THE FINANCIAL SERVICES ROUNDTABLE

Financing America's Economy

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RICHARD M. WHITING
EXECUTIVE DIRECTOR AND
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January 14, 2011

Robert E. Feldman
Executive Secretary
Attention: Meeting Documentation
Federal Deposit Insurance Corporation
550 17th Street, NW
Washington, D.C. 20429

Re: **Assessments, Assessment Base and Rates, and Large Bank Pricing**

File Numbers: FR Docs. 2010-29137, 2010-29138

Mr. Feldman:

Attached is a report by Clifford Rossi entitled "Decomposing the Impact of Brokered Deposits on Bank Failure: Theory and Practice," which Clifford Rossi, Bill Longbrake, Abby McCloskey, and I presented to and discussed with Art Murton at our meeting on Thursday, January 6, 2011. Please include the report with your public documentation of our meeting, and also with the records of the rulemakings cited above.

The report contains findings that are directly related to the proposed rules on Assessment Systems now being considered by the FDIC. We hope that you find the report's contents to be helpful.

If you have any specific questions, please do not hesitate to contact me at Rich@fsround.org.

Sincerely Yours,

Richard M. Whiting

Richard M. Whiting
Executive Director and General Counsel
Financial Services Roundtable

cc: Art Murton, Director of Division of Insurance and Research, FDIC

Decomposing the Impact of Brokered Deposits on Bank Failure:

Theory and Practice

Study prepared for the Anthony T. Cluff Fund

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September 9, 2010

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Executive Summary

Brokered deposits have been much maligned over the last few years as a factor driving rising bank failure rates and yet surprising little research exists on the theory and impact of this funding source on risk-taking, asset growth and insolvency. Hence, this study offers the first comprehensive analysis of the role brokered deposits play in banking. Key observations and findings suggest the following:

- Brokered deposits are not a factor that directly explains bank failure, contrary to popular belief; however, asset growth and risk-taking are found to be statistically significant indicators of bank insolvency.

- In maximizing bank profit, the demand for brokered deposits is determined by the least cost combination of financial and nonfinancial inputs of the institution.

- The demand for brokered deposits as a factor of production is driven in part by the risk appetite and asset growth preferences of the firm, which are laid out as guiding principles during the bank's strategic planning exercise. As a consequence, brokered deposits may be viewed at most as an enabling force for otherwise misguided business strategy, particularly in the presence of constraints on retail deposit gathering.

- Current policies that assign higher premiums on deposit insurance for brokered deposit activity or restrict the use of these funding sources altogether focus on the symptom rather than the problem of excessive risk-taking and growth strategies that can lead to bank failure.

- Policies that attack fundamental weaknesses in risk infrastructure, corporate governance and incentive alignment have greater direct impact on mitigating bank failure than restrictions on the use of brokered deposits. Hence, greater focus must be placed in establishing risk-based deposit insurance premiums that are associated with the effectiveness of bank risk infrastructure and corporate governance structure.

These policy recommendations, furthermore, are consistent with the Dodd-Frank legislation's broad emphasis on improving risk management and corporate governance in the aftermath of the financial crisis.

Brokered deposits have been the focus of much attention in the wake of the financial crisis as it was following the thrift crisis more than 20 years ago. Highly publicized bank failures with large positions in brokered deposits have fueled the debate over whether this "hot money" funding source led to the sharp increase in recent bank failures. Policy changes introduced by the FDIC have eliminated the use of brokered deposits for firms not well-capitalized, capped the rates paid on these funding sources, and raised deposit premiums associated with brokered deposits on higher growth but better capitalized firms.

The empirical evidence so far on the contribution of brokered deposits to bank failure is surprisingly scant. Studies that emerged from the thrift crisis on bank failure shed limited light on the subject and even so the banking industry has radically changed since that time. Only one other study has investigated brokered deposits during the recent financial crisis. That study found evidence that brokered deposits do not seem to play a direct role in determining bank failure, however, the analysis was limited to a small subset of recent failures and more importantly did not lay out a theoretical foundation for brokered deposits.

This study establishes a theory for the demand for brokered deposits as well as for bank insolvency. Banks, after all, are profit maximizing financial intermediaries that utilize various factors of production such as retail and wholesale funding sources to produce financial assets subject to various constraints. This standard theory of bank production highlights a key hypothesis of this study that the demand for brokered deposits by banks is driven by fundamental structural relationships such as changes in input prices for deposits. This theory is extended to include risk-taking to show how riskier behavior leads to higher output produced by the bank than firms with less appetite for risk-taking. A corollary hypothesis tested is that risk-taking facilitates faster growth which can lead to higher losses and eventual insolvency. Clearly, the theory demonstrates that simple heuristic assertions that brokered deposits drive bank failure do not adequately reflect the underlying dynamics at the firm regarding risk-taking, growth, input selection and performance.

To test these hypotheses, two different modeling approaches are employed. One of these applies a constrained profit maximization framework to understand the relationships between brokered deposits, risk-taking, asset growth and operational inefficiency. A simple two-asset (signifying low- and high-risk assets), four-liability optimization model is developed where a stylized bank maximizes return on equity subject to a portfolio level risk tolerance. Portfolio risk encompasses credit, interest rate, market and liquidity risks. As the bank's tolerance for risk rises, firm returns rise as well. In this framework, banks seek to use their least cost combination of inputs (including brokered deposits) to determine their optimal portfolio allocation. This theory forms the primary hypothesis that brokered deposits act as a key input of production rather than as a direct cause for greater risk-taking and asset growth by itself. However, once constraints are imposed on the amount of retail deposits available to the firm, it reallocates to the next available liability with the lowest costs. In this example then, the linkages between risk-taking, asset growth and demand for brokered deposits are established. When retail deposits are constrained relative to growth targets, brokered deposits are among the feasible alternative inputs that can support higher growth strategies. It is not the case that profit maximizing banks raise brokered deposits with the intent of deploying them to risky positions as some would contend. Rather, annual strategic planning determines the target product set and growth rate given the risk appetite of the firm. Subsequently, banks deploy funding alternatives that meet these business objectives and maximize returns.

The simple optimization model establishes the expected relationships between brokered deposits, risk and growth; however, an econometric analysis is used to determine whether these results hold up empirically. Quarterly FDIC Reports of Condition and Income data on all failed depositories (168) from 2007-2009 were included as well as a random sample of 300 institutions still active as of 2010. The data tracked each firm back to Q4 2003 in order to observe firm behavior over time and how it contributed to performance. Five econometric models are estimated with the following dependent variables;

- Demand for brokered deposits
- Bank risk tolerance
- Bank 4-quarter asset growth rate
- Bank risk performance (loss rate)
- Probability of insolvency

The demand for brokered deposits is estimated to be a function of bank outputs and input prices, consistent with the theory of bank production. Other factors of interest in the model include asset growth rates, financial performance and operational inefficiency metrics, risk tolerance and loss rates. Risk tolerance is measured by the ratio of risk-weighted assets (determined by risk-based capital requirements) to total assets. Results from this model find that higher asset growth and risk-taking increases the demand for brokered deposits. However, that does not imply that brokered deposits drive risky behavior.

To better understand whether brokered deposits act as a catalyst in promoting risk-taking and/or high asset growth strategies, the asset growth, risk preference and loss rate models were specified to include brokered deposits. While such factors as prior period return on equity, operational inefficiency and asset growth are found to be directly related to risk preference; brokered deposits were not found to be a factor explaining risk-taking. Similarly, the asset growth rate model was designed to further investigate whether brokered deposits were a factor in driving firm growth over time. While such factors as return on assets, operational inefficiency and risk-taking all contributed to explaining higher asset growth rates, once again, the brokered deposits variable was found to be insignificant.

The study differentiates between risk preference and risk performance (realized loss rates) in the model specification. Bank loss rates are expected to be influenced by several factors including prior period asset growth rates, risk tolerance and operational inefficiency. Asset losses grow according to their time profile of default which varies by product type. Consequently, past periods of high growth which may include expansion into new products, coupled with a higher tolerance for risk should be expected to lead to higher losses over time. And firms that exhibit operational inefficiencies are hypothesized to have process deficiencies that may show up as underwriting problems that contribute to higher losses. While risk preferences, asset growth and operational inefficiency were important factors explaining loss rates in this model, brokered deposits are found to be indirectly related to loss rates, suggesting that lower ratios of brokered deposits to total deposits yield higher loss rates across firms, controlling for other factors.

Completing the econometric analysis is a model of bank insolvency. These models have been widely used in understanding bank failure and typically relate insolvency to a series of regulatory-based factors such as capital levels, earnings quality, liquidity and other risks. Unfortunately, these models have little theoretical underpinning by themselves and hence are of limited empirical value in understanding complex relationships between risk-taking, growth, liability selection and bank failure. Using the well-known Merton default framework to characterize bank insolvency, factors influencing failure include assets and debt (including insured and uninsured deposits), expected returns and firm risk. As a result, brokered deposits enter the insolvency model along with these other factors. The empirical results show that the brokered deposits variable was not statistically important in predicting bank failure, controlling for the other factors, however, another liability; time deposits greater than $100,000 were found to be directly related to bank failure. The findings from this study clearly suggest that banks use brokered deposits as a factor of production, consistent with standard theory, and that brokered deposits do not promote greater risk-taking, asset growth or a higher likelihood of bank failure.

Brokered Deposits: Perspectives and Policies Over Time

To some observers of the use of brokered deposits by banking institutions, lightning, in a sense, has struck twice. The recent financial crisis has once again sharpened the debate over the impact brokered deposits, also known as "hot money," may have had in the rise in bank failures across the country in the last few years. Only removed a little more than two decades from today's financial meltdown, the thrift crisis spawned the first real policy changes on brokered deposits. Lately, additional restrictions on brokered deposits have come along in an effort to address concerns that such funding sources fueled excessive risk taking and asset growth, ultimately leading to failure in many cases.

To this point, little evidence has surfaced that would support such policies and so, this study puts a fresh face on an old policy issue. Studies of brokered deposits are not new and, as will be described in the next section, an extensive literature on bank failure exists, however, few have focused on brokered deposits as a variable of interest. The majority of studies were conducted not surprisingly around the time of the thrift crisis in the late 1980s and into the early 1990s and much has changed in the industry since that time. What differentiates this study from all others is it first lays out a theory for how brokered deposits enter into the bank's decisionmaking, drawing from standard economic theory of production and expected profit maximization. Building risk and uncertainty into the theoretical framework, the theory suggests that brokered deposits are one of several key inputs of production that banks use to maximize expected profitability. The second part of the study tests the theory empirically.

White characterized the argument used in the aftermath of the thrift crisis to defend policy restrictions on brokered deposits as follows:

> "If a bank or thrift pays high interest rates to attract brokered funds, it will be forced to invest those funds in high risk-endeavors, so as to earn sufficient income to cover those high interest costs.[1]"

These sentiments still resonate today as arguments promoting restrictions on brokered deposits in the aftermath of the financial crisis. For example, the Office of the Comptroller of the Currency has acknowledged their concern that brokered deposits could be used to fund unwarranted growth.[2] White correctly lays out the brokered deposits argument as essentially one of putting the cart before the horse. In his view, banks already have decided upon a high risk course of action ahead of any funding strategy.

Historically, there has been a simple relationship observed between brokered deposits and asset growth which caught the attention of the Federal Home Loan Bank Board in 1984 when it proposed restricting deposit insurance coverage to $100,000. Fast forward to the present and there has been an evolution in the policy toward the level and pricing of brokered deposits vis-à-vis bank

1 Lawrence White, The S&L Debacle, 1991, p.128.
2 Robert Garsson, OCC quoted in American Banker, "Agencies Zero in on Brokered Deposits," Joe Adler, May 22, 2008.

risk-taking. By 1991, banks that were not adequately capitalized from a regulatory capital perspective had been barred from accepting brokered deposits. Of more immediate interest is the FDIC's latest rule regarding brokered deposits. Section 29 of the Federal Deposit Insurance Act in addition to limiting the taking of brokered deposits by less than well capitalized banks also imposed restrictions on the interest rates that could be paid for deposits by these firms. According to this rule, any depository that is not well capitalized may not pay interest in excess of 75 basis points over the average interest rate paid for deposits in the bank's "normal market area". For institutions that obtain a brokered deposits waiver, the interest rate cap is relative to a national rate determined by the FDIC.

In addition to these rules, the FDIC has proposed adjustments to bank deposit insurance premium structures for brokered deposits. For well capitalized banks, there is no incremental increase for their brokered deposit activities directly. However, in computing the initial deposit insurance assessment rate for these firms, an adjusted brokered deposit ratio is computed for each well capitalized bank. Depending on the level of this ratio, in conjunction with its asset growth rate over the last four years, a higher initial assessment could be charged even to these institutions.[3] The adjusted brokered deposit ratio effectively increases premiums based on the proportion of brokered deposits to total domestic deposits of the institution. For less than well-capitalized institutions, an additional assessment up to 10bps is possible for their brokered deposits activities.

To be sure, specific cases where brokered deposits were singled out as having contributed to a bank's failure recently exist. Take for example, in 2005, when the Office of the Comptroller of the Currency (OCC) determined that ANB Financial of Arkansas had used brokered deposits to grow quickly. Unfortunately, a paucity of empirical studies exists that assess the underlying relationships of bank uses of brokered deposits in the years leading up to the crisis and afterward. More often than not, individual bank failures appear to be the primary evidence supporting current policy.

It is tempting to lay blame on brokered deposit markets for promoting high risk activities without looking closer at the theory for how financial intermediaries turn liabilities into earning assets. At first glance, based upon a simple univariate view, Table 1 (Appendix II) corroborates other statistics that seem to support some association between the level of brokered deposits and bank failure, however, the relationship is much more complex. The sharp increase in the number of bank failures over the last few years has provided fodder for some to paint brokered deposits as a leading factor for the high incidence of failures so far. *The New York Times* for instance cited the statistic that banks recently failing had brokered deposit levels four times higher than the national average.[4] They further went on to cite data that a subset of troubled institutions held levels of brokered deposits that were double the national average. Such simple relationships and individual bank failures do not establish an empirically supportable link that brokered deposits are an important factor leading to bank failure across the industry. The debate over brokered deposits at this time, in some sense, bears similarity to the issue over the use of derivatives, also much maligned in recent years. Just as derivatives can be an effective risk management tool, brokered deposits present a viable option to banks in their liability and liquidity management strategies.

During and immediately following the thrift crisis, a number of bank failure studies were conducted that included brokered deposits. These studies leveraged the seminal research on corporate bankruptcy

3 If the ratio of brokered deposits to domestic deposits is less than or equal to 10% or the growth rate of the firm is less than 40% over the last 4 years, then no increase in the initial assessment rate for brokered deposits is assigned. This is as reported in the FDIC Financial Institution Letter, FIL-12-2009, Deposit Insurance Assessments: Final Rule on Assessments, April 2009.

4 Eric Lipton and Andrew Martin, "For Banks, Wads of Cash and Loads of Trouble," New York Times. July 4, 2009.

by Altman using discriminant analysis.[5] A common approach of many of these studies is their application of bank-level accounting data such as from FDIC Call Reports of Condition and Income to develop early warning predictions of bank failure. Toward that objective, model specification efforts not surprising focused on leveraging supervisory rating systems such as CAMEL.[6] As a result, these models focused on variables describing bank capital adequacy, asset quality, management quality, earnings, liquidity and other structural attributes. Examples of such early efforts include Hanweck, Sinkey, and Wheelock and Wilson.[7] By taking a ratings-based approach to addressing the drivers of bank insolvency, these studies provide virtually no support for how key variables of interest in the models relate to one another in theory. For that reason, one of this study's major contributions is in leveraging theory of bank production and Merton's model of corporate default in formally laying out a foundation for linkages between brokered deposits, risk-taking, asset growth, loss and insolvency.

Over time some bank failure studies that include brokered deposit variables have emerged. Schaeck, in a study of US bank failures between 1984-1996 using an accelerated failure time model, found that variables reflecting brokered deposits were statistically significant and led to shorter failure times.[8] The regulatory agencies have also increasingly redeveloped their early warning models to incorporate the effects of noncore deposits including brokered deposits.[9]

Central to the present analysis is the direction of causality and linkages around brokered deposits and asset generation according to standard production theory, asset growth, risk-taking and their contributions to loss and ultimately bank failure. It will be shown that riskier firms tend to generate more assets than their risk-neutral counterparts and that this asset growth could lead to higher levels of losses and failure. But brokered deposits on their own are not hypothesized to be a direct factor in explaining bank insolvency, controlling for other factors such as risk and growth.

Recently, Mason, et al. conducted an empirical analysis solely focused on the impact of brokered deposits on bank failure using failed bank data from the financial crisis.[10] Borrowing from the previous literature approach of using proxy variables for the individual components of bank CAMEL ratings, the authors sought to determine whether brokered deposits were more or less predictive of bank failure during the thrift crisis than today. In this case, the dependent variable was bank failure in a probit model segmented along several time periods. Among the explanatory factors in the model was the FDIC adjusted brokered deposit ratio as described earlier. This variable was found to be statistically significant only in the period 1991-1993 and 1997-1999, but had no explanatory power to predict bank failures from the recent financial crisis.

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5 Edward I. Altman, "Financial Ratios, Discriminant Analysis, and the Prediction of Corporate Bankruptcy," Journal of Finance, September 1968, 23(4), pp. 589-609.

6 Rebel A. Cole and Qiongbing Wu, "Predicting Bank Failures Using a Simple Dynamic Hazard Model," working paper, April 13, 2009, p.9.

7 Gerald A. Hanweck, "Predicting Bank Failure," Board of Governors of the Federal Reserve System, Research Papers in Banking and Financial Economics, November 1977,19., Joseph F. Sinkey, Jr., "A Multivariate Statistical Analysis of the characteristics of Problem Banks," Journal of Finance, March 1975, 30(1), pp.21-36., and David C. Wheelock and Paul W. Wilson, "Explaining Bank Failures: Deposit Insurance, Regulation, and Efficiency," Review of Economics and Statistics, 1995, 77(4), pp.689-700.

8 Klaus Schaeck, "Bank Liability Structure, FDIC Loss, and Time to Failure, A Quantile Regression Approach," FDIC Working Paper, August 2006.

9 King, et' al, "Are the Causes of Bank Distress Changing? Can Researchers Keep Up?," Federal Reserve Bank of St. Louis Review, January/ February 2006, 88(1). The authors cite the use of the FDIC Growth Monitoring System and the St. Louis Federal Reserve Bank Liquidity and Asset Growth Screen models as building in these types of deposits.

10 Mason, et al., "The Effect of Brokered Deposits and Asset Growth on the Likelihood of Bank Failure," Empiris, LLC Study, December 17, 2008.

This finding has potentially important policy implications on restrictions to brokered deposits as well as on deposit insurance premiums; however, the analysis is based on a limited failure database from the recent period. At the time of the analysis, the authors were able to use failures for the recent crisis reported through the end of 2008. As a result, the authors reported having 27 bank failures for 2007 and 2008. For the results to be more robust, a larger sample of failures from 2009 is required. Further, the authors do not address causality or other relationships brokered deposits may be posited to have with asset growth, risk-taking or loss. For this reason, the current study extends the analysis by Mason et. al. by leveraging a larger database of recent failures and expands the econometric modeling to better understand brokered deposit linkages to other bank activities and attributes.

A Bank Production-Oriented Theory on the Use of Brokered Deposits

Research on the impact of wholesale deposits generally, and brokered deposits specifically on bank insolvency, lacks a rigorous theoretical framework from which to empirically test formal relationships. As indicated above, the standard approach in most analyses of wholesale deposit effects on bank insolvency is to specify a bank failure model that includes a set of proxy variables for bank risk, capital, assets and deposits. This study significantly extends the existing literature on wholesale deposit effects on bank failure by establishing a comprehensive theoretical foundation for optimal bank decisions.

Banks are assumed to be profit maximizing financial intermediaries converting various financial and nonfinancial inputs into earning assets.[11] Further, the bank is expected to maximize profit subject to technical conditions underlying a production function, $P(q_1, \ldots q_n, x_1, \ldots x_m) = 0$. In developing their strategic plans for the coming year, banks take into consideration a host of other information in setting their asset targets. These include such factors as relative peer profitability and other indicators of performance, business structural issues such as product concentrations and competitive conditions, among others. Critically important to this study is establishing the linkage between brokered deposits and the likelihood of bank failure. Through the production function whereby the bank as a financial intermediary uses its financial inputs, assumed here to include various forms of deposits including retail and wholesale sources as well as other funding sources, and nonfinancial inputs such as physical premises and personnel; the bank determines its level and combination of assets to produce, taking into account other external factors as described.[12]

To illustrate the linkage between assets and deposits in this construct, assume the bank has a single asset denoted q in the model above that is produced using two types of deposits; x_1 represents retail deposits and x_2 describes brokered deposits. The relationship described by the CES production function shows that both inputs as factors of production define the level of assets for the firm. In equilibrium, the bank will select a target level of output q that maximizes expected utility of profit formally described below. The input combinations of x_1 and x_2 are then optimized by their least cost combination in the profit function subject to any technical production constraint such as funding limitations. External factors driving target output for the bank such as peer performance or other metrics could be subsumed within the constant term C of the production function.

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11 Profit π is defined as:

$$\pi_i = \sum_{i=1}^{n} r_i q_i - \sum_{j=1}^{m} i_j x_j$$

where r_i represents the rate on earning assets q for the ith product, and i_i is the cost associated with the jth input x, either financial (e.g., brokered deposits) or real (e.g., personnel).

12 As a result, the relationship between bank output and inputs could be described by the following first-order condition of the following simple constant elasticity of substitution (CES) production function:

$$q = C\left(\left(\alpha x_1^{-\rho} + (1-\alpha)x_2^{-\rho}\right)^{-\frac{1}{\rho}}\right.$$

$$\frac{\partial q}{\partial x_1} = \frac{\alpha}{C^{\rho}}\left[\frac{q}{x_1}\right]^{\rho+1}$$

$$\frac{\partial q}{\partial x_2} = \frac{1-\alpha}{C^{\rho}}\left[\frac{q}{x_2}\right]^{\rho+1}$$

The profit model can be extended to include the production function as well as to introduce uncertainty (risk) into the decisionmaking process.[13] The term $\frac{\partial E(\pi_i)}{\partial x_j}$ represents the input demand function for the *jth* input *x*. In this specification, input demands are a function of input prices *i* as well as the production function. Taking for example, brokered deposits as an input variable of interest, the change in expected profit for a unit change in the level of brokered deposits would be dependent upon changes in the costs of its inputs as well as the relationship between bank outputs (assets) and inputs (liabilities and other real inputs) as established by the production function *P*. In other words, changes in profit arising from changes in brokered deposits are driven by underlying structural economic relationships. Taking these theoretical relationships further, we can postulate the relationship between asset growth and risk-taking which figures prominently in policy discussions of brokered deposits.[14] The implication from this result is that risk-taking leads to higher output produced by the bank than if the bank were risk-neutral. With this result we can establish then that asset growth for the bank must be related to the risk appetite of the firm. With the model establishing input demand as a function of input prices and the production function, the model describes how risk-taking at the bank relates to a target level of output. This framework suggests that brokered deposits certainly are a factor of production, but that asset growth and investment in riskier products is driven more by overall risk-taking of the firm rather than fueled by brokered deposit strategies. In this formulation, output is determined by the least cost combination of inputs subject to various constraints on those inputs. This theory stands in stark contrast to heuristic assertions that brokered deposits lead to investment in riskier strategies. However, it should be made clear that the existence of technical constraints on inputs can influence input allocation. For instance, if banks set a target level of assets for the next year that cannot be funded solely with retail deposits due to capacity constraints, then brokered and other wholesale deposits would be used to fill the gap, subject again to profit maximization conditions. Nonetheless, the role of brokered deposits in this production-oriented view of banking is central to the empirical analysis and affords a structured way of viewing the impact of brokered deposits on bank activities that has been missing in other studies.

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13 $\pi_i = \sum_{i=1}^{n} r_i q_i - \sum_{j=1}^{m} i_j x_j + \lambda \mathrm{P}(q_1,\ldots q_n, x_1,\ldots x_m)$

where λ is a Langrangian multiplier. Introducing output uncertainty into the model, the bank is assumed to maximize expected profit :

$$E(\pi_i) = \sum_{k=1}^{K} \kappa_k \left[r_i q_i - i_j x_j + \lambda \mathrm{P}(q_1,\ldots q_n, x_1,\ldots x_m \right]$$

where κ_k represents the probability of output q_i. The first order conditions with respect to output and input are as follows:

$$\frac{\partial E(\pi_i)}{\partial q_i} = \sum_{k=1}^{K} \kappa_k \left[r_i + \lambda \mathrm{P}'(q_1,\ldots q_n, x_1,\ldots x_m \right] = 0$$

$$\frac{\partial E(\pi_i)}{\partial x_j} = \sum_{k=1}^{K} \kappa_k \left[-i_i + \lambda \mathrm{P}'(q_1,\ldots q_n, x_1,\ldots x_m \right] = 0$$

In the model, it is assumed that $0 < \alpha < 1$ and $\rho > -1$ and C is a constant.

14 Adapting the profit model above, assume that the bank maximizes the expected utility of profit as follows:

MAX $E[U(\pi_i)] = \sum_{k=1}^{K} \kappa_k U(\pi_i)$

Setting the derivative of output q equal to zero yields:

$$\frac{dE[U(\pi_i)]}{dq_i} = \sum \kappa_k U'(\pi_i)(r_i + \lambda P') = 0$$

Assuming that the bank utility function follows Neumann-Morgenstern expected conditions, a bank that is risk-neutral would exhibit second-order conditions:

$$\frac{d^2U}{d\pi^2} = 0$$

In the case that the bank is a risk-taker, it can be shown that the second-order condition must satisfy the following:

$$\frac{d^2U}{d\pi^2} > 0$$

Which implies that $\sum \kappa_k U'(\pi_i)(r_i + \lambda P(q^*)') > 0$, where q* is the level of bank output that solves the profit maximization problem above. In such situations, q* is greater than the equilibrium level of q that solves $\sum \kappa_k U'(\pi_i)(r_i + \lambda P(q^*)') > 0$.

A second focal point of the theory and analysis is on establishing the relationship between brokered deposits (or more generally wholesale deposits) and bank insolvency. For this section, the Merton default model provides useful insights. Applying an option-theoretic approach to the valuation of risky debt, Merton established a relationship where the key decision variables influencing bank solvency are the bank's asset and debt (including insured and uninsured deposits) levels, expected returns, and firm risk as measured by σ. Consequently, brokered deposits appear in this model as one type of liability. However, to be clear, the potential for mispriced deposit insurance tends to promote greater risk-taking by banks and hence the level of insured deposits at the bank should also be reflected in the insolvency model.[15]

Finally, the volatility of firm value will be driven by losses in prior periods and decisions regarding product allocations and underwriting, among other factors.[16] Realized losses in time t are hypothesized to be a function of risk appetite in previous periods as loans season up over time and losses appear years afterward. The same lagged relationship is hypothesized for volatility and asset growth, where prior year growth could affect loan performance in later periods. Also, it is hypothesized that in situations where growth in markets and hence assets occurs quickly, process breakdowns can occur where insufficient staffing and/or expertise may lead to poor asset underwriting. Thus, operational inefficiencies can be directly related to higher losses for the bank. Similarly, the bank's willingness to take on greater risks, as has been shown, may be a contributing factor to higher levels of assets than would be realized in a risk neutral state. For clarity, a distinction is made here between the level of risk as measured by σ, and the risk appetite γ of the firm. The former measures the realized credit risk while the latter measures the risk-taking tendency of the firm. Rounding out these factors is the bank's asset composition, C which would be an indicator of aggregate risk based on the individual assets and their relative risk levels.

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15 The Merton default model can be described as the following:

$$E(V,D,T,t) = VN(d) - Z_t(T)DN(d - \sigma\sqrt{T-t}))$$

$$d = \frac{\ln(V / P_t(T)D)}{\sigma\sqrt{T-t}} + .5\sigma\sqrt{T-t}$$

Where E is the value of the bank's equity, V is the value of the bank, D is face value of the firm's zero coupon debt maturing at time T, s is the volatility of the firm's value, Z is the price of the zero coupon debt and N(d) is the cumulative distribution function computed at d. It can be shown that the probability that the bank becomes bankrupt is given as follows:

$$\Pr ob(V_t < D_t | V_t) = N\left[-\frac{\ln(V_t / D_t) + (\alpha - \delta - .5\sigma^2)(T-t)}{\sigma\sqrt{T-t}}\right]$$

Where α and δ are the expected return to the firm and cash payment to claimholders of the firm.

16 $\sigma_{it} = f(O_{it-n}, dA / A(\gamma_{it-n}), C_{it-n}, \gamma_{t-n})$ In this conceptual specification, the variable O represents operational inefficiencies for the firm, dA/A(γ) measures the bank's asset growth rate which is a function of risk appetite, γ and C is the firm's asset composition.

A Constrained Profit Maximization Example

To better motivate the relationships developed in the theory section, a simple constrained profit maximization problem is set up for a stylized bank. This simple two asset (outputs), four liability (inputs) bank maximizes return on equity subject to a set of operating constraints.[17] Just as in the case of an investment portfolio optimization problem, the bank faces a portfolio risk constraint. In this case, risk is defined as the sum of both asset (credit, market and interest rate risk) and liquidity risk arising from the liability side.[18] The institution's risk appetite is defined by the variables Ψ, Ω and Φ. An important assumption implicit in the portfolio risk expression is that there is no correlation between asset and liability liquidity risk.[19]

Completing the example are constraints on the percentage increase in new retail deposits as a function of existing retail deposits and an annual asset growth rate target. It is assumed that the percentage increase in assets is accompanied by a corresponding increase in asset risk due to operational issues that result in greater underwriting errors.

For this stylized example, Table 2 presents the rates and standard deviations of the assets and liabilities. Assets of the stylized bank are set initially at \$100M and equity (*E*) at \$10M. All correlations were set at .25, providing some degree of positive association between assets and liabilities. Sensitivity of results to changes in correlation assumptions is not of central interest to this example, although

17 This simple model could be extended in several ways to include losses and operating expenses, but for this example, they are assumed to be part of the net coupon rate for the assets.

$$\frac{\left[r_{LOW}\,w_{LOW} + r_{HIGH}w_{HIGH} - i_{RD}w_{RD} - r_{NRD}w_{NRD} - i_{BD}w_{BD} - i_{OBM}w_{OBM}\right]}{E}$$

Where
r_{LOW} = coupon on low risk assets,
r_{HIGH} = coupon on high risk assets,
i_{RD} = rate on retail deposits,
i_{NRD} = rate on new retail deposits,
i_{BD} = rate on brokered deposits,
i_{OBM} = rate on other borrowed money, and
E = equity

18 $\sigma_P = \sigma_A + \sigma_L \le \Psi$

Where σ_P = portfolio risk,
σ_A = asset risk, and
σ_L = liquidity risk due to liabilities
Applying a mean-variance approach to measuring both risks yields the following expressions for risk:

$$\sigma_A = w_{LOW}^2\sigma_{LOW}^2 + w_{HIGH}^2\sigma_{HIGH}^2 + 2\sigma_{LOW}\sigma_{HIGH}w_{LOW}w_{HIGH}\rho_{LOWHIGH} \le \Omega$$

$$\begin{aligned}\sigma_L = {} & w_{RD}^2\sigma_{RD}^2 + w_{NRD}^2\sigma_{NRD}^2 + w_{BD}^2\sigma_{BD}^2 + w_{OBM}^2\sigma_{OBM}^2 + 2w_{RD}w_{NRD}\sigma_{RD}\sigma_{NRD}\rho_{RDNRD} + \\ & 2w_{RD}w_{BD}\sigma_{RD}\sigma_{BD}\rho_{RDBD} + 2w_{RD}w_{OBM}\sigma_{RD}\sigma_{OBM}\rho_{RDOBM} + 2w_{NRD}w_{BD}\sigma_{NRD}\sigma_{BD}\rho_{NRDBD} + \\ & 2w_{NRD}w_{OBM}\sigma_{NRD}\sigma_{OBM}\rho_{NRDOBM} + 2w_{BD}w_{OBM}\sigma_{BD}\sigma_{OBM}\rho_{BDOBM} \le \Phi\end{aligned}$$

19 In addition, the following adding up and boundary conditions on key variables are imposed as follows:

$$0 \le w_i \le X \le 1$$

$$0 \le w_j \le Y \le 1$$

$$\sum_{i=1}^{2} w_i = 1$$

$$\sum_{j=1}^{4} w_j = 1$$

$$E / A \le R$$

where *i* represents the *ith* asset, *j* the *jth* liability, *E/A* is the required capital to asset ratio for minimum regulatory capital ratio *R*.

the analysis could easily be updated to reflect other correlations. Moreover, the covariance matrix for assets and liabilities using the above inputs is described in Tables 3 and 4.

With these inputs, several tests of relationships between risk-taking, asset growth and liability structure can be performed. Specific questions of interest are the following:

- How does the bank's maximization problem affect the least cost combination of inputs; particularly as it relates to brokered deposits?
- How does the bank's willingness to take risk affect optimal asset and liability selection?
- How does asset growth affect liability structure?
- How does operational inefficiency affect risk and asset/liability structure?
- How does a bank's liability liquidity risk preference shape liability structure?

Table 5's optimization results provide some answers to these questions. Underlying these results, asset growth is assumed to be zero over the next year. Focusing on the first set of results for when the percentage of retail deposits to total liabilities is less than or equal to 75%, ROE rises as expected with the firm's willingness to accept more risk. This is consistent with standard portfolio optimization results.

Imposing constraints on the percentage of retail deposits in the liability structure has dramatic effects on returns as well as product and liability allocations across portfolio risk scenarios. For example, as the percent of low cost retail deposits declines due to capacity constraints, returns decline reflecting greater use of higher cost inputs (brokered deposits). The results are consistent with the theory that the firm selects the least cost combination of inputs (in this case liabilities) in order to maximize returns. As capacity constraints on the cheaper retail deposits input tighten, holding risk constant, it forces the firm to opt in for the higher cost brokered deposits input.

Table 5 also illustrates that as risk-taking increases (as evidenced by higher target levels of portfolio risk), the bank allocates more of its assets to the higher risk product. Note that when the percent of retail deposits to total liabilities is capped at 50% or 75%, the percentage allocated to brokered deposits remains almost always the same regardless of risk-taking. Once retail deposits are capped at 25% there is a positive association between risk-taking and the allocation of brokered deposits. Once a more restrictive retail deposits cap is in place, the slack taken up by brokered deposits becomes more evident. In this case, a key takeaway is that risk-taking in situations where there may be tighter constraints on retail deposits can lead to greater allocation of brokered deposits.

Turning next to asset growth, Table 6 displays the results of several asset growth scenarios. Specifically, asset growth rates ranged from a low of 0% to 25% in 5% increments. Also, a cap on retail deposits of 50% was assumed. As mentioned earlier, a corresponding assumption was that the standard deviations for low and high risk products increased in proportion to the asset growth rate scenarios due to operational challenges resulting in poorer underwriting quality. Also, it assumed that there is no correlation between asset risk and brokered deposits. Finally, Table 6 assumes the bank has a target level of portfolio risk of 3%.

This assumption is critical to the results in that regardless of growth scenario, brokered deposits as a percent of liabilities remains constant at 37.5%. This relationship is tested directly in the statistical analysis section but the significance of this relationship is clearly underscored by the optimization results. (Note the increase in low risk assets as asset growth rates rise.) A tradeoff between risk and return naturally emerges whereby the overall risk constraint drives up the percentage allocation of low risk assets to the detriment of the ROE. However, by relaxing the portfolio risk constraint (i.e., allowing greater risk-taking), the bank would tend to direct more assets into high risk products.

Firm efficiency should also influence the optimization results. In the example, the rates offered on new and existing retail deposits are changed in the model as a way of defining inefficiency. Specifically, firms with a higher cost of producing deposits are deemed inefficient. For this analysis three deposit cost scenarios are compared and shown in Table 7. The baseline scenario where i_{RD} and i_{NRD} equal 1.5% and 2.0%, respectively, was used to construct the other two scenarios. That is, the optimization problem was changed for the two inefficiency (higher deposit cost) scenarios so that it minimized portfolio risk subject to the baseline target *ROE* of 34.1%. Due to the fact that brokered deposits are not correlated with asset risk, the percent allocated to this liability type remains invariant to deposit cost assumptions. However, as firms exhibit greater deposit costs and hence inefficiency, overall risk rises for the same return. Moreover, to compensate for the required return given higher deposit costs, the bank increases its high risk asset mix.

The results from this optimization exercise provide an analytical backdrop supporting the theory section and the statistical analysis to follow. It should be clear that brokered deposits as an input to production do not drive risk-taking or asset growth at banks at least in this stylized framework. Instead, banks determine their level of risk appetite and set asset growth targets to guide optimal allocation of assets and liabilities. Depending on the constraints acting upon the firm, for example in the form of brick and mortar retail branching limitations, risk preferences and asset growth targets determine the level of wholesale funding sources, rather than the other way around. The statistical analysis that follows seeks to corroborate this hypothesis regarding brokered deposits.

Econometric Methodology, Testable Hypotheses and Results

Having established a theory for the use of brokered deposits, the purpose of the statistical analysis is to better understand the role of brokered deposits in developing the bank's production, risk and growth strategy. These activities in turn influence the likelihood of failure as described by the Merton default model. For the econometric analysis, five models are specified with dependent variables defined from the Call Report data as follows:

1. Log of Brokered Deposits – Distributed Lag Regression
2. 4-Quarter Average Asset Growth Rate – Distributed Lag Regression
3. Risk Profile – Distributed Lag Regression
4. Loss Rate – Distributed Lag Regression
5. Bank Failure – Logistic Regression

A complete picture on the use of brokered deposits emerges from examining the five regression models; that is not possible when focusing only on bank failure models, as has been the case in most studies on this subject. Each model leverages the Bank Call Report panel data described in the data section that includes both failed and nonfailed depositories over time (see Appendix I). The a priori relationships of key variables on the dependent variables in the above models are shown in Table 8.

To be consistent with the theory section describing the input demand function for a firm, variables affecting the demand for brokered deposits should include asset size and composition, other liabilities and input and output prices, among other factors. In the models, the log of assets, liabilities and deposits enter as independent factors. Asset composition is captured by three variables; the percentage of assets in real estate loans (including 1-4 family residential (1^{st} and 2^{nd} liens), multifamily and construction loans), the percentage of assets in commercial and industrial (C&I) loans and finally, the percentage of all other assets. In addition to the brokered deposits variable, factors describing the percentage of other borrowed money to total deposits, and other deposits (defined as total deposits less brokered deposits and other borrowed money to total deposits) are used in the modeling. Interest and noninterest income, as a percent of assets, is a candidate variable as is interest expense, and total operating expenses (bank premises plus salaries and noninterest expense) as a percent of assets. Regulatory capital ratios, specifically Tier 1 leverage and Tier 1 risk-based capital ratios, are also incorporated into the analysis as appropriate. During the estimation process, some variables such as asset ratios and the risk preference variable do not appear together in the final models due to multicollinearity.

Based on economic theory and consistent with bank strategy, it is assumed that asset targets are determined as part of the strategic planning process with funding strategies and allocations then devised to support that strategy taking into consideration various constraints on availability of funding sources, collateral requirements and asset-liability policy.

As described in the theory section, understanding how brokered deposits affect both the type of assets a bank invests in as well as its asset growth is of great interest as the results have significant policy implications. Findings that brokered deposits have limited or no impact in predicting the types of assets a bank invests in or its degree of asset growth would provide a partial indication that brokered deposits are not responsible for fueling excessive bank risk-taking. To complete this picture requires understanding how brokered deposits affect loss and the probability of insolvency, taking into account other factors described in the theory section.

Risk-Taking, Asset Growth and the Demand for Brokered Deposits

Consistent with the theory reviewed earlier, the demand for brokered deposits should be expected to be determined by factors represented in the production function such as bank outputs and inputs, as well as input and output prices. Variables of interest that proxy for these general effects include asset size, specific asset-type ratios, financial performance metrics and operational inefficiency. The 4-quarter average asset growth rate is defined as:

$$Growth = \frac{Assets_t - Assets_{t-4}}{Assets_{t-4}}$$

Loss rates are also included in this model. Loss rate is defined as loans 90+ days past due plus nonaccrual loans as a percentage of total assets. Operational inefficiency is defined as the expense ratio in quarter *t* for firm *i* as a percent of average industry expense ratios for the same period. Higher values of this variable indicate relatively higher expense ratios than the industry average for that time period (signaling greater inefficiency). A polynomial distributed lag regression model is specified with several variables such as assets, asset growth and loss rates.

The model dependent variable is the log of brokered deposits. Various combinations of independent variables were tested with the final model presented in Table 9. The model was specified as a distributed lag regression with an autoregressive (AR1) process. Both failed and active banks were included in the model. The final model achieved a high degree of predictiveness with an R^2 of .95. The model also produced a Durbin-Watson statistic of 2.09 and so serial correlation does not appear to be a concern in the results.

A number of variables in the model were significant at the 5% level that are consistent with input demand theory. Assets, a proxy for bank total output, were significant for the current period and prior quarter, with current period assets showing a positive relationship with brokered deposits. Two inputs, *Time Deposits* > $100,000 and *Other Deposits*, were also significant. *Brokered Deposits* appear to be inversely rated to *Other Deposits* which include core bank deposits and positively related to *Time Deposits* >$100,000. Neither the income or expense ratios, proxies for output and input prices were significant.

Other variables hypothesized to influence the demand for brokered deposits turned out to be significant as well. The 4-quarter average asset growth rate was one of these variables, indicating that firms with higher growth rates tended to increase the demand for brokered deposits. This would be consistent with a view that asset growth promotes a demand for wholesale funding sources such as brokered deposits, particularly if retail deposits are constrained. The measure of risk-taking, risk-weighted assets as a percentage of total assets, was positively related to the amount of brokered deposits, suggesting that the higher the bank's risk tolerance, the higher the amount of brokered deposits. This result partially corroborates the view that risk-taking drives brokered deposits, rather than firms using brokered deposits to invest in riskier activities. The companion regression model of risk preferences reviewed later provides additional support for this perspective when controlling for brokered deposits.

Assessing Brokered Deposits Impact on Asset Growth

To better understand the impact of brokered deposits on explaining bank asset growth rates and risk preferences for the portfolio, two models are specified. The first model describes the firm's asset growth rate, which is specified as the annualized change in total assets from the previous year. Factors affecting growth rates fall into the following categories:

- Risk Appetite
- Business Composition
- Relative Peer Performance
- Funding Type

Both contemporaneous and lagged effects for variables proxying for these factors are considered in the models where appropriate. In some cases, growth rates and asset risk will be influenced by factors from previous periods due to the lagged effects of such variables on banking activity.

As shown in the theory section, risk-taking influences asset growth over time with firms willing to take greater risks producing more assets than what they would produce if they operated under a risk neutral strategy. To proxy risk appetite, an asset-risk index is constructed using the risk-weighted assets of each bank divided by their total assets. This index reflects the Basel II risk weights assigned to asset types. The level of firm asset risk decreases in index value. The expectation is for this variable to be positively related to asset growth.

Business composition is expected to influence asset growth in a couple of ways. The first could be viewed as a product or asset-class effect. Consider a thrift, due to charter type and hence specializing in mortgage loans, that may find competing over the long-term requires growing assets in other products or other segments of their primary product, such as moving more into subprime, where previously the firm had been principally prime-focused. A within-asset class effect may also reflect the underlying risk of the bank's assets and promote greater asset growth. For example, assume two thrifts had 65% of their assets in mortgages. One firm has all of its real estate assets in home equity lines of credit (HELOCs), while the other has all 1st lien mortgages. The first firm has a riskier profile than the second based on this composition, holding all else constant.[20] As a result, asset types are included in the analysis as control variables. Beyond 1-4 family residential mortgages these include multifamily mortgages, residential and commercial construction loans, credit card loans, other consumer loans and commercial and industrial loans.

20 This does not take into account any differences in underwriting that arise. The firm investing in HELOCs could impose underwriting criteria that aligns the risk of the HELOC portfolio to that of the 1st lien mortgages. In general, however, the risk of 2nd lien mortgages is generally higher than for 1st lien mortgages.

Other factors that fall under the business composition category include firm size as measured by the log of total assets and firm regulatory capital ratios. The asset size variable proxies for any economies of scale that might cause the firm to grow toward a lower average cost of production. In theory, a firm could also shrink in size if it has become too large relative to long-term average costs. Regulatory capital ratios are considered in the specification to reflect potential growth constraints that might be imposed on the bank from a regulatory perspective. Two ratios are included: the Tier 1 leverage ratio, and the Tier 1 risk-based capital ratio.

A set of variables reflecting relative peer performance are examined in the asset growth model. These include profitability metrics as defined as the firm's lagged 4-quarter net income to total assets (ROA) and return on equity (ROE) divided by the lagged 4-quarter average ROA and ROE, respectively, of the total sample in that quarter. Firms that have underperformed their industry peers may tend toward a strategy to grow the firm in an effort to boost ROE and make the firm more attractive to investors. In addition, the firm's relative operating inefficiency is included as a measure defined as the bank's total operating expense as a percent of assets over the last 4 quarters divided by the sample average over the same period. The hypothesis is that the more inefficient the firm is relative to peer institutions, the more likely it will entertain a growth strategy to lower its operating ratio, all else equal. Finally, a set of deposit and other liability variables including the brokered deposits ratio are included in testing the effect of these factors on asset growth. The hypothesis tested is that these variables should be statistically insignificant, controlling for the other variables above.

The dependent variable is defined as the 4-quarter asset growth rate. This distributed lag model again showed negligible signs of serial correlation given the Durbin-Watson statistic of 1.87 (Table 10). The overall explanatory power of the model was 73%. The major finding of this model is that there appears to be no statistically significant relationship between brokered deposits and asset growth. In other words, brokered deposits do not appear to drive asset growth. Interestingly, asset growth was found to be positively related to brokered deposits in the brokered deposits regression. Taken together then, this appears to support the view that growth and risk-taking effect the demand for brokered deposits rather than the other way around.

Banks that exhibit higher operational inefficiencies appear to have higher asset growth according to the results. Banks with lower ROAs tended to have higher growth rates. Bank risk as reflected by the risk-weighted assets ratio was significant and positively related to asset growth. This finding directly supports the theory presented before that riskier firms will tend to have higher output than lower risk firms. Another interesting result is that current period loss rates are significant but negatively related to asset growth. One explanation for this could be drawn from the behavioral economics literature where management may exhibit cognitive biases regarding loss performance. Kahneman and Tversky, in their seminal research on prospect theory, noted that where asymmetries in gains and losses exist, it can affect the degree of risk aversion of the individual.[21] Extending this theory to investors and by analogy to banking, Barberis, Huang and Santos find that prior financial performance directly affects the level of risk aversion of the investor.[22] According to this theory, if losses remain consistently low over a period of time, it could, for example, bias management toward taking more risks through rapid growth, for example.

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21 Kahneman, Daniel and Amos Tversky, "Prospect Theory: An Analysis of Decision Under Risk," Econometrica, XLVII, 1979, pp.263-291.

22 Barberis, Nicholas, Ming Huang, and Tano Santos, "Prospect Theory and Asset Prices," Quarterly Journal of Economics, CXVI, 2001, pp. 1-53.

Measuring Brokered Deposits Impact on Risk Preference

Turning next to the risk preference model, the intent of this specification is to understand some claims that brokered deposits contribute to greater risk-taking by firms. In this model, the dependent variable is defined by the asset-risk index described earlier and represents a bank's risk appetite as reflected by the regulatory risk weights assigned to each asset category under the Basel II capital framework. The higher the ratio, the higher the risk profile of the bank. The maximum ratio is 200 based on the Basel risk weights.

While the asset growth function is directly drawn from the theoretical discussion, the risk preference model is intended to complete the analysis of the brokered deposit linkage to risk-taking. As described earlier, factors that make up a bank's propensity to take greater risks are varied and can be time-dependent. For example, size and prior period asset growth may be associated with risk-taking in that higher growth rates tend to come with the expansion of existing and possibly new product types where the bank may not have a high degree of underwriting experience. Prior financial performance can also drive risk-taking to the extent that higher interest margins on assets produce better returns to the firm and put the bank in a position to be more attractive to investors. Firms experiencing lower returns may look to other products as a way of boosting performance over time which would lead to greater risk-taking. Previous loss experience could also influence risk-taking.

Other variables of interest include operational inefficiency, asset growth (contemporaneous and lagged), relative and actual financial performance, previous period loss rates and firm size. Operational inefficiencies may be associated with greater risk-taking either due to pressures to find ways of offsetting the adverse consequences to financial performance that operating inefficiencies bring, or are in some way a proxy of other management weaknesses in general as described above.

For the risk preference model, if earlier periods of loan and financial performance have been strong, it could bias management to lower their level of loss aversion.

The statistical results on the risk appetite model are shown in Table 11. Most coefficients for concurrent and prior period asset growth rates are significant and positively related to risk-taking as posited earlier. Prior period ROE is either insignificant or tends to be directly related to risk-taking. Current and prior period credit loss rates are significant and negatively related to risk, consistent with a theory that cognitive biases may influence risk-taking. Prior period relative ROE tends to be significant and negative as expected. Banks with higher operational inefficiency exhibit higher risk levels and the variable is significant. Finally, and of considerable importance, the brokered deposits ratio is not a significant predictor of risk-taking in this specification.

Translating Risk-Taking and Asset Growth into Loss: Implications for Brokered Deposits

While a bank's total losses would include those from credit as well as market and trading, among others, credit losses have featured prominently in the current financial crisis, and so losses in this model are defined as the percent of total loans past due or more 90 days including any real estate-owned (REO). Bank loss rates are expected to be influenced by several factors including prior period asset growth rates and risk tolerance as well as operational inefficiency. Asset losses grow according to their time profile of default which varies by product type. Consequently, past periods of high growth which may include expansion into new products, coupled with higher tolerance for risk-taking, should lead to higher losses over time. Firms that exhibit operational inefficiency are hypothesized to have process deficiencies that may show up as underwriting problems that lead to higher losses.

Other factors affecting the loss model include financial performance and asset/business composition. As in the other models, some variables such as asset growth rates and risk preferences are specified with lags. Other factors are included as control variates such as asset size, and capital ratios, for example. This model also tests the contribution of brokered deposits to explaining loss rates. The expectation is that as in the case of risk preference and growth, brokered deposits will not be a significant factor in the bank loss rate model.

The model results shown in Table 12 for loss rate effects suggest that growth affects loss rates only over the last two years and while those variables are significant, they have different impacts. Losses are negatively associated with current period growth rate but are directly related to prior period growth rate. Current and prior period risk tolerance is positively related to loss rate as expected and is significant for all but the earliest period. Finally, the other major variable of interest in this model is the brokered deposits ratio. In this model, the brokered deposits ratio is statistically significant but indirectly related to loss rate. There appears to be some residual effect of this funding source above and beyond asset growth and risk-taking. However, the relationship suggests that the lower the ratio of brokered deposits to total deposits, the higher the loss rate of the bank, controlling for other factors.

Assessing Risk-taking, Asset Growth and Brokered Deposits Role in Bank Insolvency

What separates this study's specification of bank insolvency from others in the literature is the option-theoretic approach described in the previous section. Typically, bank failure models are specified based on a set of factors proxying for each of the CAMEL bank rating factors. As mentioned earlier, this study departs from that approach by focusing on factors that directly explain the firm's put option value. To this point, the focus of the empirical models has been on relationships developed from an underlying theory of production. That is asset growth and by extension, risk preference models were not expected to have a direct relationship with brokered deposits based on the underlying production function and profit maximization framework. However, brokered deposits enter into the production function as a factor of production along with other inputs to be optimized in a least cost combination. Further, realized losses are likewise expected to bear, at most, an indirect relationship to brokered deposits based on the theory. As a result, once the bank has made its optimal allocation of asset, inputs and risk appetite, it is the combination of risk-taking, asset growth, and process inefficiency that will eventually lead to greater losses and increase the likelihood of bank insolvency. So, only in an indirect sense, *Brokered Deposits* is a candidate variable in a bank failure model, but should be included along with other funding sources as well.

To see this, recall that the key parameters of the bank insolvency model were the value of the bank, its debt level (or leverage), firm value volatility, and expected return. Asset size, capital and leverage are included in the bank failure specification. The log of total assets is used in the model as are the regulatory capital ratios. To avoid any potential multicollinearity, only one capital ratio is used at a time in estimating the model. Unlike the other empirical models, the bank failure equation is estimated as a binary choice model, in this specific case, a logistic regression. As a result, the dependent variable is defined as *0* if the bank remains in operation and *1* if it failed at some point between Q403 and the last data period of Q409.[23]

Variables reflecting firm volatility in the model include the risk index described earlier, as well as measures of liquidity risk defined as the ratio of total loans to assets, and the ratio of total deposits greater than $100,000 in denomination to total assets. Asset growth also enters into the bank failure model. The ratio of loans past due 90+ days or more and REO to total assets is also used to proxy for firm volatility. Variously, the model also tests loan provisions to total assets and the ratio of operating expenses to assets and operating expenses to total employees as additional proxies for firm volatility. Finally, estimates of bank expected returns include actual and relative (peer) ROA and ROE variables described earlier.

Variables describing alternative funding strategies are specified in the model. These include the ratio of brokered deposits to total deposits, other borrowed money to total deposits, and two interest expense variables; one measuring interest expense on deposits of $100,000 or less to total deposits less than $100,000 in size and, the other total interest expense on all deposits greater than $100,000 to total deposits of $100,000 and greater.

Of primary interest in the bank failure model is the brokered deposits variable. To be consistent with the theory, it is expected that this variable would be statistically insignificant, controlling for the other factors in the model. Formally, the test is the following:

$$\frac{\partial I}{\partial D_{BD}} = 0$$

Where *I* represents bank insolvency and D_{BD} is demand for brokered deposits. Again, reverting back to the production function and expected profitability maximization problem for the bank, brokered deposits are just one of several input choices the firm can make in allocating resources. Firms will choose the least cost combination of inputs to maximize expected profit. Asset growth and risk-taking by the firm are expected to be statistically significant in the bank failure model.

The model presented in Table 13 appears to have a high degree of predictive power as evidenced by the *KS* value of *.6*.[24] Of major interest to this study is the finding in Table 18 that the brokered deposit ratio is not a statistically significant predictor, controlling for the above variables as well as others. However, time deposits >$100,000 as a percent of deposits was found to be significant and directly related to failure. Asset growth is significant and positively related to bank failure as expected. Size matters to a lesser extent and is inversely related to insolvency. Not surprising, firms with greater operational inefficiencies tend to have higher failure probabilities. A similar result is found with bank loss rates.

23 The general form of the logistic regression where f(z) represents the probability of bank insolvency is the following:

$$f(z) = \frac{e^{z}}{1+e^{-z}}$$

$$z = \alpha + \sum_{i=1}^{n} \beta_i x_i$$

24 For binary choice models, of which the logistic regression model is a subset, the Kolmogorov-Smirnov (KS) test ranges from 0-1, with 1 indicating a perfect separation between classes based on the predicted probabilities.

Conclusions and Policy Recommendations

As the recent financial crisis unfolded and bank failure rates accelerated, policymakers delved into the underlying causes of bank insolvency. One of the areas garnering attention both in the media and among safety and soundness regulators is the role brokered deposits played in the crisis. Policies have been enacted based on negligible empirical foundation and economic theory that limit the use of brokered deposits by banks and in some cases assign higher deposit premiums to firms using these funding sources.

This study provides for the first time a comprehensive three-part approach to understanding the linkages between brokered deposits, risk-taking, asset growth and insolvency. First, the role of brokered deposits in banking is established from the perspective of standard production theory for a profit maximizing firm. To test the theory, optimization and econometric models are designed. The optimization model provides an opportunity to conduct specific sensitivity analyses on risk-taking, asset growth, operational inefficiency and other factors on brokered deposit usage. The econometric analysis focuses on identifying statistical relationships between these factors and brokered deposits.

Applying standard economic theory to explaining firm risk-taking and growth leads to the conclusion that brokered deposits as an input of production are not the primary cause of bank failure. Current policy appears to assume that brokered deposits are somehow *directly* related to insolvency; however, the theory and empirical results show something altogether different.

Current policy appears to assume that brokered deposits are somehow *directly* related to insolvency; however, the theory and empirical results show something altogether different.

Banks formulate strategic plans each year that determine the type of products and services to be provided. A target set of financial metrics such as earnings-per-share (EPS) are established as objectives for which the planning exercise establishes corresponding product targets, net income and loss projections, based on risk appetite. Competitive peer analysis also enters the strategic planning framework, introducing relative performance metrics into the analysis. The firm then is expected to maximize risk-adjusted returns subject to a set of constraints such as funding capacity. The target growth rate of the firm, coupled with the bank's tolerance for risk-taking, establish the direction for the firm over the next year or more. The bank then adopts a least cost combination of inputs strategy to optimize its funding mix in order to achieve its financial objectives given the product mix. To the extent that less expensive funding sources are available, the firm rationally uses those inputs; however, if those are constrained in some fashion, then alternative sources such as brokered deposits could be a viable way to bridge the funding gap.

To test the theory, a constrained profit maximization problem was constructed. A key finding from the analysis was that in situations where retail deposits are constrained, the percent allocated to brokered or wholesale deposits must rise in order to meet various growth targets. This analysis also demonstrated that profit maximizing firms will allocate their inputs in a least cost fashion; first to retail deposits and then to wholesale funding sources. This finding is important in that it points to the underlying mechanism for how firms decide what funding sources to use in their activities. Based on this framework, brokered deposits do not drive risk-taking or asset growth. Instead, it was shown that greater risk-taking could promote increased usage of brokered deposits when faced with a constraint

Brokered deposits do not drive risk-taking or asset growth. Instead, it was shown that greater risk-taking could promote increased usage of brokered deposits when faced with a constraint on retail deposits.

on retail deposits. It was also shown that brokered deposit shares remained invariant to asset growth scenarios. Again, these results are consistent with the theory of brokered deposits as an input of production.

The econometric analysis tested the theory from several vantage points. Models of bank insolvency, risk tolerance, loss rate, asset growth and brokered deposits were estimated. What distinguishes this analysis from previous studies is that the impact of brokered deposits on bank insolvency is not simply relegated to a single bank failure equation. Rather, consistent with the Merton default framework, bank failure is a function of risk, asset and liability structure. As a result, a simple bank failure model only tells part of the story on how brokered deposits affect bank performance. The major contention of this study is that brokered deposits only play an indirect role, at best, in explaining bank failure. Rather, asset growth and risk-taking that ultimately lead to higher losses are among the primary drivers of insolvency. But understanding the factors affecting asset growth, risk-taking and loss are fundamental to completing the picture of how brokered deposits impact bank processes and insolvency. Also, a model of the demand for brokered deposits provides further evidence on what drives bank wholesale funding allocations.

The results from the econometric model provide compelling support for the hypothesis that brokered deposits do not play a direct role in bank failure. It was found that risk profile and asset growth were important factors determining brokered deposit levels. However, brokered deposits were not a significant factor in predicting the level of risk at the institution. Likewise, brokered deposits were not found to be significant and directly related to asset growth. In a model of bank loss, firms with riskier asset profiles experienced higher losses as would be expected. While the brokered deposits variable was statistically significant, its sign was negative indicating that higher levels of brokered deposits were associated with lower loss rates, controlling for all other factors. Further these results were stable across multiple specifications.

Bank failure is a function of risk, asset and liability structure.

Finally, brokered deposits were not a significant factor in explaining bank failure, although asset growth and risk profile were among the significant factors contributing to insolvency, again consistent with the theory. Taking into account the results from the other models, a picture emerges supporting the view that brokered deposits do not drive asset growth, risk-taking or insolvency. Such results have important implications for designing policies to mitigate bank failures going forward and for regulating the brokered deposit market.

From a policy perspective, the primary focus of regulation must be on arresting aggressive risk-taking and asset growth. Regulation of brokered deposits, based on the findings of this study, focuses on the symptom and not the root cause for bank failure and may actually introduce unintended inefficiencies into the market for wholesale liabilities. Policies should focus instead on strengthening the risk-based deposit insurance premium structure to incent high quality bank risk infrastructure, strong corporate governance and well-aligned incentive structures across the organization. Current efforts to reform deposit insurance are a step in the right direction.

The current policy restricting brokered deposits for certain banks based on growth and capital levels should be revisited. It is not clear what empirical support exists for the current thresholds assigning higher deposits premiums associated with brokered deposits. Given that this study finds no evidence of a direct linkage between bank failure and brokered deposits, care must be taken at imposing restrictions on this funding source. Brokered deposits play an important role in funding bank activities. Not unlike the use of derivatives instruments, brokered deposits have recently inspired much condemnation in the wake of the financial crisis. However, specific cases of bank misuse of brokered deposits should not be generalized across this funding type without a close theoretical and empirical analysis. This study's findings support that view and set the stage for a new direction in analyzing brokered deposits.

Appendix I: Data and Summary Statistics

The econometric portion of the study relied on quarterly data obtained from the FDIC Reports of Condition and Income (Call Reports). The period of interest was Q403 through Q409. As the focus of the study was on the impact of brokered deposits on bank failures following the financial crisis, only firms failing in 2007-2009 were used. Table 14 summarizes the failures in each of these years.

In order to better understand the long-term effects of business decisions on bank failure, asset growth, and risk, Call Report data for each failed institution was obtained for the periods beginning in Q403 until the bank's reported closure date (last Call Report quarter). Impacts on bank loss rates are dependent on asset mix, level of risk, underwriting quality in the years leading up to problems based on the underlying time profile of losses of the assets. In this regard, it is expected that a model of contemporaneous effects would be less predictive than a model where at least some key factors are lagged.

Augmenting the failed bank data was a randomly selected group of active institutions as of Q409. Quarterly data on this group was obtained extending back to Q403 as well. In summary then, the full dataset consists of 168 failed banks from the 2007-2009 period and a random sample of 300 banks active as of Q409. A time series of quarterly observations from their most recently available Call Report was constructed beginning in Q403. Statistics for a set of key variables drawn from the Call Reports is summarized below for the combined dataset of failed and active firms. Tables 15-17 provide summary statistics on the same variables for the failed and active bank groups.

As reported earlier, the percent of brokered deposits to total deposits is 2.5 times greater for failed banks than active ones over the time period of interest. Figure 1 compares brokered deposit ratios of failed and active banks in the sample over time and clearly there is a wide divergence beginning in that latter part of 2006 between the two groups. Brokered deposit ratios for active firms tended to decline sharply until mid-2007 at which point they leveled out. By contrast, brokered deposit ratios for failed banks consistently rose over time.

Not surprising, loss rates were higher for failed banks, and regulatory capital ratios lower. Active banks had nearly three times the proportion of assets in real estate loans than failed banks during the period. Interest expense ratios were comparable for both groups.

Fourth quarter average asset growth rates were slightly larger for failed banks than active firms averaged over the sample period. However, a somewhat different perspective emerges comparing 4-quarter asset growth rates over time between failed and active banks as shown in Figure 2. Growth rates of failed banks between Q404 and at the onset of the crisis around Q107 were consistently well above that of the active banks during the period, after which the trend reversed, reflecting the accelerating deterioration of the failed banks.

Before specifying the models, some simple correlations were produced for the brokered deposits ratio, asset growth ratio and loss rate variables. The results of this are depicted in Table 18. While most variable pairs do not show a strong correlation, there are a few that stand out. Specifically, these include correlations between brokered deposits and other deposits based on the substitution effect between these input types and correlations between brokered deposits and time deposits greater than $100,000 in denomination.

Appendix II: Tables and Figures

Table 1. Asset Asset Growth and Brokered Deposit Rates

4 Quarter Asset Growth Rate	Brokered Deposit Average Rate %	
	Failed	Active
<40%	13.11	3.36
40-70%	19.80	6.93
>70%	18.03	4.16

Table 2. Asset & Liability Rates and Standard Deviations

Asset/Liability	Rate (%)	σ
Low Risk Asset	4.5	1.5
High Risk Asset	6.0	2.5
Retail Deposits	1.5	1.0
New Retail Deposits	2.0	1.25
Other Borrowed Money	4.0	1.5
Brokered Deposits	3.5	1.4

Table 3. Asset Covariance Matrix

	Low Risk	High Risk
Low Risk	.000225	.000093
High Risk	.000093	.000625

Table 4. Liability Covariance Matrix

	RD	NRD	OBM	BD
RD	**.000100**	**.000125**	**.000150**	**.000140**
NRD	.000125	**.000156**	**.000188**	**.000175**
OBM	.000150	.000188	**.000210**	**.000210**
BD	.000140	.000175	.000210	.000196

Table 5. ROE, Brokered Deposit, and Low Risk Product Shares by Risk and Retail Deposits (RD) Capacity Scenario

Target Std Dev	< = 75% RD			< = 50% RD			< = 25% RD		
	ROE	BD%	Low Risk %	ROE	BD%	Low Risk %	ROE	BD%	Low Risk %
3.25%	38.1	6.3	0.0	31.3	37.5	16.1	31.3	70.3	20.5
3.00%	35.4	6.3	18.0	31.3	37.5	20.1	25.8	68.8	23.9
2.75%	33.4	6.3	31.7	29.3	37.5	33.4	23.6	68.8	38.6
2.50%	30.9	6.3	48.1	26.9	37.5	51.8	20.7	66	56.1
2.25%	25.5	16.3	74.8	22.9	37.5	76.3	15.5	50	80.2

Table 6. Asset Growth Scenario Results

Asset Growth Scenario (%)	ROE %	Brokered Deposits %	Low Risk %
0	31.0	37.5	18.3
5	29.7	37.5	36.5
10	28.8	37.5	50.7
15	28.4	37.5	60.7
20	28.0	37.5	69.6
25	27.6	37.5	77.7

Table 7. Inefficiency Scenario Analysis

Scenario	ROE	BD %	σP	Low Risk %
i_{RD} = 1.5% i_{NRD} = 2.0%	34.1	37.5	3.0	18.3
i_{RD} = 1.75% i_{NRD} = 2.25%	34.1	37.5	3.2	7.9
i_{RD} = 1.925% i_{NRD} = 2.5%	34.1	37.5	3.4	0.0

Table 8. Expected Relationships

Variable of Interest	Bank Failure Probability	Asset Growth Rate	Demand for Brokered Deposits	Loss Rate	Risk Profile
Asset Size	+	–	+		+
Risk Tolerance	+	+	+	+	N/A
Asset Growth	+	N/A	+	+	+
Loss Rate	+	+	+	N/A	–
Brokered Deposits	None	None	N/A	None	None
Liability Structure	+	+	+		
Input Prices			–		
Output Prices			+		
Operational Inefficiency	+	+	+	+	+

Table 9. Regression Parameter Estimates, Log Brokered Deposits Model Variable

Log Brokered Deposits Model Variable	Coefficient	Std Error	Pr > t
Intercept	4.71	0.45	0.0001
Log Assets(t)	0.44	0.02	0.0001
Log Assets(t-1)	−0.39	0.12	0.0017
Log Assets(t-2)	0.59	0.12	0.0001
Log Assets (t-3)	−0.14	0.11	0.2071
ROE	−0.01	0.01	0.4833
Loss Rate(t)	0.23	0.53	0.6641
Loss Rate(t-1)	−0.02	0.82	0.9853
Loss Rate(t-2)	0.85	0.72	0.2349
4 Quarter Asset Growth	0.11	0.07	0.0999
(Assets-Deposits)/Assets	−1.76	0.22	0.0001
Time Deposits >$100K/Deposits	0.48	0.14	0.0009
Interest Expense Ratio	−0.05	0.69	0.9476
Total Income/Assets	−0.02	0.61	0.9783
Operational Inefficiency	−0.06	0.07	0.4044
Risk-weighted Assets/Assets	0.48	0.16	0.0031
Other Deposits/Deposits	−7.28	0.16	0.0001
DW	2.09		
R^2	94.5		

Number of Observations = 7,809
Variables in Bold are statistically significant at least at the 10% level.

Table 10. Regression Parameter Estimates, Asset Growth Model Variable

Asset Growth Model Variable	Coefficient	Std Error	Pr > t
Intercept	−0.1045	0.0756	0.1609
Log Assets (t)	0.0027	0.0011	0.0084
Log Assets (t-2)	−1.3121	0.0176	0.0001
Log Assets (t-3)	0.4732	0.0243	0.0001
Log Assets (t-4)	−0.2671	0.0256	0.0001
ROA(t)	−0.1845	0.1005	0.0664
ROA(t-1)	0.1097	0.1301	0.3985
ROA(t-2)	−0.1351	0.1329	0.3096
Relative ROE	−0.0001	0.0003	0.8155
Loss Rate (t)	−0.4309	0.0781	0.0001
Loss Rate (t-1)	−0.3823	0.1893	0.0435
Loss Rate (t-2)	−0.0262	0.1954	0.8934
Tier 1 Leverage Ratio	0.2292	0.0564	0.0001
(Assets-Deposits)/Assets	−0.0666	0.0634	0.2938
Brokered Deposits Ratio	0.0819	0.0587	0.1632
Risk-weighted Assets/Assets	0.0758	0.0135	0.0001
Other Deposits/Liabilities	−0.0201	0.0647	0.7572
Time Deposits >$100K/Deposits	0.0181	0.0189	0.3391
Interest Expense Ratio	0.0782	0.1075	0.4671
Operational Inefficiency	0.0282	0.0057	0.0001
DW	1.87		
R^2	73.2		

Number of Observations = 7,809
Variables in Bold are statistically significant at least at the 10% level.

Table 11. Regression Parameter Estimates, Risk-weighted Asset/Assest Model Variable

Risk-weighted Asset/ Assest Model Variable	**Coefficient**	**Std Error**	**Pr > t**
Intercept	0.4822	0.0649	0.0001
Other Deposits/Liabilities	−0.0165	0.0441	0.7073
Log Assets	0.0181	0.0033	0.0001
ROE(t)	−0.0011	0.0018	0.6062
ROE(t-1)	0.0031	0.0019	0.1033
ROE(t-2)	0.0054	0.0015	0.0004
90+ & Nonaccrual/Assets(t)	−0.1843	0.0547	0.0007
90+ & Nonacccrual/Assets(t-1)	−0.3392	0.0702	0.0001
90+ & Nonaccrual/Assets(t-2)	−0.0234	0.0621	0.7062
Tier 1 Leverage Ratio	−0.0368	0.0284	0.1947
Relative ROE(t)	0.0001	0.0004	0.8576
Relative ROE(t-1)	−0.0011	0.0003	0.0011
Relative ROE(t-2)	0.0005	0.0003	0.1089
Brokered Deposits/Deposits	0.0428	0.0404	0.2905
4 Quarter Asset Growth Rate(t)	−0.0023	0.0046	0.6234
4 Quarter Asset Growth Rate(t-1)	0.0365	0.0051	0.0001
4 Quarter Asset Growth Rate(t-2)	−0.0346	0.0049	0.0001
4 Quarter Asset Growth Rate(t-3)	0.0981	0.0051	0.0003
(Assets-Deposits)/Assets	0.0649	0.0413	0.1159
Other Borrowed Money/Liabilities	0.0081	0.0313	0.7982
Time Deposits >$100K/Deposits	0.0263	0.0133	0.0482
Interest Expense Ratio	0.0494	0.0412	0.2309
Loan Loss Provision/Assets	0.0501	0.0659	0.4484
Operational Inefficiency	0.0761	0.0051	0.0001
DW	2.06		
R^2	93		

Number of Observations = 7,809
Variables in Bold are statistically significant at least at the 10% level.

Table 12. Regression Parameter Estimates, Loss Rate Model Variable

Loss Rate Model Variable	Coefficient	Std Error	Pr > t
Intercept	−0.0201	0.0072	0.0053
Asset Growth Rate (t)	−0.0111	0.0009	0.0001
Asset Growth Rate (t-1)	0.0067	0.0013	0.0001
Asset Growth Rate (t-2)	−0.0002	0.0014	0.9039
Asset Growth Rate (t-3)	−0.0015	0.0014	0.2967
Relative ROE	0.0001	0.0001	0.0062
Log Assets	0.0014	0.0003	0.0001
Operational Inefficiency	0.0027	0.0009	0.0019
ROA	−0.3107	0.0158	0.0001
Loan Loss Provision/Assets	−0.1171	0.0226	0.0001
C&I Loans/Assets	−0.0098	0.0046	0.0344
(Assets-Deposits)/Assets	−0.0821	0.0089	0.0001
Tier 1 Risk-Based Capital Ratio	0.0096	0.0041	0.0181
Other Borrowed Money/Liabilities	−0.0063	0.0061	0.2978
Time Deposits >$100K/Deposits	0.0101	0.0028	0.0004
Brokered Deposits/Deposits	−0.0311	0.0091	0.0006
Other Deposits/Liabilities	0.0082	0.0053	0.1237
Risk-weighted Assets/Assets(t)	0.0074	0.0014	0.0001
Risk-weighted Assets/Assets(t-1)	0.0141	0.0038	0.0003
Risk-weighted Assets/Assets(t-2)	0.0099	0.0041	0.0141
Risk-weighted Assets/Assets(t-3)	0.0013	0.0041	0.7412
DW	1.98		
R^2	79		

Number of Observations = 7,809
Variables in Bold are statistically significant at least at the 10% level.

Table 13. Logistic Regression Parameter Estimates, Bank Failure Model Variable

Bank Failure Model Variable	Coefficient	Std Error	Pr>ChiSq
Intercept	0.2727	2.0075	0.8919
(Assets-Deposits)/Assets	−14.2827	1.8114	<.0001
Other Deposits/Liabilities	−8.2876	1.9557	<.0001
Log Liabilities	4.2937	2.1721	0.0481
Log Assets	−3.6918	2.1733	0.0894
Interest Expense Ratio	28.4943	3.0662	<.0001
Tier 1 Leverage Ratio	4.1602	1.5621	0.0077
4-Quarter Asset Growth Rate	1.5345	0.1548	<.0001
Risk-weighted Assets/Assets	−1.6772	0.2311	<.0001
Other Borrowed Money/Liabilities	1.8058	0.7985	0.0237
Relative ROE	0.1026	0.0154	<.0001
Operational Inefficiency	0.6408	0.0957	<.0001
90+ Past Due & Nonaccrual/Assets	66.7834	3.9312	<.0001
ROA	−10.1216	2.9369	0.0006
Time Deposits >$100K	1.694	0.3278	0.0001
Brokered Deposits Ratio	−0.8527	1.7018	0.6163
KS	0.61		
Observations			
BKVAR = FAIL = 1	2668		
BKVAR = ACTIVE = 0	5649		

Variables in Bold are statistically significant at least at the 10% level.

Table 14. Number of Bank Failures, by Year

Year	Number of Bank Failures
2007	3
2008	25
2009	140

Table 15. Summary Bank Statistics — Failed and Active Institutions — Q104 - 109

Variable Name	Mean	σ	Max	Min
Relative ROA (%)	0.94	1.71	32.34	−49.58
Relative ROE (%)	1.06	3.94	27.48	−75.78
Operational Inefficiency (%)	0.77	0.77	24.03	0
Brokered Deposits (%)	11.50	0.14	100.00	0
Loan Loss Provision/Total Assets (%)	0.63	0.01	29.15	−4.73
HELOC/Total Assets (%)	9.40	2.93	36.28	0
1st Lien Mortgage/Total Assets (%)	12.00	11.45	74.16	0
Closed-end 2nd Mortgages/Total Assets (%)	2.19	1.65	22.44	0
Credit Card Loans/Total Assets (%)	3.42	4.19	90.46	0
Other Consumer Loans/Total Assets (%)	4.64	3.91	42.12	0
Mortgage Construction Loans/Total Assets (%)	1.00	4.69	56.27	0
Other Construction Loans/Total Assets (%)	2.91	7.26	57.33	0
Risk Weighted Assets/Total Assets (%)	82.41	17.35	194.00	7.13
Log of Total Liabilities	18.06	1.41	20.13	4.07
Past Due Loans 90+ and Nonaccruing/Total Assets (%)	2.00	0.05	24.98	0
Operating Expenses/Total Assets (%)	1.43	0.02	42.53	−0.12
Deposits/Assets(%)	10.50	0.10	77.80	0
(Assets-Deposits)/Assets (%)	32.91	0.12	100.00	−10.13
Log of Total Assets	17.97	1.39	20.23	762
Log of Total Deposits	17.55	0.13	19.84	688.45
Time Deposits >100,000/Total Deposits (%)	16.35	0.03	99.55	0
Total Income/Total Assets (%)	4.08	0.03	77.18	−7.25
Interest Expense/Total Assets (%)	3.45	0.02	71.86	0
ROA (%)	1.12	0.14	30.61	−31.58
ROE (%)	0.86	0.11	3,131.04	−887.45
Other Borrowed Money/Total Deposits (%)	10.19	0.11	98.69	0
Other Deposits/Total Deposits (%)	81.18	0.17	100.00	0
Total Assets ($)	288,257,265.00	20,827,386.00	608,657,000.00	2059
Total Deposits ($)	186,238,069.00	13,519,784.00	414,131,000.00	0
Total Equity ($)	4,323,858.00	87,194.00	1,115,655.00	−161976
4 Quarter Asset Growth Rate (%)	12.00	0.29	817.57	−67.84
Tier 1 Risk-based Capital Ratio (%)	9.10	0.12	379.12	−16.77
Tier 1 Leverage Ratio (%)	1.95	0.08	110.18	−13
Other Real Estate Owned/Total Assets (%)	0.14	0.01	26.90	0
Real Estate Loans/Total Assets (%)	28.57	0.07	73.47	0
C&I Loans/Total Assets (%)	10.55	0.08	63.48	0

Number of Observations = 11,288

Table 16. Summary Bank Statistics - Failed Institutions - Q104 - Q409

Variable Name	Mean	σ	Max	Min
Relative ROA (%)	1.12	1.88	30.21	−17.47
Relative ROE (%)	1.28	6.06	27.48	−75.78
Operational Inefficiency (%)	0.69	0.47	3.93	0
Brokered Deposits (%)	21.10	0.18	89.91	0
Loan Loss Provision/Total Assets (%)	0.74	0.02	21.19	−2.14
HELOC/Total Assets (%)	1.61	3.36	36.28	0
1st Lien Mortgage/Total Assets (%)	6.22	9.34	74.16	0
Closed-end 2nd Mortgages/Total Assets (%)	0.89	1.54	22.44	0
Credit Card Loans/Total Assets (%)	0.12	1.88	59.71	0
Other Consumer Loans/Total Assets (%)	0.63	2.46	25.21	0
Mortgage Construction Loans/Total Assets (%)	2.34	6.53	56.27	0
Other Construction Loans/Total Assets (%)	7.06	10.18	57.33	0
Risk Weighted Assets/Total Assets (%)	84.51	12.27	1.32	26.98
Log of Total Liabilities	14.69	1.39	17.02	6.98
Past Due Loans 90+ and Nonaccruing/Total Assets (%)	3.18	0.18	24.98	0
Operating Expenses/Total Assets (%)	0.95	0.01	8.14	−0.12
Deposits/Assets (%)	19.19	0.12	77.80	0
(Assets-Deposits)/Assets (%)	27.57	0.11	93.96	−10.13
Log of Total Assets	14.97	1.44	17.12	868.47
Log of Total Deposits	14.62	1.41	16.82	688.45
Time Deposits >100,000/Total Deposits (%)	27.05	0.15	89.70	0
Total Income/Total Assets (%)	2.47	0.02	33.16	−7.25
Interest Expense/Total Assets (%)	3.31	0.02	21.15	0
ROA (%)	0.16	0.03	11.23	−31.58
ROE (%)	1.30	0.25	3,131.04	−887.45
Other Borrowed Money/Total Deposits (%)	14.78	0.12	98.69	0
Other Deposits/Total Deposits (%)	66.05	0.21	100.00	0.72
Total Assets ($)	7,050,212.00	2,385,632.00	27,302,220.00	5912.00
Total Deposits ($)	4,756,191.00	1,616,267.00	20,272,569.00	977.00
Total Equity ($)	259,409.00	128,368.00	1,115,655.00	−161,976.00
4 Quarter Asset Growth Rate (%)	14.10	0.39	817.57	−50.88
Tier 1 Risk-based Capital Ratio (%)	7.92	0.14	379.12	−16.77
Tier 1 Leverage Ratio (%)	4.27	0.07	110.18	−13.00
Other Real Estate Owned/Total Assets (%)	0.52	0.02	26.90	0
Real Estate Loans/Total Assets (%)	13.25	0.09	73.47	0
C&I Loans/Total Assets (%)	7.20	0.08	63.48	0

Number of Observations = 4294

Table 17. Summary Bank Statistics - Active Institutions - Q104 - Q409

Variable Name	Mean	σ	Max	Min
Relative ROA (%)	0.61	1.55	32.34	−49.58
Relative ROE (%)	0.68	1.58	15.91	−73.57
Operational Inefficiency (%)	0.91	6.91	24.03	0
Brokered Deposits (%)	8.57	0.11	100.00	0
Loan Loss Provision/Total Assets (%)	0.59	0.01	29.15	−4.73
HELOC/Total Assets (%)	11.78	2.62	19.28	0
1st Lien Mortgage/Total Assets (%)	13.76	11.82	73.78	0
Closed-end 2nd Mortgages/Total Assets (%)	2.58	1.69	15.49	0
Credit Card Loans/Total Assets (%)	4.42	5.11	90.46	0
Other Consumer Loans/Total Assets (%)	5.88	4.24	42.12	0
Mortgage Construction Loans/Total Assets (%)	0.59	2.85	41.16	0
Other Construction Loans/Total Assets (%)	1.64	3.95	35.57	0
Risk Weighted Assets/Total Assets (%)	80.06	19.06	194.11	194.11
Log of Total Liabilities	18.79	1.36	20.13	20.13
Past Due Loans 90+ and Nonaccruing/Total Assets (%)	0.82	0.09	5.32	0
Operating Expenses/Total Assets (%)	0.41	0.02	42.53	0
Deposits/Assets (%)	7.85	0.08	55.34	0
(Assets-Deposits)/Assets (%)	34.54	0.11	100.00	1.38
Log of Total Assets	18.89	1.28	20.23	762
Log of Total Deposits	18.44	1.21	19.84	692.07
Time Deposits >100,000/Total Deposits (%)	13.09	0.11	99.55	0
Total Income/Total Assets (%)	4.57	0.03	77.18	−0.28
Interest Expense/Total Assets (%)	3.49	0.03	71.86	0.04
ROA (%)	1.42	0.01	30.61	−31.37
ROE (%)	8.22	0.21	3,131.04	−993.7
Other Borrowed Money/Total Deposits (%)	8.75	0.11	98.69	0
Other Deposits/Total Deposits (%)	85.87	0.13	100.00	0
Total Assets ($)	374,059,871.00	26,387,663.00	608,657,000.00	2,059.00
Total Deposits ($)	241,612,277.00	17,126,086.00	414,131,000.00	0
Total Equity ($)	7,481,197.00	40,788.00	411,283.00	0
4 Quarter Asset Growth Rate (%)	11.36	0.19	401.30	−67.84
Tier 1 Risk-based Capital Ratio (%)	9.46	0.08	321.60	0
Tier 1 Leverage Ratio (%)	1.24	0.08	106.22	0
Other Real Estate Owned/Total Assets (%)	0.02	0.01	9.54	0
Real Estate Loans/Total Assets (%)	33.24	0.04	60.64	0
C&I Loans/Total Assets (%)	11.57	0.08	62.18	0

Number of Observations = 6925

Table 18. Selected Variable Correlations

	Brokered Deposits Ratio	Asset Growth Rate	Loss Rate	Risk−weighted Assets/ Total Assets
Brokered Deposits Ratio	1	0.145	0.201	0.222
Asset Growth Rate	0.145	1	−0.161	0.149
Loss Rate	0.201	−0.161	1	0.103
Risk−weighted Assets/Assets	0.222	0.149	0.103	1
Log of Assets	0.337	0.073	0.056	0.325
(Assets−Deposits)/Assets	0.179	0.001	−0.161	−0.219
Time Deposits > $100K/Deposits	0.456	0.162	0.139	0.188
Operating Inefficiency	−0.136	−0.031	0.033	−0.125
Relative ROE	0.041	−0.026	0.109	0.045
C&I Ratio	0.078	0.082	−0.008	0.373
Other Deposits Ratio	−0.752	−0.145	−0.199	−0.222
Other Borrowed Money/Liabilities	0.077	0.001	−0.032	0.065
Total Income/Assets	−0.034	−0.022	−0.144	−0.061
Interest Expense Ratio	0.233	−0.028	0.085	0.091

Figure 1. Brokered Deposit Ratios Q403-Q409: Failed and Active Banks

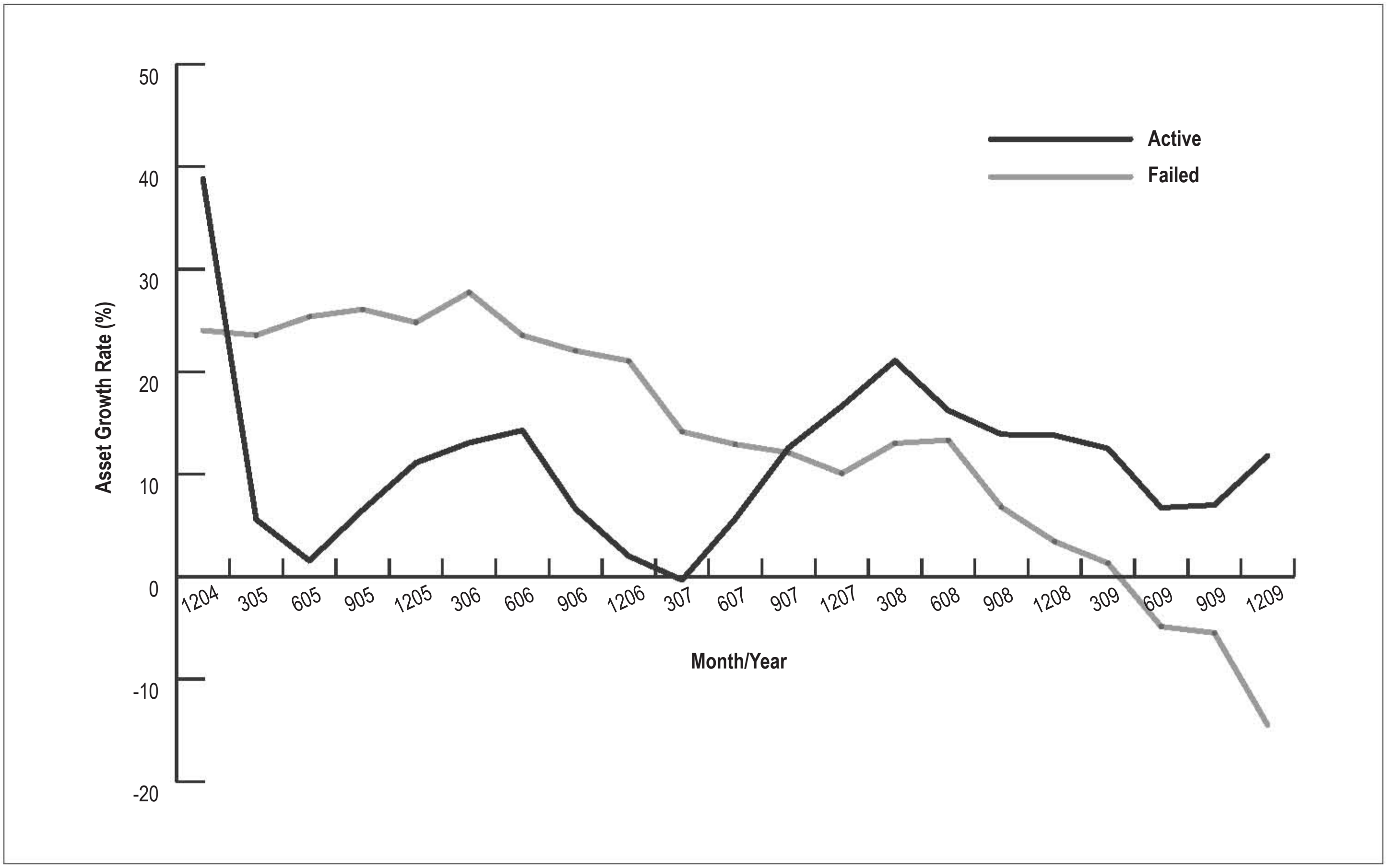
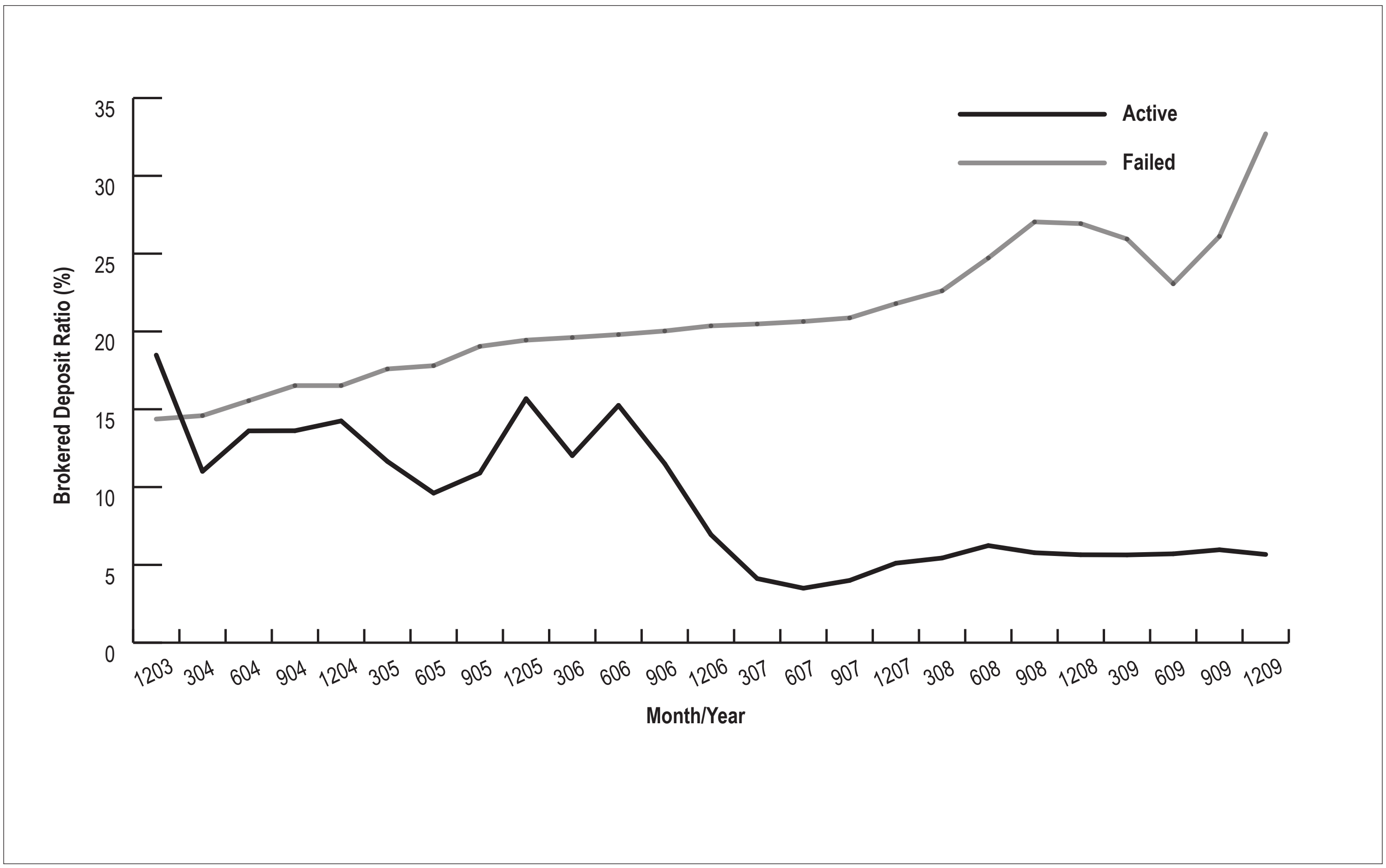


Figure 2. Rolling 4 Quarter Average Asset Growth Rates Q404-Q409: Failed and Active Banks



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About the author

Professor Cliff Rossi is a Tyser Teaching Fellow in the Finance Department at the University of Maryland's Robert H. Smith School of Business and Executive-in-Residence of the Center for Financial Policy. Prior to entering academia, Professor Rossi had nearly 25 years experience in banking and government, having held senior executive roles in risk management at several of the largest financial services companies.

His most recent position was Chief Risk Officer for Consumer Lending at Citigroup where he was intimately involved in TARP funding and stress tests performed on Citi. While there he was responsible for overseeing a $300B global mortgage portfolio with 700 employees under his direction. He also served as Chief Credit Officer at Washington Mutual (WaMu) and as Chief Risk Officer at Countrywide Bank.

Previous to these assignments, Dr. Rossi held senior risk management positions at Freddie Mac and Fannie Mae and worked for a number of years at the Treasury Department and Office of Thrift Supervision working on key policy issues affecting depositories. Professor Rossi also was an adjunct professor in the Finance Department at the Robert H. Smith School of Business for 8 years and has a score of academic and professional publications on banking industry topics. He holds a PhD in financial economics from Cornell University.