilling (or unable) to issue subordinated debt in bad times. While Gilbert and Vaughan (2001) discern no effect on the behavior of uninsured savings deposits following a public enforcement announcement, Billet, Garfinkel, and O'Neal (1998) notice that a downgrade from Moody's increases a bank's reliance on insured deposits.

This paper is based on the tradition of the quantity approach. The purpose of the paper, however, is not to focus solely on how the quality of bank fundamentals influences the behavior of uninsured deposits, a phenomenon that is already well documented in the literature. Its objective is to add a new dimension to the analysis and account for the fact that both prices and quantities of uninsured deposits may change in response to deteriorating fundamentals. When bank fundamentals deteriorate, depositors discipline their banks by withdrawing their uninsured deposits. This raises the price of uninsured deposits. Banks, however, can mitigate this drain on deposits by further raising the deposit interest rates. Depending on depositors' interest sensitivity, troubled banks may continue to attract funds by offering higher interest rates to compensate uninsured depositors for the increasing risk they bear. To our knowledge, no paper has attempted to capture explicitly the possible endogeneity between the quantity and price mechanisms of uninsured deposits.

In a general equilibrium framework, Boyd, Chang, and Smith (2002) study the role of the elasticity of the deposit supply curve on banks' behavior. In contrast to our model, their model focuses on the cost of funding as banks' binding constraint. In their model, when the supply of savings is allowed to be interest sensitive, banks cannot costlessly adjust their deposit interest rates in the face of higher deposit insurance risk premia and must adjust their risk profile to reduce their funding costs. We are interested in a similar phenomenon, except that our attention is on the quantity of uninsured deposits as banks' binding constraint. If deposits are an important source of funding, and assuming that the supply of uninsured deposits is interest sensitive, weak banks may not be able maintain their deposit base through higher prices and presumably will need to reduce their risk profile.

[12] Using data for Argentina, Chile, and Mexico, Martinez Peria and Schmukler (2001) find that even small insured depositors exert depositor discipline by withdrawing deposits from weak banks. Barajas and Steiner (2000) notice that banks with stronger fundamentals benefit from lower interest costs and higher lending rates in Colombia. Meanwhile, Birchler and Maechler (2002) discover that in Switzerland depositors respond to institutional changes in the Swiss depositor protection system and behave differently across different types of banks with different implicit insurance levels.

Note that this paper does not shed light on the effectiveness of depositor discipline in reducing banks' risk appetite. It examines the extent to which banks can (and do) raise their interest rates to retain their deposit base. In a theoretical framework, Blum (2002) demonstrates that higher prices may not necessarily ensure that a bank reduces its risk profile. Practical limitations have constrained empirical studies to investigate how depositors react to excessive bank risk taking, as opposed to how bank managers respond to or prevent higher funding costs. In a recent empirical study on U.S. bank holding companies, Bliss and Flannery (2002, page 361) conclude that the ability of changes in security prices to influence subsequent managerial actions "remains, for the moment, more a matter of faith than of empirical evidence." In an attempt to overcome this difficulty, Nier and Baumann (2003) examine the relationship between bank asset risk and bank capital, and find that banks with a higher share of uninsured liabilities choose larger capital buffers for a given level of risk.

II. Modeling Approach

A. Empirical Methodology

We use the generalized-method-of-moments (GMM) estimators developed for dynamic models of panel data by Arellano and Bond (1991).[13] This methodology, which will be referred to hereafter as the Arellano and Bond (AB) model, is specifically designed to address three econometric issues relevant to the present paper, namely (i) the presence of unobserved individual effects (in the present case, bank-specific effects); (ii) the autoregressive process in the data regarding the behavior of uninsured deposits (i.e., the need to use a lagged-dependent-variable model); and (iii) the likely endogeneity between the dependent variable, the quantity of uninsured deposits, and one of the explanatory variables, the price (i.e., the interest rates) of uninsured deposits.

In this paper, we are particularly interested in capturing the interaction between the movement in the quantity of uninsured deposits and a change in these same deposits' interest rate margin. The panel estimator controls for this possible endogeneity by using internal instruments, that is, instruments based on lagged values of the explanatory variables. We use the following general reduced form:

$$(UD_{it} - UD_{it-1}) = \alpha' \sum_{s=1}^{3} (UD_{it-s} - UD_{it-s-1}) + \beta' (IM_{it} - IM_{it-1}) + \rho' (X_{it-1} - X_{it-2}) + \theta' (M_{it} - M_{it-1}) + (\varepsilon_{it} - \varepsilon_{it-1}) \tag{1}$$

where UD_{it} is the share of uninsured deposits to total deposits, X_{it-1} is a vector of bank-specific variables, IM_{it}, the interest rate margin between the interest rate on uninsured deposits and that on total deposits, and M_t is a vector of macroeconomic variables.

[13] For further readings, see also Arellano and Bover (1995) and Blundell and Bond (1998).

The vector of bank-specific variables, X_{it-1}, is included with a lag to account for the fact that balance-sheet and income-statement information is available to the public with a certain delay. In some regressions, we include an interest rate margin to control for movements in the price of uninsured deposits. According to equation 1, a bank's ratio of uninsured deposits to total deposits, apart from bank-specific differences, is determined by four main factors: previous behavior of uninsured deposits, movements of the price variable, the evolution of the bank fundamentals, and general developments in the macroeconomy.

B. Data

To investigate the presence of depositor discipline in the United States, we use only public bank-specific information that is available to depositors. These data are derived from data submitted quarterly by the banks in the Quarterly Condition and Income Reports, generally known as the Call Reports. The Thrift Financial Report (TFR) supplied the data for thrift institutions. These data were supplemented with macroeconomic data to control for factors that might influence broad movements in the availability of uninsured deposits. The data for real GDP growth, GDP deflator, and inflation rate are derived from the Bureau of Economic Analysis, whereas interest rate information, such as the Treasury one-year constant maturities and the federal funds rate, came from the Federal Reserve Board.

We initially collected data for all FDIC-insured institutions from 1987 to 2000. We used an annual frequency and selected the June quarter's data, because June had the most complete reporting requirements for deposit information. The initial data contained 19,852 FDIC-insured financial institutions (banks and thrifts). First, we eliminated merged institutions at the time of their merger. It was necessary to have a consistent approach to institutions that had merged during the sample period. If we had used the standard merger adjustment for banks, which involves creating a weighted average of the variables of merged banks, a great deal of useful information about risky banks would have been lost in the merger-adjusting process. Without any adjustments, the levels of the bank-specific variables would have jumped each time two institutions merged. Therefore, we decided to eliminate the merged institutions from the sample at the time of their merger. This reduced the data set to 19,551 financial institutions.

We also dropped those institutions for which we had fewer than five years of observations, which reduced the number of institutions to 12,921. For computational reasons, we removed the small banks, those that had assets of less than $100 million (in 1996 dollars). This restriction further decreased the sample to 3,095 institutions. The sample was further limited to 1,863 because of missing data for explanatory variables.

In the regressions, all of the bank-specific variables are lagged by one year in order to reduce the possibility of endogeneity in one or more of the right-hand-side variables of the equation and because we think depositors will normally react to bank-specific information after some time has elapsed. This delay may stem from a delay in access to information or, in the case of certificates of deposit (CDs), from a desire of the depositor to avoid penalties by waiting until maturity to withdraw deposits.

C. Summary Statistics

The summary statistics are presented in Table 1. The names of the variables are provided in column 1. The remaining three columns present the summary statistics for the variables over the entire 1987–2000 sample period (column 2), in 1989 (column 3), and in 2000 (column 4). For each period, the table indicates the total number of observations and the average value for each variable, with the standard deviation presented below in parentheses. The number of banks included in the sample declines between 1989 and 2000, both because the total number of U.S. banks fell over the sample period but also because merged banks were dropped from the sample at the time of their merger, as mentioned in the previous section.

Dependent variable

We define the dependent variable in the model as the quantity of uninsured deposits as a percentage of total deposits, or *UninsDep*. According to Table 1, uninsured deposits represented on average 15 percent of total deposits, rising from under 14 percent in 1989 to over 19 percent in 2000 for the average bank in our sample.

Price variables

To control for the dynamic process between the quantity of uninsured deposits and their price, we compute *UninsIntMarg*, the margin between a bank's interest rate on uninsured deposits (Jumbo CDs) and its average deposit interest rate. This price variable captures the desired composition of deposits in a particular bank (i.e., whether a bank is willing to pay a higher price to attract more insured or uninsured deposits). The interest rate data are inferred indirectly from computing the ratio of interest expenditures on Jumbo CDs to the level of total Jumbo CDs. A rise in *UninsIntMarg* means that bank *i* pays a relatively higher price for its uninsured deposits than for its insured deposits; hence, the rise should be associated with a higher share of uninsured deposits to total deposits, the dependent variable *UninsDep*.

To check the robustness of our results, we have computed two alternative measures of interest margins: *JumboIntMarg*, the margin between the interest rate of bank *i* on a jumbo CD and the industry average interest on jumbo CDs; and *DepIntMarg*, the margin between the deposit interest rate of bank *i* and the industry average deposit interest rate. By capturing the price of deposits offered by a particular bank relative to the price offered on average in other banks, these alternative price variables help explain the allocation of deposits among banks (i.e., whether a particular bank is willing to offer a higher interest rate relative to that offered by other banks).

Table 1: Summary Statistics in Level
(as a percentage unless indicated otherwise)

Variable Name	Full Set of Data		In 1989		In 2000	
(1)	(2)		(3)		(4)	
	Obs	Mean (Std. Dev.)	Obs	Mean (Std. Dev.)	Obs	Mean (Std. Dev.)
Uninsured deposit 1/	20630	94,747	1846	91,110	830	153,909
		(633,882)		(655,872)		(1,061,837)
Total deposits 1/	20630	478,418	1846	409,267	830	809,934
		(4,281,228)		(2,728,150)		(9,181,614)
Dependent Variable						
UninsDep	20630	14.91	1846	13.75	830	19.16
		(13.98)		(13.74)		(15.17)
Price Factors						
UninsIntMarg	20030	1.59	1761	2.21	826	1.74
		(1.55)		(1.57)		(0.93)
JumboIntMarg	20030	-0.01	1761	-0.04	826	0.03
		(1.48)		(1.41)		(0.91)
DepIntMarg	20601	-0.33	1843	-0.44	829	-0.19
		(0.83)		(0.92)		(0.77)
Bank Specific Variables						
Assets 1/	20630	725,633	1846	666,980	830	1,088,684
		(6496123)		(4882174)		(11,900,000)
Size	20630	12.49	1846	12.44	830	12.69
		(0.86)		(0.89)		(0.86)
AssetGrowth	18768	8.64	1839	6.34	830	7.59
		(54.54)		(12.56)		(12.70)
Equity	20630	9.02	1846	8.20	830	10.46
		(3.31)		(2.48)		(4.37)
RoA	20630	1.11	1846	1.08	830	1.30
		(1.06)		(0.74)		(0.82)
Loans	20630	59.26	1846	60.81	830	62.67
		(15.13)		(15.00)		(14.97)
ResidLoans	20621	34.70	1845	31.17	829	40.28
		(22.67)		(21.25)		(24.98)
NonCLoans	20375	1.70	1763	1.87	829	0.76
		(2.21)		(2.07)		(1.08)
Macroeconomic Variables						
GDP	20630	3.03	1846	3.55	830	5.09
		(1.46)		(0.00)		(0.00)
Infl	20630	2.70	1846	3.96	830	2.23
		(0.82)		(0.00)		(0.00)
Treas1	20630	6.11	1846	8.44	830	6.17
		(1.44)		(0.00)		(0.00)

1/ In thousands of 1996 U.S. dollars.

Bank-specific factors

The size of a bank may influence depositors' willingness to hold uninsured deposits at that institution. Larger banks may attract large businesses that require large transaction accounts and a variety of special lending and service arrangements. Larger banks may also be perceived as less likely to fail, either because their larger, more diversified customer base makes them appear more substantial (and safer) or because they may have a larger chance of being bailed out if they should run into financial difficulties. Against this background, we computed three proxies to control for the size of the bank. First, the table of summary statistics presents the level of assets (in thousands of 1996 U.S. dollars), or *Assets*. According to Table 1, the assets of an average bank in our sample increased by over 60 percent between 1989 and 2000, increasing from $667 million in 1989 to $1,089 million in 2000. Because the constant (1996) dollar value of *Assets* had such a large relative variance when compared with the percentage of uninsured deposits to total deposits, we included in our regressions the natural log of *Assets*, which we defined as our size variable, *Size*. We also included asset growth (*AssetGrowth*), defined as the percentage growth rate of real assets between two years, to control for differences between higher-growth banks and lower-growth banks. Over the sample period, assets grew on average by 8.6 percent. Presumably banks with higher-than-average growth are flourishing and may exhibit a higher demand for uninsured deposits. On the other hand, high growth in a bank may indicate excessive risk taking and an aggressive asset acquisition policy, possibly to the detriment of asset quality, and thus be associated with lower uninsured deposits.

The remaining explanatory variables include a set of four proxies for bank quality that uninsured depositors are most likely to monitor. A bank's equity level is an important indicator of the bank's health and ability to withstand adverse shocks. To examine the effect of equity on uninsured deposits, we included the variable *Equity*, measured as the ratio of total equity capital (the residual between liabilities and assets) to total assets, multiplied by 100 to convert it into a percentage. According to Table 1, *Equity* over the sample averaged 9 percent of assets and increased from 8.2 percent in 1989 to 10.5 percent in 2000. Another important indicator of bank health is return on assets, *RoA*, which averaged 1.1 percent return over the whole sample, increasing from slightly less than 1.1 percent in 1989 to 1.3 percent in 2000.

Interest income and fees generated by lending activities, which typically represent a major source of income for banks, affect overall bank profitability and hence influence depositors' willingness to keep uninsured money in their banks. To capture this effect, we included loans and leases as a percentage of assets, or *Loans*. *Loans* represented slightly under 60 percent of assets for the banks in the sample overall, increasing from 59 percent in 1989 to 63 percent in 2000. We also included loans made for the purchase of residential real estate as a percentage of total loans, or *Residential*.[14] These loans, which include only loans made for properties that accommodate small numbers of families, are typically considered to be very safe. Therefore, a bank that invests heavily in this type of loan (rather than, for example, in commercial and industrial loans) would generally be considered a low-risk bank. On average, the loan portfolios of the banks in the sample consisted of 35 percent residential real estate loans; this percentage rose from 31 percent to 40 percent between 1989 and 2000.

We also included a variable *NonCLoans*, which is defined as the percentage of loans that are non-current — 90 days or more past due — to capture the quality of banks' loan portfolios. This variable is typically considered to be a very good indicator of bank health. Over the sample period, average *NonCLoans* fell 1.1 percentage points, from 1.9 percent to 0.8 percent between 1989 and 2000, with a panel average of 1.7 percent across the sample.

Macroeconomic factors

To control for the general conditions of the banking system, we included three macroeconomic variables to capture the possibility that the behavior of uninsured deposits is linked to general economic conditions. Our regressions contained the GDP growth rate and its lagged variable (GDP_t and GDP_{t-1}) to control for the general strength of the economy, the change in the GDP deflator (*Infl*) to control for the falling value of insurance limits,[15] and the one-year constant maturity U.S. Treasury bond interest rate (*Treas1*). This Treasury interest rate controls for the effect of changes in the return on alternative saving instruments on bank deposits. We expect *GDP* and *Infl* to have a positive relationship with the dependent variable (*UninsDep*), and *Treas1* to have a negative relationship with the dependent variable. The latter expectation is based on the idea that bank deposits may lose their attractiveness when the return on other savings instruments, such as Treasury bonds, rises.

Real GDP growth surged toward the end of the sample to 5.1 percent in 2000, whereas inflation remained fairly low throughout the period, with a sample average of 2.7 percent. The one-year Treasury interest rate fluctuated between 8.4 percent in 1989 and 6.2 percent in 2000.

D. Simple Correlations

Table 2 provides the partial correlations between the dependent variable and bank-specific variables: in the top section, the partial correlation is in levels; in the bottom section it is in differences.

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[14] The residential loans in this variable include only mortgages made on properties that house one to four families.

[15] In addition, controlling for both the inflation rate and a proxy for the nominal interest rate allows us to talk about movements in the real interest rate.

The most noteworthy result is the contrast between the positive partial correlation between the level of uninsured deposits and the interest margin (top section) and the negative partial correlation between changes in uninsured deposits and changes in the interest rate (bottom section). The banks that exhibit a relatively high share of uninsured deposits are also the banks that offer a relatively high interest rate on their uninsured deposits. However, this does not mean that banks can necessarily raise funds from uninsured depositors by raising their interest rates on uninsured deposits.

Table 2. Partial Correlations

In Levels	*UninsDep*	*UninsDep_L1*	*UninsIntMarg*	*Equity_L1*	*Size*	*NonCL_L1*
UninsDep	1	...	...	...	...	...
UninsDep_L1	0.9063	1	...	...	...	...
UninsIntMarg	0.0869	0.0954	1	...	...	...
Equity_L1	0.0519	0.043	-0.0419	1	...	...
Size	0.4467	0.4457	0.0123	-0.0971	1	...
NonCurrLoans_L1	0.0915	0.1059	0.0193	-0.071	0.0484	1
ResidLoans_L1	-0.4021	-0.4092	-0.1164	0.1458	-0.1586	-0.1674
In First Differences	*D.UninsDep*	*D.UninsDep_L1*	*D.UninsIMarg*	*D.Equity_L1*	*D.Size*	*D.NonCL_L1*
D.UninsDep	1		...	...	...	...
D.UninsDep_L1	-0.2761	1	...	...	...	...
D.UninsIMarg	-0.019	0.0377	1	...	...	...
D.Equity_L1	0.0427	-0.0541	0.0419	1	...	...
D.Size	0.1677	0.0114	-0.0231	-0.0224	1	...
D.NonCurrLoans_L1	-0.019	-0.013	-0.0015	-0.0015	-0.0467	1
D.ResidLoans_L1	0.0144	-0.0207	0.0081	0.0095	-0.0367	-0.0261

1/ L1 = with one-period lag; D = in first difference

The negative relationship between a change in the price and a change in the quantity of uninsured deposits suggests that some banks that raise their interest rates experience a fall in the level of uninsured deposits. This seems to indicate that some banks face an upward shift in their supply of uninsured deposits. Although the data are marred with noise both across banks and across economic cycles, some banks may have to offer a higher interest rate in order to attract the same, or even a lower, level of uninsured deposits.

At this juncture in the model, a mechanism is needed that allows us to differentiate between an upward shift in the supply curve of uninsured deposits (where, for each given level of interest rate, depositors are willing to supply a lower volume of uninsured deposits) and an upward shift in the demand curve (where, for each given level of interest rate, banks are demanding a larger quantity of uninsured deposits). Assume a bank's deteriorating fundamentals induce an outflow of uninsured deposits, which reduces the supply of deposits and endogenously raises their price. The relationship between price and quantity can be further obscured because a bank may respond to such a deposit drain by offering a higher interest rate on its uninsured deposits. Thus, it is important to use an econometric model that can control for the endogenous price effect of a supply shift and can focus on banks' independent pricing decisions. Assume, for example, that a weak bank raises its interest rate to retain its deposit base. At this higher price, some depositors may be willing to leave their uninsured deposits with this (weak) bank. Even though a simple reading of the quantity data may not necessarily suggest that depositors penalize weak bank performance, the behavior of depositors would be consistent with depositor discipline. These issues are examined empirically in the next section.

III. Results

A. Controlling for Bank Fundamentals

As a first approximation, we examine the extent to which movements in bank-specific variables explain the behavior of uninsured depositors, controlling for general macroeconomic conditions. In this set of regressions, we do not include any price mechanism. The dependent variable and the explanatory variables are all expressed in first differences. The results are illustrated in Table 3. Column 1 presents the results of the first-step estimation, while column 2 presents the two-step estimates. Arellano and Bond (1991) recommend using the first-step estimates for inference on coefficients, since these are calculated using a robust estimator of the variance-covariance matrix. The two-step estimates are used primarily to compute robustness tests.

The particular model specification (and variable choice) presented in columns 1 and 2 has been selected because (i) it follows closely the bank-specific variables used in earlier related papers, (ii) it replicates standard results found in the literature using a minimum number of bank-specific variables, and (iii) the results remain robust across a wide variety of variables and groupings of variables.[16] Thus, we are confident that our regression results are not specific to the particular choice of bank-specific variables included in our model.

The data seem to support our general hypothesis that the fraction of uninsured deposits to total deposits is related to the movements in a bank's fundamentals. Except for non-current loans and leases, *NonCLoans*, which is not statistically significant, we find that all of our bank-specific variables are statistically significant and have the expected sign. For example, a bank with a rising equity rate will experience an upward movement in its share of uninsured deposits. This is shown by the statistically significant and positive coefficient of *Equity*.

[16] We have run the model specification of column 1 with a large number of alternative variables and sets of variables, all of which turned out either not to be statistically significant or not to add value to the interpretation of the results.

Table 3. Empirical Results

		Without Price Mechanism		Exogenous Price Mechanism		Endogenous Price Mechanism	
Variable Name	Lags 1/	One-step Robust (1)	Two-step (2)	One-step Robust (3)	Two-step (4)	One-step Robust (5)	Two-step (6)
UninsDep	*L1D*	0.419 ***	0.387 ***	0.392 ***	0.342 ***	0.381 ***	0.339 ***
	L2D	0.022	0.026 ***	0.025	0.029 ***	0.026	0.022 **
	L3D	-0.002	0.003	-0.004	-0.008	-0.001	-0.007
UninsIntMarg	*D*	...	...	0.098	-0.036	0.890 *	0.502 ***
Equity	*L1D*	0.468 ***	0.425 ***	0.468 ***	0.429 ***	0.459 ***	0.445 ***
Size	*D*	9.705 ***	11.433 ***	10.058 ***	12.839 ***	9.889 ***	12.882 ***
NonCLoans	*L1D*	-0.013	0.006	-0.023	0.014	-0.052	0.006
ResidLoans	*L1D*	0.053 *	0.037 **	0.054 *	0.048 ***	0.058 *	0.049 ***
GDP	*D*	0.190 ***	0.151 ***	0.207 ***	0.150 ***	0.236 ***	0.181 ***
	L1D	0.040	0.072 ***	0.056	0.087 ***	0.080 *	0.095 ***
Infl	*D*	0.496 ***	0.147	0.556 ***	0.106	0.599 ***	0.132
Treas_1	*D*	-0.203 **	-0.173 ***	-0.280 ***	-0.184 ***	-0.456 ***	-0.288 ***
Cons		-0.005	-0.066	-0.024	-0.100 *	-0.047	-0.122 **
Obs.		13,085	13,085	12,826	12,826	12,826	12,826
Banks		1,863	1,863	1,863	1,863	1,863	1,863
AB test of no AR(1) Pr > z =		0.00	0.00	0.00	0.00	0.00	0.00
AB test of no AR(2) Pr > z =		0.93	0.95	0.73	0.96	0.60	0.88
Sargan test of over-identification Pr > chi2 =		...	0.02	...	0.08	...	0.12

1/ L*i*D = in first difference with *i* lag(s); and D = in first difference.

The coefficient of *Size* is positive and particularly strong. Because the AB model uses all variables in first difference, the coefficient for *Size* can be thought of as the effect of asset growth. It may also reflect an increased demand for uninsured deposits on the part of the bank. This possible demand effect is discussed in more depth below. Similarly, the positive coefficient of *ResidLoans* is consistent with the relatively safe nature of residential loans and suggests that uninsured depositors have more confidence in a bank that exhibits a higher share of residential mortgage lending in its credit portfolio.

The behavior of uninsured deposits seems to respond to business conditions. All three macroeconomic variables are strongly significant with the expected sign. The growth of uninsured deposits tends to rise during booms (high GDP growth), during periods when inflation is increasing, and during periods when Treasury bond rates are falling.[17]

It is interesting to note that our results suggest a strong persistence in the behavior of uninsured depositors. If an innovation raises uninsured deposits today, the effect of this innovation will persist over the following year(s), although at a decreasing rate. This is shown in column 1 of Table 3, where the first lag and in some cases the second lag of uninsured deposits (respectively, *UninsDepL_D* and *UninsDep_L2D*) are significant in predicting next year's growth of uninsured deposits. This result is confirmed by the AB test of autocorrelation presented at the bottom of column 1.[18] The persistence in the behavior of uninsured deposits reflects the relative stability of the U.S. banking system. Typically, if a bank is small today, it will remain small tomorrow and hence attract the same type of depositors. Similarly, if a bank has a good reputation today, it is likely to enjoy a good reputation tomorrow. But if something changes in the system — say, a bank's fundamentals start deteriorating — the results suggest that, in line with the depositor discipline hypothesis, depositors will punish this bank by withdrawing their uninsured deposits. Thus, persistence in the behavior of deposits can be consistent with depositor discipline.

Finally, consistency of the GMM estimator depends also on the validity of the instruments. To address this issue, we use the Sargan test of over-identifying restrictions, which tests the overall validity of the instruments. If the regression specification passes the test, we can safely discard the possibility that the relationship between the quantity of uninsured deposits (as a share of total deposits) and the price of uninsured deposits is due to a simultaneity bias or omitted variables.[19] Unfortunately, the results for this regression do not satisfy the Sargan test, suggesting that the model specification presented in columns 1 and 2 is misspecified. A possible reason for this misspecification may be that we do not control properly for the dynamic interactions between the quantity and price of uninsured deposits. This problem may be best illustrated with an example.

We have seen above that the coefficient of *Size* is positive and particularly strong, suggesting that depositors interpret strong asset growth as a signal of good health. Presumably, however,

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[17] The last two results suggest that the share of uninsured deposits to total deposits falls when real interest rates rise.

[18] In the AB framework, by construction there should be first-order autocorrelation in the residuals, but there should be no second-order autocorrelation.. Our findings are consistent with this requirement. The null hypothesis of no first-order autocorrelation in the differenced residuals is rejected, but it is not possible to reject the null hypothesis of no second-order autocorrelation.

[19] Under the Sargan test, the null hypothesis assumes that the over-identifying restrictions are valid. If the Sargan test from the one-step homoskedastic estimator rejects the null hypothesis, this may be due to heteroskedasticity (the AB framework allows for the presence of first-order autocorrelation in the differenced residuals, as this type of autocorrelation does not imply inconsistent estimates). Using a two-step estimator can produce large efficiency gains. For this reason, the two-step Sargan test is typically used for inference on model specification.

strong asset growth may also reflect a bank's greater need for deposits, which may or may not be a function of the bank's good performance. For example, a bank that engages in an aggressive asset acquisition policy may also experience strong asset growth, although this would be the result of excessive risk taking rather than prudent management. Assuming that this bank is willing to offer higher interest rates to satisfy its growing funding needs, strong asset growth may be associated with a rise in uninsured deposits, even if depositors recognize the higher underlying risk profile of the bank. To properly conclude whether good fundamentals or a bank's desire to retain its uninsured deposit base through higher interest rates causes a rise in uninsured deposits, we need to control for movements in the interest rates. This issue is addressed in the next section.

B. Introducing an Exogenous Price Mechanism

In this section, we examine whether the price (the interest rate) of uninsured deposits influences the behavior of depositors. We include *UninsIntMarg*, the margin between the interest rate on uninsured deposits and that on total deposits, as an additional explanatory variable. In this specification, we focus on whether an increase in the interest margin is associated with a rise in the level of uninsured deposits (as a share of total deposits).

We find that an increase in the interest margin, when treated as an exogenous change, has an effect on uninsured deposits that is very slightly positive but not statistically different from zero. This is shown in column 3, where the coefficient of *UninsIntMarg* is positive but not statistically significant. The positive relationship between changes in the price and quantity of uninsured deposits contrasts with the *negative* partial correlation shown in Table 2. By controlling for risk factors that shift the quantity of uninsured deposits, we are able to capture some of the mechanisms driving the negative partial correlation, although we are not yet able to say convincingly whether banks can raise their level of uninsured deposits by raising the price of uninsured deposits. The other bank-specific and macroeconomic coefficients remain consistent with those found under the previous specification presented in columns 1 and 2.

As in the previous section, our results are consistent with the requirement of no second-order serial correlation and continue to fail the Sargan test of over-identification. This suggests that we are still not properly controlling for the dynamic process between the quantity and price of uninsured deposits. One problem may be that we are missing a dimension in the endogenous mechanism driving the behavior of uninsured deposits.

A bank's decision to raise its interest rates may not be independent of depositors' desire to withdraw their funds, which in itself is a function of banks' risk profile. To address this issue, we need to control for the impact of a change in bank fundamentals on the quantity and price of uninsured deposits so that we can examine separately the fundamental effect of a bank's decision to raise its interest rates on the behavior of uninsured deposits. If a bank's deteriorating fundamentals cause depositors to withdraw their uninsured deposits, the bank in response may decide to raise its interest rate in an effort to retain its uninsured deposits. The overall effect on uninsured deposits would be ambiguous, as suggested by our results. In practice, depositors may be disciplining (or penalizing) their banks by shifting the supply of uninsured deposits upward and raising the cost of bank funding. The disciplining effect of depositors is obscured by the bank's ability to raise its interest rates. Thus, we need to address the three-dimensional relationship between the price of uninsured deposits, the quantity of uninsured deposits, and a bank's financial health.

C. Addressing the Endogeneity of the Price Mechanism

In this section, we account for the fact that movements in the price and quantity of uninsured deposits may be jointly determined with the financial soundness of a bank. For this, we need to control for the possibility that a weak bank, which is experiencing a drain of uninsured deposits due to deteriorating fundamentals, may raise its interest rate. The idea is to eliminate potential parameter inconsistency arising from simultaneity or reverse causality between quantity and price movements of uninsured deposits and examine whether a change in the interest rate can exogenously influence the quantity of uninsured deposits.

According to the standard depositor discipline hypothesis, a deterioration in a bank's fundamentals should induce depositors to withdraw their uninsured deposits from this weak bank. Graphically, this would represent an upward shift of the supply curve of uninsured deposits, where the equilibrium moves along the demand curve to a lower quantity and higher price of uninsured deposits. It is possible, however, that a weak bank may raise its interest rate on uninsured deposits further to contain the deposit drain, hence shifting upward the demand curve for uninsured deposits. To disentangle these two effects, we need to control for the possible price impact of deteriorating bank fundamentals (i.e., the supply shift due to deteriorating fundamentals) and examine whether a rise in the interest rates can exert a causal impact on the quantity of uninsured deposits (i.e., a shift in the bank's demand for uninsured deposits).

The way the AB model controls for the dynamic interactions between quantity and price movements of uninsured deposits is by using internal instruments. Appropriate instruments are highly correlated with the endogenous variables and not correlated with the error term. Hansen (1982) has shown that a first-difference transformation, like the one used in equation 1, allows the use of suitably lagged levels of the endogenous variables as valid instruments.[20] More recently, AB have identified how these lagged levels can be combined with first-differences of the strictly exogenous variables to control for potential biases induced by simultaneity or reversal causality between endogenous variables.[21] This technique allows us

[20] The use of lagged observations of the independent and explanatory variables as instruments was first introduced in the GMM framework pioneered by Hansen (1982). Efficient GMM estimators will typically exploit a different number of instruments in each time period. For more details, see Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998).

[21] This methodology has been used widely in the growth literature, where it is important to disentangle the factors that contribute to economic growth (such as financial development or capital accumulation) from the reverse effect of how economic growth influences these factors. A good illustration is presented in Levine, Loayza and Beck (2000).

to determine whether interest rate movements have an *exogenous* impact on the quantity of uninsured depositors, independently of the endogenous impact of deteriorating fundamentals on the price and quantity of uninsured deposits.

The first- and second-step estimates are presented in, respectively, columns 5 and 6 of Table 3. The model specification passes the Sargan test, suggesting that the relationship between the quantity of uninsured deposits (as a share of total deposits) and the price of uninsured deposits is not flawed by a simultaneity bias or omitted variables. Similarly, the model satisfies the no second-order serial correlation requirement. Except for *UninsIntMarg*, the coefficients remain broadly consistent with those found in the previous regressions. In the case of *UninsIntMarg*, the coefficient is positive and statistically significant. This result suggests that once we control for the dynamic process determining the behavior of uninsured deposits, banks are able to borrow additional uninsured deposits by offering higher interest rates.

If banks are able to raise their uninsured liabilities by offering higher interest rates, the question remains by how much should banks have to raise their interest rates to benefit from an inflow of uninsured deposits. Our results suggest that banks have to pay a relatively high price to receive additional uninsured funds. According to column 5, the coefficient of *UninsIntMarg* is 0.89. This means that if a bank were to increase its interest margin on uninsured deposits by 1 percentage point (from, say, 2.2 percent to 3.2 percent), uninsured deposits would rise by 0.89 percentage points (from, say, 10 percent to 10.89 percent). This seems to represent a very high funding cost to the banks.

For illustration, assume a bank has $10 million uninsured deposits, which represent 10 percent of the bank's total deposits. For the sake of this exercise, assume that at the beginning the bank pays no interest rate on its deposits. Then, to raise more funds, it is willing to pay 1 percent interest rate on its uninsured deposits. For simplicity, further assume that the rise in interest rate induces an inflow of new uninsured deposits. In this case, it is easy to show that uninsured deposits would increase by $9.99 million to $109.99 million and the bank would have to pay $1.099 million in interest, or an 11 percent funding cost. The supply curve of uninsured deposits seems to be fairly inelastic. It is likely that this high average funding cost comes from large differences among banks of different qualities. In Section IV.A we examine the possibility of a nonlinear relationship between the interest elasticity and a bank's quality.

The results suggest that uninsured depositors discipline their banks. This is an interesting result, given that approximately 75 percent of all deposits are guaranteed under the U.S. deposit insurance scheme. Thus, despite a high level of deposit insurance, we find evidence that in the United States the depositors holding the remaining 25 percent of uninsured deposits discipline their banks.

IV. ROBUSTNESS TESTS

A. Weak versus Healthy Banks

In this section, we examine whether depositors in weak banks are more sensitive and require a higher price premium than depositors in healthy banks. We use the CAMEL ratings to subdivide our sample of banks into different quality categories. CAMEL ratings are the result of a supervisory examination and are confidential information. They assess the Capital adequacy, Asset quality, Management, Earnings, and Liquidity of banks and express an overall rating on a scale of 1 to 5 in ascending order, where 1 is the best rating and 5 is the worst rating.[22] Although depositors are not generally aware of changes in the CAMEL rating of their bank, these ratings are a good proxy for the overall quality of a bank.

Given the time series nature of the econometric model, we needed a system for categorizing the quality of a bank that was consistent for a given bank throughout the entire sample. Thus, using the CAMEL ratings, we have computed three broad types of banks; “good” banks (if the bank always had a CAMEL rating of 1 or 2), “bad” banks (if the bank ever earned a CAMEL rating of 3, 4, or 5 at any time during the sample), and “very bad” banks (if the bank ever earned a CAMEL rating of 4 or 5 at any time during the sample).[23] The majority of banks included in our regression results are good banks (1,307 banks). There were also 556 bad banks and 207 very bad banks. On average, the good banks included in our regressions held a lower percentage of uninsured deposits to total deposits than banks with worse CAMEL ratings. Good banks held 15.2 percent of uninsured deposits (as a share of total deposits), whereas the bad banks had an average uninsured deposits of 16.2 percent, and the very bad banks, those with CAMEL ratings of 4 or 5, had an average of 16.7 percent of uninsured deposits to total deposits.[24]

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[22] In 1997, a fifth component, Sensitivity was added to the rating system to capture sensitivity to market risk. Since then, the acronym has been changed to CAMELS.

[23] Banks may switch from one rating category to another, and for the purpose of this exercise it is not relevant to restrict our analysis to banks that always remain within one particular category. Instead, we have computed broader categories that allow a bank’s performance to be followed across CAMEL ratings.

[24] This result is driven mostly by the large sample size differences across categories and the relatively flat distribution curves. Typically, the sample size problem (especially in the case of bad and very bad banks) is best addressed by looking at the median rather than the mean. Another important note is that a bank needs to have only a one-time CAMEL 3 or worse rating to be categorized as a “bad” bank. This factor helps explain the relatively high share of uninsured deposits for our category of bad and very bad banks. If we restrict our attention to the CAMEL rating categories, the median share of uninsured deposits to total deposits is highest for the best-rated banks (12.3 percent) and drops progressively to 8.5 percent for the worst-rated banks.

Table 4. Empirical Results across Different CAMEL-based Classifications 1/ 2/

Variable Name	Lags 3/	Benchmark (1)	Good Banks (always 1 or 2) (2)	Bad Banks (if ever 3, 4 or 5) (3)	Very Bad Banks (if ever 4 or 5) (4)
Uninsured Deposits		15.474	15.161	16.185	16.676
(% of total deposits)		(13.508)	(13.452)	(13.608)	(13.974)
UninsDep	*L1D*	0.382 ***	0.349 ***	0.376 ***	0.426 ***
		(0.064)	(0.074)	(0.093)	(0.111)
	L2D	0.025	0.028	0.005	-0.065
		(0.036)	(0.045)	(0.040)	(0.070)
	L3D	-0.002	-0.027	0.036	0.041
		(0.030)	(0.040)	(0.028)	(0.058)
UninsIntMarg	*D*	0.880 *	1.292 *	0.162	0.698
		(0.497)	(0.746)	(0.205)	(0.680)
Size		9.721 ***	8.549 ***	10.581 ***	13.066 ***
		(2.340)	(3.251)	(2.849)	(4.022)
Loans&Leases		0.038 *	0.067 **	-0.008	-0.043
		(0.021)	(0.030)	(0.034)	(0.054)
ResidLoans	*D*	0.061 **	0.039	0.093 *	0.195 *
		(0.031)	(0.039)	(0.050)	(0.106)
Equity	*L1D*	0.445 ***	0.439 **	0.386 ***	0.626 ***
		(0.133)	(0.180)	(0.126)	(0.205)
NonCLoans	*L1D*	-0.046	-0.094	-0.038	-0.014
		(0.040)	(0.061)	(0.052)	(0.069)
GDP	*L1D*	0.245 ***	0.257 ***	0.205 ***	0.132
		(0.047)	(0.059)	(0.061)	(0.128)
	L1D	0.090 *	0.141 **	-0.051	-0.145
		(0.049)	(0.061)	(0.069)	(0.164)
Infl	*D*	0.599 ***	0.908 ***	0.140	-0.352
		(0.187)	(0.245)	(0.217)	(0.555)
Treas_1	*L1D*	-0.474 ***	-0.716 ***	0.031	0.283
		(0.146)	(0.200)	(0.107)	(0.313)
Cons	*D*	-0.048	0.004	-0.010	-0.083
		(0.124)	(0.174)	(0.128)	(0.209)
Observations		12826	8912	3914	1380
Banks		1863	1307	556	207
Test of no AR(1) 4/		0.000	0.000	0.000	0.007
Test of no AR(2) 4/		0.597	0.838	0.456	0.340
Sargan test 5/		0.146	0.032	0.095	0.318

1/ Model with endogenous price mechanism.

2/ Coefficients from first-step robust estimations, unless specified otherwise.

3/ L*i*D = in first difference with *i* lag(s); and D = in first difference.

4/ AB(*i*) is the Arellano and Bond test of no autocorrelation of degree *i*.

5/ Sargan test is based on two-step regression results.

Table 4 presents the regression results across different CAMEL-based categories. Column 1 reprints the results of the benchmark model specification, that is, the first-step version of the model with the endogenous price mechanism presented in column 5 of Table 3. The next three columns in Table 4 present the results of the same model specification run under the various CAMEL-based bank categories. Column 2 presents the regression results for the good banks, column 3 for the bad banks, and column 4 for the very bad banks.

According to our benchmark model presented in Section III.A, banks can raise the ratio of uninsured deposits to total deposits by increasing their uninsured deposit interest rates, but only by paying a relatively high price (a 1 percentage point increase in the interest margin raises the ratio of uninsured deposits to total deposits by 0.89 percentage point). By differentiating between different qualities of banks, we find that for a 1 percentage point increase in the interest rate, good banks can raise a relatively higher proportion of uninsured deposits than banks with a lower-quality standing. This is shown in column 2, where the coefficient of *UninsIntMarg* is higher (1.29) than that for the benchmark model (0.89) in column 1. We also find that weak banks cannot attract more uninsured deposits (as a share of total deposits) by raising their uninsured deposit interest rates. This is shown in columns 3–5, where the coefficients of *UninsIntMarg* are not statistically significant for banks with a CAMEL rating worse than 2.

B. Alternative Interest Margins

In this section, we check whether our results are robust to different interest margin specifications. So far, our price variable *UninsIntMarg* reflects the spread between the interest rate on jumbo CDs and the interest rate on total deposits in bank *i*. Because this variable tracks interest rate movements between two different types of deposits held in a particular bank, it can be interpreted as capturing the ability of a bank to change the composition of its deposits by changing its relative deposit interest rates.

Next, we compute two further interest rate margins that capture differences in interest rates among banks, by comparing a bank's interest rates with the industry average. First, we compute the margin between the interest rate of bank *i* on a jumbo CD and the annual industry average interest rate on jumbo CDs (*JumboIntMarg*). This price variable captures the extent to which a particular bank can attract new uninsured deposits by offering a higher interest rate on its uninsured deposits relative to the industry average. Presumably, a rise in *JumboIntMarg* is associated with a rise in uninsured deposits (as a share of total deposits) in bank *i*.

We also compute the margin between the average deposit interest rate of bank *i* and the industry average deposit interest rate (*DepIntMarg*). We would expect an increase in *DepIntMarg*, which raises the average price of deposits in bank *i*, to augment total deposits. This effect may or may not be associated with a rise in uninsured deposits (as a share of total deposits), depending on whether the bank attracts mostly insured or uninsured deposits.

Table 5 provides the partial correlation between the alternative interest rate margins. The margin that a bank pays for uninsured deposits relative to its overall interest rate, *UninsIntMarg*, and the margin it pays for uninsured deposits relative to the industry, *JumboIntMarg*, are highly positively correlated both in levels and in first differences. The interest rate margin that a bank pays on total deposits above the industry average, *DepIntMarg*, is much less highly correlated to the other interest rate measures. This would tend to indicate that changes in the *UninsIntMarg* are being driven by changes in the interest rate on Jumbo CDs rather than by changes in the interest rate on deposits more generally.

Table 5. Partial Correlations with Alternative Interest Margins 1/

In Levels	*UninsDep*	*UninsIntMarg*	*JumboIntMarg*	*DepIntMarg*
UninsDep	1.000	...	...	...
UninsIntMarg	0.083	1.000	...	...
JumboIntMarg	-0.006	0.837	1.000	...
DepIntMarg	-0.160	-0.310	0.224	1.000
In First difference	*D.UninsDep*	*D.UninsIMarg*	*D.JumboIMarg*	*D.DepIMarg*
D.UninsDep	1.000	...	...	...
D.UninsIntMarg	-0.032	1.000	...	...
D.JumboIntMarg	-0.050	0.956	1.000	
D.DepIntMarg	-0.100	-0.094	0.152	1.000

1/ D = in first differences.

The regression results are presented in Table 6. We find that if a bank raises its average interest rates, it attracts mostly insured deposits: the ratio of uninsured deposits to total deposits falls. This is shown in column 3, where the coefficient of *DepIntMarg* is negative and statistically significant. This result is consistent with our prior hypothesis that deposit insurance mitigates depositor discipline. It seems to be relatively easy for a bank to attract insured deposits by raising its interest rates. In the case of uninsured deposits, however, depositors seem to be more cautious before entrusting their savings to a particular bank, examining both the risk profile of a bank and the rate of return it offers. This result is robust across different specifications, including when the model controls for movements in other interest margins, such as *UninsIntMarg* and *JumboIntMarg*, as is shown in columns 5–7.

We also find that a bank cannot automatically increase its uninsured deposits (as a share of total deposits) by raising the interest rate on uninsured deposits above the industry average. This is shown in column 2, where the coefficient of *JumboIntMarg* is not statistically significant. Again, this result is robust across specifications as shown in columns 6 and 7. The only exception is found in column 4, where the coefficient of *JumboIntMarg* is strongly significant and negative, in conjunction with that of *UninsIntMarg*, which is strongly significant and positive. This result needs to be interpreted with a high degree of caution since it is severely tainted by the high degree of correlation between the two interest rates (see Table 5).

Table 6. Empirical Results across Different Interest Margins 1/ 2/

Variable Name	Lags 3/	(1)	(2)	(3)	(4)	(5)	(6)	(7)
UninsDep	*L1D*	0.382 ***	0.394 ***	0.368 ***	0.374 ***	0.348 ***	0.352 ***	0.353 ***
		(0.064)	(0.064)	(0.067)	(0.065)	(0.067)	(0.066)	(0.066)
	L2D	0.025	0.024	0.021	0.029	0.024	0.026	0.027
		(0.036)	(0.037)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
	L3D	-0.002	-0.005	0.004	0.008	0.005	0.006	0.006
		(0.030)	(0.030)	(0.031)	(0.030)	(0.030)	(0.030)	(0.030)
UninsIntMarg	*D*	0.880 *	...	...	2.200 **	0.197	...	-0.496
		(0.497)			(0.904)	(0.233)		(0.558)
JumboIntMarg		...	0.061	...	-1.953 **	...	0.285	0.818
			(0.312)		(0.942)		(0.268)	(0.709)
DepIntMarg		...	...	-2.298 **	...	-2.315 **	-2.505 ***	-3.073 **
				(1.056)		(0.989)	(0.975)	(1.355)
Size	*D*	9.721 ***	9.914 ***	9.574 ***	9.697 ***	9.829 ***	9.871 ***	9.881 ***
		(2.340)	(2.321)	(2.126)	(2.245)	(2.211)	(2.223)	(2.226)
Equity	*L1D*	0.445 ***	0.460 ***	0.373 ***	0.394 ***	0.379 ***	0.384 ***	0.387 ***
		(0.133)	(0.128)	(0.129)	(0.127)	(0.127)	(0.127)	(0.129)
NonCLoans	*L1D*	-0.046	-0.012	-0.070 *	-0.073 *	-0.086 **	-0.085 **	-0.087 **
		(0.040)	(0.041)	(0.042)	(0.040)	(0.041)	(0.041)	(0.043)
ResidLoans	*L1D*	0.061 **	0.056 *	0.061 **	0.067 **	0.061 **	0.059 *	0.059 *
		(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
LoansLeases	*L1D*	0.038 *	0.033 *	0.040 **	0.034 **	0.036 **	0.039 **	0.040 **
		(0.021)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
GDP	*D*	0.245 ***	0.212 ***	0.196 ***	0.279 ***	0.226 ***	0.210 ***	0.185 ***
		(0.047)	(0.043)	(0.042)	(0.052)	(0.042)	(0.042)	(0.043)
	L1D	0.090 *	0.062	0.086 *	0.135 ***	0.114 **	0.106 **	0.095 **
		(0.049)	(0.050)	(0.050)	(0.052)	(0.050)	(0.050)	(0.046)
Infl	*D*	0.599 ***	0.563 ***	0.456 ***	0.461 **	0.520 ***	0.489 ***	0.438 **
		(0.187)	(0.170)	(0.171)	(0.189)	(0.175)	(0.167)	(0.173)
Treas_1	*D*	-0.474 ***	-0.277 ***	-0.294 ***	-0.725 ***	-0.391 ***	-0.336 ***	-0.214 **
		(0.146)	(0.094)	(0.090)	(0.215)	(0.098)	(0.090)	(0.100)
Cons		-0.048	-0.021	0.005	-0.111	-0.019	-0.008	0.018
		(0.124)	(0.124)	(0.123)	(0.124)	(0.125)	(0.123)	(0.125)
Obs.		12,826	12,826	12,826	12,826	12,826	12,826	12,826
Banks		1,863	1,863	1,863	1,863	1,863	1,863	1,863
AB test of no AR(1) Pr > z =		0.000	0.000	0.000	0.000	0.000	0.000	0.000
AB test of no AR(2) Pr > z =		0.597	0.730	0.941	0.742	0.782	0.758	0.755
Sargan test of over-identification 4/ Pr > chi2 =		0.1463	0.0397	0.0006	0.0001	0.0002	0.0000	0.0000

1/ Model with endogenous price mechanism.

2/ Coefficients from first-step robust estimations, unless specified otherwise.

3/ L*i*D = in first difference with *i* lag(s); and D = in first difference.

4/ Sargan test is based on two-step regression results.

Overall, our results suggest that a bank can raise its share of uninsured deposits to total deposits by raising the premium it pays on uninsured deposits relative to the interest rate on total deposits (the coefficient of *UninsIntMarg* is positive). However, the evidence that a bank can induce an inflow of (new) uninsured deposits (as a share of total deposits) by raising its uninsured deposit interest rate above the industry average is much weaker (the coefficient of *JumboIntMarg* is not statistically significant).

Finally, if a bank raises its deposit interest rates above the industry average, it attracts mostly insured deposits (the coefficient of *DepIntMarg* is negative), raising total deposits (the denominator of the dependent variable). Note, however, that the very strong negative coefficient of *DepIntMarg* may suggest that a large part of the movement in the ratio of uninsured deposits to total deposits is related to movements in total deposits. In fact, it is possible to argue that weak banks may actually reduce the interest rate premium on uninsured deposits rather than raise it, as suggested earlier. This would still be consistent with the positive coefficient of *UninsIntMarg* but would suggest that banks in need of funding may try to substitute insured deposits for uninsured deposits.[25]

V. CONCLUSIONS

This paper attempts to capture banks' dynamic response to depositors' desire to withdraw their uninsured deposits if the performance of their bank is no longer satisfactory. In our view, depositors' reaction and banks' response must be modeled as a jointly determined process. When a bank's fundamentals are deteriorating, both the price and quantity of uninsured deposits may be shifting simultaneously, obscuring the effect of depositor discipline.

According to our results, the behavior of uninsured deposits is sensitive to bank fundamentals. This result, which is robust over a broad selection of banks and thrifts, shows evidence that the quality of a bank helps determine the quantity of uninsured deposits that a particular bank can attract for a given price. Furthermore, we find that the behavior of uninsured deposits is driven not only by changes in bank quality but also by price movements. Once we control for the endogeneity between the price and quantity mechanisms of uninsured deposits, our results suggest that banks are able to increase the quantity of uninsured deposits by raising the price (i.e., the interest rate) of uninsured deposits. We find, however, that they are able to do so only at a relatively high price. When differentiating among various qualities of banks, we find that good banks are in a better position to use prices to attract uninsured deposits than banks with a lower quality standing, suggesting that

[25] Further preliminary research suggests that a rise in the interest rate on uninsured deposits still has a substantial effect on the quantity of uninsured deposits as a share of total assets. These results, which eliminate the possible denominator effect, are consistent with those presented in this paper.

the price of raising uninsured deposits is related to a bank's quality, which is consistent with our hypothesis of depositor discipline.

This paper confirms the presence of depositor discipline in the U.S. banking system. Uninsured depositors monitor the health of their banks and discipline bad bank behavior by withdrawing their uninsured deposits and demanding a higher risk premium. Given the high level of U.S. deposit insurance coverage, this discipline for practical purposes affects only 25 percent of all deposits. Nevertheless, our results suggest that regulators may be able to exploit the information contained in declining insured deposits or a rising premium for uninsured deposits. In addition, if regulators can encourage depositor discipline, our results suggest that depositors would generate a greater penalty to banks for excessive risk appetite.

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