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Macroeconomic shocks and discipline in the market for large certificates of deposit

Abstract

The Basel II Accord charged banks with being more effective at risk measurement and management. Supervisors were charged with using market information to aid them in assessing bank risk. However, little research has been done to incorporate market discipline into how risk is measured over the business cycle. The authors explore how macroeconomic shocks affect discipline in the market for large certificates of deposit. Discipline is estimated using bank-specific measures of risk. The authors' results show that as the economy strengthens depositors increase discipline of banks with low capital. As the economy weakens depositors encourage banks to hold more liquidity. As monetary policy contracts depositors punish banks with low capital and high non-performing loans. These findings mainly hold for large banks. The results provide insight into how depositor discipline varies over time, and imply that supervisors can use changes in risk premiums to assess bank-specific risk over the business cycle.

Introduction

As a byproduct of the development and implementation of the Basel II Accord, bankers and academicians are paying more attention to how the level of bank risk changes over the business cycle. The Accord also has renewed interest in the role of debtholders in aiding supervisors in assessing and disciplining banking system risk over the business cycle. Despite this focus on systemic risk and discipline, little has been done in the market discipline literature to explore the effects of cyclical shocks on how markets assess bank risk.

To address this shortcoming, our paper explores the effect of macroeconomic shocks on discipline in the market for large certificates of deposit (CDs), to answer the question of whether cyclical shocks affect bank risk[1]. We estimate traditional cross-sectional measures of market discipline, characterized by the relation between bank-specific measures of risk and CD rates and CD runoffs. The innovation of our paper, however, is in examining how macroeconomic shocks affect measures of discipline.

In general, given an adverse macroeconomic shock, depositors should expect an unfavorable impact on a bank's future condition. The resulting increased probability of default should currently exact higher premia and runoffs. Empirically, increased discipline has meant that the coefficients on bank-specific measures of risk should increase in size or significance. We argue that increased discipline could also

entail depositors changing their assessment of risk, emphasizing certain financial ratios and deemphasizing others, as the macroeconomic environment deteriorates. Under this scenario, increased discipline means depositors refocus discipline on the measures of bank-specific risk most relevant under the new macroeconomic environment.

Our approach on discipline differs from the traditional one in that it emphasizes how macroeconomic shocks might currently alter depositor perceptions of future bank condition. The literature emphasizes the cross-sectional measurement of discipline, where discipline is averaged over a block of time. Any changes in discipline result from structural breaks associated with changes in regulations that affect incentives or enforcement. While traditional discipline studies include macroeconomic shocks, they usually treat them as control variables that affect bank debt prices and runoffs directly and equally for all banks. We argue that the information content of macroeconomic shocks, in predicting future bank condition, should be immediately considered by depositors in disciplining banks. We model this behavior by allowing macroeconomic shocks to directly alter discipline.

The remainder of the paper is organized as follows. The next section reviews the literatures on the effects of macroeconomic shocks on bank condition and on market discipline. The second section lays out our two-stage econometric model and hypotheses tests. The third section presents the data. The fourth section shows the empirical results and explores some implications of our model. The final section concludes the paper.

1. Literature review

We review the literature on how macroeconomic shocks affect bank condition, how the discipline literature has treated macroeconomic shocks and

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[1] We explore the market for large CDs because of its potential to provide regulators with useful information on bank risk. Large CD holders have risk preferences that are similar to those of regulators.

how our approach differs from other discipline papers that have incorporated business cycle effects.

1.1. Macroeconomic shocks and bank condition.
Several literatures link macroeconomic shocks to increased bank default in general, and changes in bank financial statement condition, in particular. Early warning models show that macroeconomic shocks are good predictors of bank default from six months to two years in advance (Cole and Guenther, 1998 for U.S. banks). Studies on financial crises argue that adverse macroeconomic shocks can substantially weaken bank condition causing banking and currency crises (Kaminsky and Reinhart, 1999). In this literature the effect of adverse shocks on bank condition depends on balance sheet strength prior to the shock.

The banking literature provides evidence that bank balance sheet and income statement condition varies over the business cycle and with changes in monetary policy. Quagliariello (2007) shows that bank profits and non-performing loans are pro-cyclical. Barajas and Steiner (2000) show that asset liquidity is counter-cyclical. Banking and finance textbooks often argue that the effect of interest rate risk and policy rates on bank equity capital and profits is countercyclical (Mishkin, 2014).

1.2. Market discipline and the treatment of macroeconomic shocks.
Discipline requires debt holders to monitor and assess bank default risk and demand debt prices commensurate with their perceptions of risk. If banks do not pay these prices, debt holders will withdraw funds. These actions of risk pricing are traditionally referred to as discipline[1]. An important focus of the discipline literature has been on establishing the existence of discipline by measuring the ability of the market to accurately assess bank risk in a timely manner. In panel studies that emphasize cross-sectional differences in bank risk, the literature shows evidence consistent with depositors pricing bank risk in several countries (Monschean and Opiela, 1999 for Poland; Opiela, 2004 for Thailand) and pricing risk associated with large CDs at banks (Hall et al., 2004; and at holding companies Hannan and Hanweck 1988).

The traditional discipline studies mentioned above all employ panel data, but measure discipline as the cross-sectional relation between debt prices (or debt funding) and bank-specific measures of risk, emphasizing the average response of discipline over a sample period. Our approach also looks at how depositor risk pricing reacts to cross-sectional differences in bank risk. However, we measure the ability of depositors to monitor and assess bank risk quarterly and then examine how depositors change that assessment with changes in the macroeconomic environment. The traditional approach to measuring discipline, included in most of the above-mentioned studies, either excludes macroeconomic shocks or treats them as control variables. Additionally, the traditional approach does not allow macroeconomic shocks to produce differential effects across banks.[2] This treatment implicitly assumes that any differential effects of macroeconomic shocks on bank condition and discipline show up in bank-specific financial ratios at some time in the future. Only then will depositors recognize any effects of these shocks and discipline banks accordingly. In contrast, our paper assumes that when a macroeconomic shock occurs depositors form expectations as to how it will affect a bank's future condition. With these expectations, depositors place appropriate emphasis on relevant bank-specific measures of risk to gauge a bank's condition. This allows macroeconomic shocks to affect the relation between bank-specific measures of risk and deposit rates.

1.3. The effect of macroeconomic shocks on market discipline.
Despite evidence of a link between macroeconomic shocks and bank condition, the incorporation of this effect into how depositors discipline banks has not been well explored. We know of only three studies that attempt to address this issue. Levy-Yeyati, Peria and Schmukler (L-P-S, 2004) examine the recent banking crises in Argentina and Uruguay, arguing that during periods of high systemic risk, bank-specific measures of risk may be poor indicators of default risk for depositors. In a VAR they show that the link between non-performing loans and deposit rates weakens as news on the extent of systemic risk increase. Opiela (2006), concentrating on banks in Thailand in the period leading up to the 1997 banking and currency crisis, extends the focus of L-P-S (2004), arguing that the information content of some bank-specific ratios may decrease while that of others may increase. Opiela finds that as measures of systemic risk increase, depositors attach lower premia to a given non-performing loan ratio as in L-P-S, 2004), but demand higher premia for the same capital-to-asset and liquidity-to-asset ratios. Santos (2004) explores the credit spreads of bank bonds during economic expansions to those in recessions, for banks that differ by risk profile. He finds that riskier banks have larger increases in their spreads during recessions than do safer banks.

Our paper tests for the effect of macroeconomic shocks on discipline in the large CD market. The focus of our paper depends on two premises. Depo-

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[1] Recently the market discipline literature has also focused on whether risk pricing and runoff responses can directly affect the risk behavior of banks. This line of inquiry distinguishes between monitoring and influence. While this distinction is important, we focus on how monitoring changes over the business cycle. To our knowledge, time-varying monitoring has not been previously explored.

[2] Most studies, however, include a measure of scale to distinguish differences in discipline due to bank size.

sitors are aware that adverse macroeconomic shocks could affect future bank condition. Consequently, they should change their discipline of banks over the business cycle. What form this change in discipline takes depends on depositor perceptions of how the shock will manifest itself in bank balance sheets. We explore two possibilities. First, perceived changes in bank condition resulting from macroeconomic shocks induce depositors to change their emphasis on what information is most relevant to gauging default risk. Depositors will emphasize those financial ratios that indicate bank strength given their perception of how the adverse macroeconomic shock will play out on bank condition. Second, in the absence of perfect information on how adverse macroeconomic shocks will affect future bank condition, depositors might use measures of strength such as asset size and capitalization to gauge the impact of these shocks.

Our study includes several important innovations not included in the above-mentioned related three studies that emphasize systemic risk. First, we focus on a well developed banking system over the business cycle, rather than an emerging market during a crisis. Second, our sample spans over 25 years and three business cycles and includes over one million bank quarters for the U.S. banking system. Third, we use business cycle indicators rather than proxies for banking system risk. Fourth, because we are interested in time-varying discipline, we measure discipline quarterly in first-stage regressions and examine how these measures change with macroeconomic shocks, unlike the one-stage interaction model in Opiela (2004). This former specification controls for local shocks in the first stage regressions, allowing us to focus on the effect of macroeconomic shocks alone. Finally, instead of breaking the business cycle into expansions and recessions, we look at a continuous time effect of macroeconomic shocks on discipline. This allows the measurement of shocks on discipline over the entire cycle.

Our approach contributes to a better understanding of how the macroeconomic environment alters depositor perceptions of bank risk and how these perceptions are incorporated into large CD rates and runoffs. This approach has implications for regulatory policies, the results of past discipline event studies and the transmission of monetary policy through the banking system.

A better understanding of how direct market discipline changes over time can complement bank supervision. Several studies have shown that while direct depositor discipline exists, its signals may be so small as to have minimal impact on bank costs and deposits (e.g., Hall et al., 2004). Because discipline studies measure average discipline over a block of time it is not clear

whether direct discipline is more intense during financially stressful times than it is during safer times. Our study also has implications for indirect discipline. The implication that the market changes its emphasis on relevant financial information could be used by supervisors to gauge what bank-specific ratios are most important in assessing bank default over the business cycle.

A major focus of the discipline literature has been on event studies that test for structural breaks in discipline due to changes in conjectural guarantees or regulatory policies. However, these studies do not take into account the effect of macroeconomic shocks on discipline. The omission of this effect could bias the results of these studies if the macroeconomic environment changes the intensity of discipline between the two periods tested. For example, some studies show diminishing discipline associated with increased conjectural guarantees. If the period of increased guarantees is also associated with an expanding economy, it may be the latter effect that is decreasing discipline, rather than the former (Hall et al., 2004) allude to this type of bias.

2. Methodology

We hypothesize that large CD holders form perceptions of a bank's default risk based on how the current macroeconomic environment will affect the bank in the future. We model this approach in two stages. First, we regress CD rates on bank-specific measures of risk, and bank and geographic-specific control variables to obtain coefficients for 88 quarters from 1984Q1 to 2007Q2. Second, we regress the first-stage coefficients on a set of macroeconomic variables.

Stage-1 model. The first-stage quarterly cross-sectional regression equations for CD rates are given by:

$$RCD_{it} = \alpha_0 + \Sigma_{j=1\text{-}7} \beta_{jt}(BANKRISK_{j,i,t-1}) + \varphi_k (DUM_{BRKDEP}) + \Sigma_{k=1\text{-}49} \theta_k (DUM_{State,k}) + \delta_k (DUM_{MSA}) + \varepsilon_{it}. \qquad (1)$$

Where, RCD is the imputed interest on large CDs for the ith bank. $BANKRISK$ is a vector of j one-quarter lagged bank-specific measures of risk. This vector includes: non-performing loans to total loans (NPL), securities and cash to total assets (LIQ), three measures of loans (commercial and industrial loans, residential real estate loans, and other real estate loans) to total loans, equity capital to total assets (KAS) and the net return on assets (ROA).

Three control variables are included. A dummy variable, $DUM_{State} = 1$ for each of 49 states and $= 0$ otherwise is employed. We include a dummy variable, $DUM_{MSA} = 1$ if a bank is located in an MSA and $= 0$ otherwise. We also include the logarithm of total as-

sets for each bank. Finally, we include a dummy variable for brokered deposits (DUM_{BRKDEP}). The quarterly cross-sectional specification in equation (1) allows the coefficients associated with all variables to differ between quarters. We are interested in the β_{jt}, which show the relation between each of the bank-specific measures of risk and CD rates and quantities, respectively. These measures can be written as the partial derivatives:

$$\beta_{jt} = \partial RCD_{it} / \partial (BNKRISK_{j \cdot i, t-1}). \tag{2}$$

The signs of the β_{jt} should conform to those established in the discipline literature.

Stage-2 model. Because we are interested in the effect of macroeconomic shocks on discipline, the β_{jt} are used as dependent variables in a second stage, regressed on macroeconomic shocks, and are expressed as:

$$\beta_{jt} = \alpha_1 + \Sigma_{k=1-4} \Sigma_{m=1-4} \gamma_{jk}(MACRO_{k,\,t-m}) + \phi_j(DUM_{FDI-CIA}) + \Sigma_{n=1-3} \eta_{jn}(DUMSEAS_n) + v_{jt}. \tag{3}$$

$MACRO_{k,\,t-m}$ is a vector of k macroeconomic variables used to gauge the effect of macroeconomic shocks on discipline. This vector consists of four measures: real GDP growth, the federal funds rate, the percentage change in the S&P 500 stock index and the GDP Deflator inflation rate. Real GDP growth is a measure of overall economic activity, the federal funds rate is an indicator of monetary policy, the S&P 500 index is a measure of financial strength and the inflation rate proxies for inflation uncertainty that affects bank balance sheet decisions. We include four lags of each macroeconomic variable. We also include a dummy variable that proxies for the effect of FDICIA on market discipline. $DUM_{FDICIA} = 1$ for the period 1991Q1 to 2007Q2 and zero otherwise. DUMSEAS consists of three seasonal dummy variables. The main focus of our study is on the signs and significance of the coefficients γ_k and γ^*_k, which can be expressed as the partial derivatives,

$$\gamma_{jk} = \partial \beta_{jt} / \partial (MACRO_{kt}) = \partial^2 RCD_{it} / [\partial (BANKRISK_{j \cdot i, t-1}) \partial (MACRO_{kt})]. \tag{4}$$

These coefficients represent the effect of the kth macroeconomic shock on market discipline associated with the jth financial ratio for CD rates and runoffs, respectively. These parameters tell us how the market is changing its emphasis on a particular bank-specific measure of risk as the macroeconomic environment changes.

We have argued that adverse macroeconomic shocks should have an adverse effect on future bank condition and that depositors should react to this information by disciplining banks more intensely. Thus, in general,

we expect at least some of the γ_k and γ^*_k to indicate increased discipline. Also, if the discipline literature is any guide, we expect depositors to discipline small and low-capital banks more intensely than other banks over the business cycle. This means that we might expect the coefficients on certain ratios to increase.

3. Data

All bank-level data for federally insured commercial banks were obtained from the *Report of Condition and Income* (*Call Report*). The data are quarterly from 1984Q1 to 2007Q2. Table 1 summarizes key variables for the four bank groups considered. The first column in Table 1 lists the bank-specific financial ratios we employ for our first-stage regressions to estimate discipline. For the two bank-size classifications we rank banks each quarter according to their total assets and define those at or above the 95th percentile as "large" and those below the 95th percentile as "small". To classify banks by capitalization, we list those with a capital-to-asset ratio of 8% and above as "high-capital" and those with a ratio below 8% as "low-capital".

Table 1. Descriptive statistics on variables used in the regressions (divided into 4 bank-group characteristics)

	Small banks		Large banks	
	Mean	Median	Mean	Median
Total assets (millions of 2000 dollars)	906.6	524.9	718.93.9	151.94.1
NPL (as % of total loan)	1.74	0.98	1.70	1.07
Liquidity (as % of total ast)	33.52	31.95	25.37	23.60
C&I loan (as % of total loan)	18.72	16.04	24.32	22.69
RE loan (as % of total loan)	25.75	23.83	21.53	19.12
Other RE loan (as % of total loan)	13.90	11.1	15.51	13.98
ROA	0.60	0.58	0.64	0.59
Cap-to-ast	9.50	8.81	7.78	7.26
LTD (as % of total dep.)	12.23	10.19	15.20	11.02
# of bank-quarter observations	841.350		44.324	

4. Results

Our results for large CD rates consist of first-stage and second-stage regression coefficients. We report results for three variables, which represent liquidity risk, asset quality (credit risk), and leverage. These variables consist of the liquidity-to-total asset ratio (LIQ), the non-performing loan-to-total loan ratio (NPL) and the leverage ratio (KAS). We report first-stage results in Table 2A and second-stage multivariate results for

GDP growth and the fed funds rate in Table 2B[1]. Our results in Table 2B are for small and large banks.

4.1. First-stage results. The mean value of the quarterly first-stage regression coefficients are reported in Table 2A, for banks categorized by asset size. A couple of observations are worth noting. All coefficients are of the expected signs and all are significant at the 5% level at least. Second, the NPL sensitivity of CD rates is bigger for the large banks.

4.2. Second-stage results - liquidity (LIQ). The results for the second stage are reported in Table 2B. We regress the sensitivity of discipline (the coefficients for LIQ, NPL and KAS) on GDP growth and the federal funds rate for small and large banks. As mentioned above, the first-stage results show that when LIQ drops CD rates rise, which is consistent with an increase in the demand for deposits. We now focus on how the sensitivity of this relation changes with changes in GDP growth and the federal funds rate. The coefficients on the effect of *GDP Growth* on *LIQ Sensitivity* are positive for CD rates and significant for both bank groups. This combination of signs indicates that as GDP growth falls the sensitivity between LIQ and CD rates rises. This result indicate greater discipline.

The response *LIQ Sensitivity* for a rise in the federal funds rate is positive and significant for large banks. This result implies that during a monetary contraction a fall in LIQ is accompanied by a smaller rise in CD rates. As with a fall in GDP growth, the most plausible explanation within a deposit supply and demand framework is that deposit demand is rising by less and deposit supply falling by more, indicating greater discipline through LIQ.

Table 2A. Small and large bank market discipline sensitivities (Stage 1 Regression)

	Mean effect on interest rate	
	Small	*Large*
LIQ sensitivity	-0.005 *** (0.00)	-0.008*** (-0.00)
NPL sensitivity	0.086 *** (0.00)	0.155*** (0.000)
KAS sensitivity	-0.049*** (0.00)	-0.031** (0.03)

Notes: 1. Each regression also includes lagged values of commercial & industrial loans to total loans ratio; real estate loans to total loans ratio; other real estate loans to totals loan ratio; return on asset; and dummies for brokered deposits, MSA, and state. 2. Numbers in parenthesis are probability values. 3. These are the mean values of the regression coefficients for the 88 cross-sectional regressions.

Table 2B. Response of small and large bank market discipline sensitivities to macroeconomic shocks (stage 2 multivariate regressions)

Dep. variable	GDP growth-	GDP growth	Fed funds	Fed funds

	small banks	large banks	ratesmall banks	ratelarge banks
	Rate	Rate	Rate	Rate
LIQ sensitivity	0.008*** (0.00)	0.018*** (0.01)	-0.0001 (0.78)	0.003*** (0.00)
NPL sensitivity	0.047** (0.04)	0.146* (0.07)	0.007* (0.07)	0.004 (0.75)
KAS sensitivity	-0.003 (0.89)	-0.104** (0.04)	-0.005 (0.15)	0.01 (0.25)

Note: 1. Each regression equation also contains four lags of the percentage change in the S& P500, four lags of the inflation rate, an indicator variable for the FDICIA period and three seasonal indicator variables. 2. Numbers in parentheses are probability values.

4.3. Second-stage results – non-performing loans (NPL). The first-stage results in Tables 2A show that when NPL increases, large CD rates rise, which is consistent with discipline. The second-stage results in Table 2B show that the second-order effect for GDP growth is positive and significant at the 10% level for large banks and 5% level for small banks. This indicates that as GDP growth increases the sensitivity between NPL and CD rates increases. That is, as the economy expands depositors force banks with higher NPLs to pay a higher premium, indicating greater discipline.

This Table also shows that as the federal funds rate rises, *NPL sensitivity* rises. This means that during contractionary monetary policy increases in NPL have a larger impact on decreasing deposit supply, indicating greater discipline through NPL during contractionary policy.

4.4. Second-stage results – equity capital (KAS). The first-stage results in Tables 2A show that as KAS falls, deposit rates rise for both bank groups. This is consistent with results in the discipline literature. In the second-stage *GDP Growth* increases the *KAS Sensitivity*, indicating greater discipline. Here we find that large bank CDs are the only ones responsive. This is indicative of depositors pressuring large banks to hold more capital during expansions.

4.5. The economic significance of the results. The results show macroeconomic shocks affect market discipline. We now examine the size of these results. The effect of a change in KAS on RCD, is given by $\beta_{KAS,t} = -0.031$ (from Table 2A). This indicator of market discipline shows that when KAS decreases by 1% RCD increases by 3.1 basis points. This first-order effect is small, but consistent in size with a similar measure in Hall et al. (2004). The associated second-order effect for an increase in GDP growth is given by $\beta_{KAS-GDP,t}$, which equals -0.104 (from Table 2B). This derivative indicates that an increase in the growth rate of real GDP by 1% is associated with a decrease in $\beta_{KAS,t}$ by 10.4 basis points. In other words, a 1% de-

[1] The results for all first-stage and second-stage variables are available on request.

crease in KAS accompanied by a simultaneous increase in real GDP growth by 1% will result in a 13.5 basis point increase in the large CD rate (3.1 + 10.4). This is a 335% increase in $\beta_{KAS,t}$ for every 1% increase in the growth rate of the economy (10.4/3.1). Because the gap in the quarterly annualized growth rate in real GDP from peak to trough has been over 8% over the last two business cycles, the CD rate could fluctuate by as much as 100 basis points for every 1% change in KAS over for an average large bank.

4.5. Implications of our results. Our results that macroeconomic shocks affect bank risk premiums on large CDs imply that supervisors could find use estimations of these premiums to gauge bank risk over the business cycle. This could aid regulators in assessing overall financial fragility within the banking system. These premiums could be used as an indicator of stability in the financial system.

Conclusion

We test for the effect of macroeconomic shocks on discipline in the market for large certificates of deposit. We test our hypotheses in a two-stage model. In the first stage discipline is estimated quarterly using bank-specific measures of default risk, conditional on a given macroeconomic environment. In the second stage we regress these time-varying measures of dis-

cipline on various macroeconomic variables. Our results show that as the economy strengthens depositors place more value on high capital and low non-performing loans. As the economy weakens depositors encourage banks to hold more liquidity. This result mainly obtains for large banks. As monetary policy contracts depositors punish banks with low liquidity, low capital and high non-performing loans. This result holds for large banks and low-capital banks.

Our approach contributes to a better understanding of how the macroeconomic environment alters depositor perceptions of bank risk and how these perceptions are incorporated into large CD rates and runoffs. These results have several implications for regulatory and monetary policies. For example, our study can help to better understand how direct market discipline might be working. Several studies have shown that while direct depositor discipline exists, its signals may be so small as to have minimal impact on bank costs and runoffs, especially for large banks.

This study explores the effect of macroeconomic shocks on bank-specific predicted risk premiums. It uses several variables that are associated with the macroeconomy. This study could be extended by including additional variables on the financial system to assess the effect of financial indicators on risk premiums and financial stability.

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