Capital Buffer and Risk Adjustments in BHCs

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Abstract

This paper makes use of a panel of United States (US) bank holding company (BHC) and commercial bank balance sheet data in order to examine the relationship between capital buffer and portfolio risk adjustments since the introduction of Basel I. Estimating a set of 'limited information' as well as 'full information' simultaneous equations, we find that for highly capitalized banks, adjustments in capital and risk are *negatively* correlated. The time-varying nature of the relationship in adjustments is then investigated, and found to change significantly around 1993.

1 Introduction

Capital regulation has become one of the key instruments of modern banking regulation providing both a 'cushion' during adverse economic conditions, as well as a mechanism aimed at preventing excessive risk taking ex ante (Rochet, 1992; Dewatripont and Tirole, 1993). Theoretical work focussing on assessing the ef- fects of capital requirements both on bank capital as well as on bank risk appetite have traditionally been dominated by a theory of moral hazard, in which information asymmetries and deposit insurance shield banks from the disciplining control of depositors. Such studies have analysed conditions, or regulatory set-ups that act to eliminate moral hazard in banking. Taking capital as exogenous and abstracting from dividend and recapitalization choices this strand of literature analyses incentives in asset risk choice. Studies in this regard have focused on the notion that although capital adequacy regulation may reduce the total volume of risky assets, the composition

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may be distorted in the direction of more risky assets, and average risk may increase. Risk consistent weights here are not sufficient to correct for this moral hazard effect in limited liability of banks[1].

Attention more recently has shifted towards the 'capital buffer theory'[2], predicting that banks will aim to maintain a level of capital above the required minimum (a 'buffer' of capital) due to both the explicit and implicit regulatory costs, which would result from falling below the minimum level[3]. Buser et al. (1981) and Milne and Whalley (2001) argue that implicit costs of regulation may arise from regulatory interference, subsequently reducing the charter value[4] of the bank. As a result, adjustments in bank portfolio risk and regulatory capital are expected to be positively related[5]. Banks will increase capital when their portfolio risk rises and vice versa, ensuring that capital buffers will remain at the desired level. Those banks whose capital has fallen below their required level will have an incentive to increase their capital levels by reducing portfolio risk and raising new capital. It is therefore possible that a negative relationship between changes in portfolio risk and the capital ratio for less capitalized banks may exist.

These two contending theories have varying implications for both bank capital and risk adjustments. The *'moral hazard theory'* indicates that when banks are forced to increase their capital level, they will react by either increasing or decreasing their level of risk. Here, capital can have either a positive or a negative relationship with risk and is independent of the amount of capital that is held in relation to the regulatory requirement (ie.it is not necessary for banks to hold excess capital). Essentially, if capital is exogenous (determined by the regulator), and the bank has a high charter value, then it is possible to get a non-linear relationship between capital and risk. For example, when capital is very low, and the probability of default high, then banks may take on a high level of risk since only large payoffs will provide a return to shareholders. In this case, higher bank capital leads to lower risk taking. On the other hand, when the probability of default is low, then the bank will take

[1]See Koehn and Santomero, 1980; Kim and Santomero, 1988; Rochet, 1992a&b; and Freixas and Rochet 1997.

[2]See among others Milne and Whalley, 2001; Peura and Keppo, 2006; VanHoose, 2007

[3]The traditional moral hazard theory predicts that banks will hold just as much capital as required by regulation.

[4]Also referred to as the "franchise value" (See Rojas-Suarez and Weisbrod, 1995; Demsetz, Saidenberg and Strahan, 1996), charter value is the value that would be foregone if the bank closes.

[5]See Shrieves and Dahl, 1992; Jacques and Nigro, 2001 and Aggarwal and Jaques, 1998 for evidence of this for the US market.

on a lower degree of risk to avoid losing franchise value. In this case, a higher level of bank capital will lead to higher risk taking. The *'capital buffer theory'* differs in that it makes it more plausable that high risk taking can occur following a temporary reduction in capital below the desired level. The contribution made by this theory is therefore such that it allows for capital to be endogenous, and second, introduces a short term departure of bank capital from desired levels. This indicates that bank capital and risk taking will be jointly determined and that the relationship between the two will differ in both the short and the long run.

Several empirical papers have focused on understanding the relationship between risk and capital, testing whether increases in capital requirements force banks to increase or decrease their risk (see Shrieves and Dahl, 1992; Jacques and Nigro, 1997; Aggarwal and Jacques, 2001; Rime, 2001). Most of these studies have found a positive relationship between capital and risk adjustments, indicating that banks that have increased their capital levels over time, have also increased their risk appetite. Shrieves and Dahl (1992) argue that a positive relationship between the variables is in line with several hypotheses which include the unintended effect of minimum capital requirements, regulatory costs, banckruptcy cost avoidance as well as managerial risk aversion. Jacques and Nigro (1997) on the other hand find a negative relationship between changes in capital and risk levels. They note that such a finding may be attributable to methodological flaws in the risk-based guidelines. Alternatively, as suggested by Shrieves and Dahl (1992), a negative relationship may exist between capital and risk adjustments if banks seek to exploit the deposit insurance subsidy. Evidence on the *'capital buffer theory'* however are far more limited. For a set of German savings banks, Heid et. al (2004) assess how capital and risk is adjusted under regulation. Their findings suggest that the coordination of capital and risk adjustments depends on the amount of capital the bank holds in excess of the regulation. Banks with low capital buffers try to rebuild an appropriate capital buffer by raising capital while simultaneously lowering risk. In contrast, banks with high capital buffers try to maintain their capital buffer by increasing risk when capital increases. These findings are in line with the predictions of the *'capital buffer theory'*.

Investigating the relationship between risk and capital has several important policy implications. The recent modification in the capital requirement regulation (Basel II) is a structural change that places far more emphasis on the range of capital that may be required given the specific risks faced by each bank. Several European banks have already adopted the new rules, with the remaining institutions following within the next year. Implementation in the US is slightly lagging. Large banks in the US will start implementing the new regulation in 2009.

Several concerns regarding the new regulation have been raised. One effect of the new rules is to give credit-rating agencies an explicit role, particularly for less sophisticated banks, in determining how much capital is enough. Moreover, Basel II encourages banks to use instruments such as credit derivatives, while the complexity and number of such instruments lie behind banks' difficulty in knowing who will ultimately bear the exposure to defaults. Its most prominent feature however is its risk-sensitivity compared to its predecessor. The new framework serves to align bank capital more closely to risks inherent in the system at any point in time, thereby ensuring adequate 'cushions' of capital to maintain stability within the system.

It has been argued that a more risk-sensitive capital adequacy regulation may reduce banks' willingness to take risk. However, if banks already risk-adjust their total capital, ie. minimum capital plus buffer capital, more than implied by Basel I, then replacing Basel I with Basel II may not affect the capital to asset ratio or risk profile of banks' portfolio as much as feared. It is therefore clearly of interest to understand the relationship between risk and capital buffer formation.

In this paper, we address this issue for a sample of US bank holding companies (BHCs). Here, we estimate a set of simultaneous equations to analyse the relationship between capital and risk adjustments. Of particular interest to us is the time-varying nature of this relationship since the introduction of Basel I, and in the period leading up to implementation of Basel II. Our estimations show that adjustments in capital and risk are negatively correlated for highly capitalized banks. However, we are able to show that the relationship changes substantially over the sample period.

The rest of the paper is organized as follows: Section 2 outlines the empirical framework adopted. Section 3 describes the data and defines the hypotheses to be tested. Section 4 presents our empirical estimations and results. Section 5 briefly discusses our findings and concludes.

2 Empirical Framework

The question we address here is whether or not there appears to be a significant relationship between capital buffer and risk adjustments over time. To do this, we need to acknowledge that banks will manage their buffer level by accounting primarily for risk of default. Similarly, the amount of risk the bank is willing to take on will depend on how close the buffer level of capital is to the minimum requirement. Hence, since the level of capital buffer and amount of risk are simultaneously determined by the bank, the model we are interested in estimating can be set in the general form:

$$BUF_{it}^{*} = \beta RISK_{it}^{*} + \gamma X + \varepsilon_{it} \qquad (1)$$

$$RISK_{it}^{*} = \zeta BUF_{it}^{*} + \eta Y + v_{it} \qquad (2)$$

where BUF_{it}^{*} and $RISK_{it}^{*}$ are the target levels of the capital buffer and the risk of the bank respectively; X and Y are sets of predetermined variables; β and ζ and the vectors γ and η are coefficients to be estimated; ε_{it} and v_{it} are the exogenous random shocks for bank i at time t.

The framework outlined above assumes that banks aim to establish optimal capital and risk levels. Over time, exogenous shocks will drive actual levels away from optimal levels desired by the banks.They will therefore need to adjust both capital and risk to get back to their optimum level. Full adjustment of bank capital to the optimum level however, may be too costly or infeasible. Banks will hence be faced with the trade-off of facing these adjustment costs, and operating with a sub-optimal level of capital. We therefore assume here that banks adjust capital levels only partially towards the optimal level following an exogenous shock. Our model in (1.) and (2.) above is then revised to allow for partial adjustment towards the optimal level within each time period.

The long-run level of optimal capital buffer and risk is then:

$$BUF_{it}^{*} = \xi Z_{it} \qquad (3)$$

$$RISK_{it}^{*} = \varphi Z_{it} \qquad (4)$$

Here Z_{it} captures all variables (including risk and the capital buffer) that act as determinants of the banks' optimal level of capital buffer and risk. ξ and φ are the vectors of coefficients to be estimated.

The partial adjustment model can then be written as:

$$BUF_{it} - BUF_{it-1} = \xi_0(BUF_{it}^{*} - BUF_{it-1}) + \xi_1 RISK_{it} + \mu_{it} \qquad (5)$$

$$RISK_{it} - RISK_{it-1} = \varphi_0(RISK_{it}^{*} - RISK_{it-1}) + \varphi_1 BUF_{it} + \kappa_{it} \qquad (6)$$

Here ξ_0 and φ_0 are the speeds of adjustment of the capital buffer and risk respectivly; BUF_{it} and $RISK_{it}$ are the actual levels of the capital buffer and risk; BUF_{it}^{*} and $RISK_{it}^{*}$ are the optimal levels of capital buffer and risk; and BUF_{it-1} and $RISK_{it-1}$ capture the actual level of the capital buffer in the previous period. $BUF_{it} - BUF_{it-1}$ and $RISK_{it} - RISK_{it-1}$ then represent the actual change in capital and risk between two periods, while $BUF_{it}^{*} - BUF_{it-1}$ and $RISK_{it}^{*} - RISK_{it-1}$ denote the desired change. These equations highlight the fact that observed changes in the buffer and risk levels in period t are a function of the differences between the target level of capital and risk in period t and previous period's actual capital and risk, and any exogenous shock.

Equations(5.) and (6.) postulate that the actual changes in capital and risk in any given time period t is some fraction ξ or φ of the desired change for that period. If ξ (φ)= 1, then the actual buffer (risk) level will be equal to the desired buffer (risk) level. That is, essentially, adjustment to the optimal level is instantaneous. If on the other hand, ξ (φ)= 0, it means that nothing changes, since the actual level of buffer (risk) at time t is the same as that observed in the previous period. Typically then, ξ and φ will lie between these extremes since adjustment to the desired stock of capital is likely to be incomplete for several reasons.

The partial adjustment framework can then alternatively be presented as:

$$BUF_{it} = \xi_0 BUF^*_{it} + (1-\xi_0)BUF_{it-1} + \xi_1 RISK_{it} + \mu_{it} \tag{7}$$

$$RISK_{it} = \varphi_0 RISK^*_{it} + (1-\varphi_0)RISK_{it-1} + \varphi_1 BUF_{it} + \kappa_{it} \tag{8}$$

showing that the observed level of buffer (risk) at time t is a weighted average of the optimal level of buffer (risk) at that time, and the buffer (risk) existing in the previous period, ξ (φ) and $1-\xi$ $(1-\varphi)$ being the weights.

Substituting (3.) and (4.) into (7.) and (8.) we obtain:

$$BUF_{it} = \lambda + (1-\xi_t)BUF_{it-1} + \mu_{it} \tag{9}$$

$$RISK_{it} = \varrho + (1-\varphi_t)RISK_{it-1} + \kappa_{it} \tag{10}$$

Where λ and ϱ are equal to $\xi_0(\xi Z_{it})$ and $\varphi_0(\varphi Z_{it})$ respectively.

3 Hypotheses and Data

In this paper we are interested in determining how individual banks adjust their capital buffers (risk) in relation to changes in risk (capital buffers). Therefore it is necessary for us to analyse the relationship between changes in risk and changes in capital buffers, rather than the relationship between levels of risk and capital. Moreover, since the desired buffer stock BUF^*_{it} and risk level, $RISK^*_{it}$ cannot be observed we approximate them by various cost and revenue variables discussed in detail in Section 3.1 below. Our estimated model derived in the previous section then becomes:

$$\Delta BUF_{it} = \alpha_1 + (1-\xi_0)\Delta BUF_{it-1} + \xi_1 \Delta RISK_{it} + \xi_2 CHARTERVAL + \xi_3 SIZE + \xi_4 ROA + \xi_5 LOANLOSS_{it} + \xi_6 LIQUIDITY + \xi_7 GDP + u_{it} \quad (11)$$

$$\Delta RISK_{it} = \alpha_2 + (1-\varphi_0)\Delta RISK_{it-1} + \varphi_1 \Delta BUF_{it} + \varphi_2 CHARTERVAL + \varphi_3 SIZE + \varphi_4 LOANLOSS_{it} + \varphi_5 LIQUIDITY + +\varphi_6 GDP + w_{it} \quad (12)$$

where ΔBUF_{it} and $\Delta RISK_{it}$ are the changes in capital buffers and risk respectivly, i = 1,2...N is an index of banks and t = 1,2,...T, is the index of time observation for bank i at time t. u_{it} and w_{it} are the error terms that can be decomposed as: $u_{it} = \mu_i + \varepsilon_{it}$ and $w_{it} = \kappa_i + v_{it}$ consisting of a bank-specific component μ_i and κ_i and white noise ε_{it} and v_{it}. μ_i and $\kappa_i \sim IID(0, \sigma^2_\mu)$ and ε_i and $\nu_i \sim IID(0, \sigma^2_\nu)$ are independent from one another and among themselves.

We take as our null hypothesis: H_0 **that adjustments in both capital buffer and bank risk have no impact on one another.** We can hence define the alternative hypotheses to be tested as follows:

H_{1A} : $\xi_1 > 0$ and $\varphi_1 > 0$; **Adjustments in capital buffer and risk are positively related for banks with large buffers of capital. This hypothesis is in line with the theory that well-capitalized banks will maintain healthy buffers of capital over time.**

and

H_{1B} : $\xi_1 < 0$ and $\varphi_1 < 0$; **The level of buffer capital varies systematically, but negatively, with the level of risk ie. Riskier banks will tend to hold less capital in their buffer stock. This hypothesis is in line with the notion that banks with buffers near the regulatory minimum will try to build up their buffers of capital over time.**

3.1 Sample Selection

To estimate the model, we create a panel of US commercial bank and bank holding companies (BHCs) covering the period between 1986[6] and 2006. All bank-level data is obtained from the Consolidated Report of

[6]US banks were not subject to specific numerical standards imposed by regulators prior to this time. Rather, banker and supervisory judgment was exercised such that the circumstances of the individual institution were considered. To this effect, important factors such as managerial capability, loan portfolio quality and adherence to fixed ratios were considered as arbitrary rules that did not always account for the most important factors.

Condition and Income (referred to as the Call Reports) published by the Federal Reserve Bank of Chicago[7]. Since all insured banks are required to submit Call Report data to the Federal Reserve each quarter we are able to extract income statement and balance sheet data for a large number of commercial banks. In addition, we obtain information for the Fed Funds Y-9 form, filed by BHCs[8]. By identifying the high-holder to which the individual commercial banks belong, we are able to merge[9] the two datasets to obtain balance sheet, income as well as risk-based variables for around 2000 bank holding companies[10]. We focus our analysis solely on the BHCs since we are primarily concerned with analysing the capital buffers levels over time. Individual subsidiary banks seldom issue independent equity and are rather wholly owned by a holding company. Equity financing generally occurs at the BHC level.

At the end of our sample, three BHCs dominated the industry: Bank of America, J.P. Morgan Chase and CitiBank. These banks had an average a Tier 1(total capital) ratio of around 8.35(11.23) percent. In general the BHCs in the sample have been well capitalized throughout the sample. The average bank has exceeded the minimum required capital ratio by a comfortable margin. The average[11] Tier 1(total) capital stood at 7.55(9.55) percent of RWA in 1986 but reached 9.88(13.44) percent by 1994 and has remained relatively stable since (see Table 1). Figure 1 documents the evolution of both Tier 1 and Total capital ratios over time. We can see that in 1992, both Tier 1 and Total capital ratios rose substantially. Several reasons can be put forward as a possible explanation of this. First, the rise in bank capital might simply reflect an unusual period of inflated bank profitability and share price appreciation during the 1990s. BHC capital ratios might thus have risen 'passively', simply because bank managers failed to raise dividends or repurchase shares. Second, this was around the time that the Basel I rules were introduced in the US. The Federal Deposit Insurance Committee Improvement Act (FDICIA) subsequently sought to impose greater credit risk on uninsured bank liability holders and consequently introduced a

[7] This data is publically available at www.chicagofed.org.

[8] A bank holding company, under the laws of the United States, is any entity that directly or indirectly owns, controls, or has the power to vote 25% or more of a class of securities of a U.S. bank. Holding companies do not however, administer, oversee, or manage other establishments of the company or enterprise whose securities they hold. They are primarily engaged in holding the securities of (or other equity interests in) companies and enterprises for the purpose of owning a controlling interest or influencing the management decisions.

[9] See A2. for more information on the data manipulations.

[10] Once the initial dataset is obtained, we further clean the data by keeping only those bank holding companies for which we have three consecutive quarters of data.

[11] weighted by market capitalization.

mandatory set of prompt corrective actions (PCA) that increased the cost of violating the capital standard. Hence, direct supervisory pressure may have contributed to the capital buildup. Although PCA does not directly apply to BHCs, it is relevant, because it applies to their bank subsidiaries and therefore may affect the amount of excess capital held at the holding company level.

Dependent and Explanatory Variables

Bank Capital Buffers Our dependent variable BUF_{it}, is defined as the amount of capital the bank holds in excess of that required by the regulator. In the beginning of our sample, pre-Basel I, US regulators employed a simple leverage ratio to assess capital adequacy: primary capital[12] had to exceed 5.5 percent of assets, while the total amount of primary plus secondary[13] capital had to exceed 6 percent of assets. Hence, in the period between 1986 and end 1990, we consider a ratio of 7 percent as the regulatory minimum with which we calculate the buffer of total capital[14]. Effective December 31, 1990, banks were required to hold at least 3.25 percent of their risk-weighted assets as Tier 1 capital and a minimum of 7.25 percent of their risk-weighted assets in the form of total capital (Tier 1 + Tier 2). Finally, Basel I was introduced at the end of 1992. The minimum Tier 1 and total capital ratios were subsequently raised to 4 percent and 8 percent, respectively. In the US, banks are restricted not only by the capital requirement regulation, but an additional leverage ratio of primary capital[15] to total capital requirement imposed by the FDICIA. Current regulations therefore state that in order to be *adequately-capitalized*, a BHC must have a Tier 1 capital ratio of at least 4 percent, a Total capital ratio of at least 8 percent and a leverage ratio of at least 4 percent.

The Tier 1 ratio of a bank is defined as the Tier 1 capital[16] over the banks total assets, where Tier 1 capital gives the ratio of a banks' core equity capital to its total risk-weighted assets (RWA)[17]. Due to reporting changes, data on RWA are not available as far back as 1986.

[12] the sum of equity plus loan loss reserves.

[13] primarily qualifying subordinated debentures.

[14] This criterion is based on the Federal Reserve Boards definition of zones for classifying banks with respect to supervisory action. Banks with total capital in excess of 7 percent at this time are deemed to have adequate capital.

[15] Primary capital consisted mainly of equity and loan loss reserves.

[16] Tier 1 capital is the book value of its stock plus retained earnings. It is the core measure of a banks financial strength from a regulators point of view. It consists of the types of financial capital considered the most reliable and Liquidity and therefore acts as a measure of the capital adequacy of a bank.

[17] Risk-weighted assets are defined as the total of all assets held by the bank, weighted for credit risk according to a formula determined by the countries regulator.

We therefore create proxy series for these variables prior to this time in order to analyse capital management decisions dating back to the implementation of Basel I.

We adopt the methodology put forward by Beatty and Gron (2001) to estimate RWA prior to 1990. Our estimated RWA variable, defined as $ERWA$ is calculated as follows:

$total\ loans + (0.2 * agency\ securities) + (0.5 * municipal\ securities) + (1 * corporate\ securities)$

Moreover, we proxy missing values of Tier 1 capital with the series for total equity. We can then compare pre- and post- Basel periods. The correlations for both series are good. We find that between 1990 and 2006, the correlation between the $ERWA$ to total assets series and the true risk weighted assets to total assets is around 60 percent. The correlation between the ratio of common equity to total assets and the Tier 1 capital to total assets ratio is around 97 percent.

Risk Essentially, risk can be thought of as being related to the costs of bank failure. From a regulators point of view, banks with a relatively risky portfolio, ie. with a high credit risk should hold a relatively high level of buffer capital. Otherwise, these banks will be more likely to fall below the minimum capital ratio, increasing the probability of bankruptcy and likelihood of facing costs associated with failure[18]. Measuring bank risk is not a simple task since each alternate measures has its own characteristics and limitations. Consequently no single measure provides a perfect measure of bank risk. Various measures of bank risk have therefore been widely utilized in the banking literature.

In this study were are concerned with portfolio risk, the proportion of risky assets in the bank's portfolio, since this is the measure of risk on which bank regulators base their capital guidelines. Even though the proportion of certain risky assets in a bank's portfolio may not exactly reflect the overall asset risk of a bank, it may reflect project choice by bank managers and, thus, to some degree the overall asset risk. For this reason, several authors (Godlewski, 2004; Berger, 1995; Gorton and Rosen, 1995; McManus and Rosen, 1991) have used the composition of a bank's portfolio as a measure of asset risk. Given that the objective of this study, it is crucial that we correctly estimate risk in a manner that captures changes in management policy with regard to the risk profile of the bank at any point in time. Therefore, several measures are adopted here to capture this.

As our first measure of risk ($RISK$), we create an idex as per Chessen

[18] See Ancharya (1996).

(1987), Keeton (1989) and Shrieves and Dahl (1991). The index, constructed from accounting data, is calculated as follows:

$(0 * non\ interest\ bearing\ balances\ and\ currency\ and\ coins) + (0.25 * interest\ bearing\ balances) + (0.10 * short - term\ US\ treasury\ and\ government\ agency\ debt\ securities) + (0.50 * state\ and\ local\ government\ securities) + (0.25 * bank\ acceptances) + (0.25 * fed\ funds\ sold\ and\ securities\ purchased\ under\ agreements\ to\ resell) + (0.75 * standby\ letters\ of\ credit\ and\ foreign\ office\ guarantees) + (0.25 * loan\ and\ lease\ financing\ committments) + (0.50 * commercial\ letters\ of\ credit) + (1.00 * all\ other\ assets)$

The weighted sum of these asset amounts is then divided by total assets.

Previously used portfolio risk measures include the ratio of risk-weighted assets to total assets derived from the Basel Accord risk-based capital guidelines (RWA/TA), the ratio of non-performing loans to total assets (NPL), and commercial and industrial loans to total assets (the $CIratio$).

In addition to the $RISK$ measure described above, we consider the risk-weighted assets to total assets ratio RWA/TA. The risk-weighted assets are calculated in accordance with the Basel I rules. A higher value here represents an increased level of risk. The rationale for this proxy is that the allocation of bank assets among risk categories is the major determinant of a bank's risk[19]. This measure of risk however does not account for market risk and therefore serves to capture credit risk only. As a consequence, it captures only one part of the true asset risk. Moreover, the relative weights assigned to each portfolio category may not correspond to the actual risk involved. Since there are only four kinds of relative weights (0, 20, 50 and 100 percent), each category within the portfolio may consist of assets with varying levels of risk[20]. Therefore, it is likely that two banks with the same RWA/TA ratio in fact have different levels of risk exposure. The ratio of non-performing loans[21] to total loans and credits NPL is additionally adopted as a measure of risk. This measure of loan portfolio quality is an ex-post measure of risk since banks with non-performing loans are obliged to make provisions for loan

[19] See Chessen, 1987 and Keeton, 1989. Jacques and Nigro (1997) argue that the RWA/TA captures the allocation as well as the quality aspect of portfolio risk. Avery and Berger (1991) and Berger (1995) show that this ratio is positively correlated with risk.

[20] For instance, all commercial loans have the same weight (100 percent) regardless of the creditworthiness of the borrower.

[21] Non-performing loans are those that are 90 days or more past due or not accruing interest.

losses. In order to affectively capture risk through this methodology, we need to acknowledge that the risk of loans originated in a given year will not be reflected in past due and non-accrual classifications until the subsequent period. Therefore the quality of loans in a given year must be measured as those past due or non-accruals recorded the following year. As a final measure, we calculate the ratio of commercial and industrial loans to total assets ($CIRatio$). This measure is adopted since C&I loans are generally riskier than the other categories of loans[22]. Empirical studies (Gorton and Rosen, 1995; Samolyk, 1994) find evidence that banks with a higher proportion of C&I loans to assets also have higher levels of non-performing assets. The RWA/TA ratio is generally considered to be a better ex- ante indicator of overall risk than the $CIRatio$, since it is a more comprehensive measure. Thus, while the $CIRatio$ focuses only on a specific portfolio item, the Basel Accord guidelines group all assets into different portfolio categories and assign different risk weights according to the perceived riskiness of all of the portfolio categories. In contrast to the other two measures (the ($CIRatio$) and the RWA/TA), the NPL ratio is an ex-post measure of risk. Thus, the NPL ratio inherently depends on luck or chance and other factors, in addition to ex-ante risk. The NPL ratio may contain information on risk differences between banks not caught by the RWA/TA ratio, and thus is used as a complementary risk measure to the RWA/TA ratio.

Therefore, if banks consider the true credit risk of their portfolios when deciding on the total amount of capital, one would expect the buffer capital to vary positively with any risk measure included as a regressor. Essentially replicating the true risk profile of banks' portfolios rather than the risk weights in Basel I.

In addition to the influence that risk will have on capital buffer formation, from the literature we are able to define several other key variables as determinants of the capital buffer X and risk Y, from equations (4.1) and (4.2), assumed by banks.

Charter value: A more satisfactory account of bank risk-taking emerges when allowance is made for the charter value of the bank. The larger the charter value of the bank, the greater the incentive to reduce risk-taking and to maintain a capital buffer level that is not in danger

[22] The major loans made by U.S. commercial bank lending activities can be segregated into four broad categories. These are real estate, C&I, individual, and others. C&I loans includes credit to construct business plants and equipment, loans for business operating expenses, and loans for other business uses. It is the second largest loan category in dollar volume among the loan portfolio of U.S. commercial banks.

of falling below the regulatory minimum[23]. The charter value thus acts as a restraint against moral hazard in banking (Marcus (1984); Keeley (1990); Demsetz et al (1996)) and can explain the relationship between capitalisation and the risk appetite of the bank (Demsetz et al (1996)). Two measures are widely used in the financial literature as proxies of charter value. These are the market-to-book-value of bank assets, and the market-to-book-value of equity. For instance, Keeley (1990), Saunders and Wilson (1994) and Demsetz et al (1996) among others use the market-to-book-value of assets, while market-to-book-value of equity is found in Saunders and Wilson (1997), Gallowey, Lee and Roden (1997), Brewer, Mondschean and Strahan (1997). These measures are sometimes presented as proxies of the Tobin's Q ratio used by Linderberg and Ross (1981) to assess monopoly rents in non-banking industries. Saunders and Wilson (1994) show how one can derive market to book value of assets as a measure of Tobin's Q. Their model is built on two main assumptions, namely: 1) a bank's equity value reflects the present value of all expected future dividend payments to shareholders, and 2) a 'clean surplus accounting rule' holds. In the rest of this study, charter value $CHARTERVAL$ will refer to the market-to-book-value of assets. We would expect to observe a positive relationship between $CHARTERVAL$ and the capital buffer; such that banks with higher charter values will hold larger capital buffers. Moreover a negative relationship between $CHARTERVAL$ and risk is expected, indicating that banks with higher charter values have greater incentive to reduce their risk.

Bank size: The Size of a bank may play a role in determining the banks' risk level through its impact on investment opportunities and diversification possibilities and access to equity capital. Large banks might be covered by the 'too-big-to-fail' phenomenon whereby any distress will be bailed out by government assistance. Therefore, to capture size effects on both buffer and risk movements, we include the log of total assets, $SIZE$ whith an ambiguous expected sign in both cases.

Return on assets: Since bank profitability may have a positive effect on bank capital if the bank prefers to increase capital through retained earnings rather than through equity issues. This might be the case since equity issues may convey negative information to the market about the banks value in the presence of asymmetric information. We therefore additionally include bank return on assets ROA, as a measure of bank profits. The expected sign on the coefficient of such a variable

[23] Banks with larger charter values will want to protect this value by lowering their risk-taking.

would be positive since the level of buffer capital would in this case be expected to move in line with the level of bank profitability.

Loan loss provisions: A bank's current loan losses will have an impact on the risk level of a bank since a bank with a higher level of loan losses will tend to exhibit lower levels of risk-adjusted assets in the future. We proxy these losses $LOANLOSS$, by the ratio of new provisions to total assets. The effect of loan losses on the buffer capital level is expected to be positive since banks with greater expected losses can be assumed to raise their levels of buffer capital in order to comply with regulatory requirement and to mitigate solvency risk. We include the $LOANLOSS$ variable in the risk equation based on the assumption that banks with higher level of loan losses will exhibit lower future levels of risk-adjusted assets. As a result, a negative relation should exist between target risk and loan loss provisions for bad loans.

Liquidity: Banks with higher liquidity ratios are generally faced with less risk and, hence, need to hold less capital. Such banks may then be willing to increase their levels of risk. Therefore we expect a negative relationship between $LIQUIDITY$, calculated as cash plus securities over total assets, and the level of a bank's capital buffer. Moreover, we expect a positive relationship between $LIQUIDITY$ and the level of risk.

GDP Growth: Finally, we include US GDP growth, GDP, in our equations to capture cyclical or accelerator effects. The relationship between GDP, risk and captal buffers is an ambiguous one. During business cycle upturns, when banks expand their lending, potential risks arise and banks increase their capital buffers by more than average in order to account for these increasing risks. Similarly in business cycle downturns, when risks materialize, banks draw from these higher buffers of capital. In this case, the observed relationship will be positive. Similarly, if banks activly increase their capital buffers during economic adversity, implying a lack of capital buildup during economic upturns when it might be easier and cheaper for them to do so, a negative relationship between GDP, risk and the buffer of capital would be apparent.

4 Estimation: Methodology and Results

Our model, as outlined in (11.) and (12.) is estimated for a variety of combinations of risk measures outlined above. All variables adopted in the study are defined in Table 2. Table 3 presents correlations of all variables in levels. Since banks with relatively low risk aversion will choose relatively high leverage (low capital) and high asset risk (see Kim and Santomero, 1988), we would expect to find a negative cross-sectional correlation between the level of portfolio risk and and bank capital ratios simply due to the cross-sectional variation in risk preferences. Interestingly, only the correlation between the level of capital buffer and the $RISK$ variable is negative. All other measure of risk appear to be positively correlated with the level of the buffer capital. Moreover, signs of correlations between the variables in first differences change. The correlation between the ΔBUF and ΔRISK is positive, while the correlation between the ΔBUF and ΔNPL is now negative [24], highlighting the importance of specifying the dynamics of bank behaviour relative to risk and capital in terms of first differences rather than in levels.

These initial correlation studies however do not account for any other variables that may affect the relationship and therefore do not clarify whether the correlations noted are due to simultaneous changes in the variables. Our estimations therefore serve to account for various factors that could affect the level of capital and risk held to provide a more concise understanding of the relationships.

Since we estimate a dynamic model, including the lagged endogenous variables, we employ the two-step generalized method of moments (GMM) procedure of Arellano and Bond (1991) estimator. Applying this methodology rather than the 3 stage least squares (3SLS) approach that is common in the literature[25], allows us to account for possible bank-specific effects, and will therefore allows us to obtain unbiased estimates. The methodology assumes no autocorrelation in the u_i and uses the entire set of lagged BUF_{it} as instruments. We also include two to four lags of our other principal explanatory variables ($RISK$ and ROA) as instruments in order to avoid correlation with u_{it}. Moreover, since we have included both macro as well as micro data variables in our equations, we 'cluster adjust' our standard errors, allowing for covariance structure where error terms are correlated within clusters, but uncorrelated across clusters[26]. The number of instruments chosen in each model was the largest possible, for which the Sargan J-statistic for over-identification restrictions was still satisfied. We additionally apply the Newey-West correction for heteroskedasticity and autocorrelation consistent covariances to further adjust the t-values for additional heteroskedasticity and autocorrelation.

[24] The correlations in first differences are not presented here for brievety

[25] see among others Schrieves and Dahl (1992); Jacques and Nigro (1997); Aggarwal and Jacques (2001); Rime (2001) and Heid et al. (2004).

[26] See Moulton (1990) for a detailed discussion of this issue

4.1 Global GMM:

As mentioned in the previous section, several varying measures of risk have been adopted in the literature, and consequently, no consensus on which measure is most suitable exists. We therefore begin by estimating variations of our model with different measures of risk outlined above. We start by estimating 'limited information' equations, whereby (11.) and (12.) as separate equations.

Capital equation The results from estimating variations of (11.) are presented in Table 4. For *Model I*, risk is proxied by risk-weighted assets to total assets RWA/TA. In *Model II*, risk is captured by the ratio of non-performing loans to total loans and credits NPL. *Model III* measures risk as the ratio of C&I loans to total assets ($CIRatio$).*Model IV* combines the NPL and RWA/TA measures of risk. *Model V*, introduces the risk index calculated in Section 3.1, while *Model VI*, is a combination of the risk index ($RISK$) and NPL. In each case, the risk measure is taken to be the change in risk as discussed in Section 3. All of these measures act to proxy portfolio risk.

In general, the relationship between the changes in capital and risk appears to be negative, however we do find a positive relationship whenever the NPL measure of risk is included. The negative relationship here is in contrast to previous findings. However, most of the authors in the literature to date have proxied risk by non-performing loans (see Shrieves and Dahl, 1992; Jacques and Nigro, 2001 and Aggarwal and Jaques, 1998 for evidence of this for the US market). We are able to replicate this positive finding with our NPL measure of risk, however note that in since all of our other measures return a negative relationship, more work into a correct proxy of risk might be required.

In addition to the risk variables, the estimated coefficients generally carry the expected sign with mostly significant coefficients. The reported coefficients on the lagged dependent variable BUF_{it-1} are estimates of 1-ξ_1 ie. the closer the estimated coefficient on the lagged dependent variable is to 0 the faster the speed of adjustment. This finding is in line with the view that the costs of capital adjustment are an important explanation of the holding of large capital buffers. Our finding indicates that BHC's appear to adjust towards their optimal buffer level rather quickly. In particular, we find the fastest speed of adjustment in *Model V*. Here it seems that banks on average plan to close the gap between their actual and desired level of capital by around 78 percent each quarter. The expected positive sign on the $CHARTERVAL$ coefficient is found only in two of the six cases *Model V and Model VI*, however, the coefficients are not significant in either case. For *Model I, Model II,* *Model III and Model IV*, the coefficients are negaitive and significant, indicating that banks with a relativiley higher charter value will hold a smaller capital buffer. Our $SIZE$ variable is consistently negative, but only significant in two of the six cases *Model I and Model VI.* The negative coefficient is in line with the 'too big to fail hypothesis' as well as with the notion that smaller banks tend to experience greater difficulty in accessing the capital markets. Furthermore, this finding could provide evidence in favor of scale economies whereby larger banks will generally enjoy a higher level of screening and monitoring than their smaller counterparts resulting in a reduction excess capital held as insurance. Moreover, the negative coefficient is consistent with the notion that smaller banks are less diversified than their larger counterparts and therefore hold higher levels of buffer capital. ROA is consistently positive and mostly significant, indicating the importance that BHCs place on retained earnings to increase their capital buffers. $LOANLOSS$ is positive and significant in five of the six cases, indicative of the notion that banks with greater expected losses raise their levels of buffer capital in order to comply with regulatory requirements and to mitigate solvency risk. The $LIQUIDITY$ variable shows that banks with higher liquidity ratios generally hold less capital. While the estimates have the correct sign, the results are only significant in two of the six the models *Model V and Model VI.* Finally, the cycle variable, GDP is positive and significant in all cases. This finding indicates that banks tend to increase capital in business cycle expansions and reduce capital in recessions.

Risk equation Similarly to above, the 'limited information' risk equation, (12.) is estimated varying the dependent variable. Here, the coefficient on the lagged dependent variable $RISK_{it-1}$ captures the speed of adjustment towards the desired level of risk. The speed of adjustment is again relatively fast, however significantly slower than the adjustment noted in the buffer equation above. Again, we find that the speed of adjustment for *Model IV* is the fastest. Here, banks will generally close around 50 percent of the gap between the actual and desired buffer levels in each period following a shock. The coefficients on ΔBUF are generally negative and significant apart for *Model II* where the coefficient is positive and significant at the five percent level. Again this positive relationship confirms previous findings in this field. $CHARTERVAL$ is positive and significant for all models in contrast to our expectations, idicating that banks with a higher charter value have a greater incentive to increase their level of risk taking. $SIZE$ is positive in all case but significant only for *Model II and Model III.* As above, this finding is consistent with the notion that larger banks have higher optimum levels of risk than smaller banks. The coefficient on $LOANLOSS$ coefficients are positive and significant indicating that contrary to expectations, banks with higher loan losses tend to exhibit higher levels of portfolio risk. $LIQUIDITY$ coefficient is positive as expected, but not significant in any of the cases. Finally, GDP is positive and significant in almost all cases, in particular, for *Model IV*, the cycle variable is highly significant. This finding is in line with that of the buffer equation and indicates that bank portfolio risk tends to increase during business cycle upturns as opposed to during recessions.

Our findings above indicate that the relationship between changes in capital and risk appears to be negative. Essentially, BHC's that increase their capital buffers over time tend to decrease their risk taking and vice verse. Our single equation estimations show that increases in the risk appetite of a bank will generally render lower buffers of capital while similarly, increases in the buffer of capital will result in an decrease in risk taking. In general, we see that regardless of the risk measure adopted, except for NPL, the results are qualatively independent of the measure adopted. For the rest of this paper, we therefore adopt $RISK$ as our measure of risk. We chose the composite risk index $RISK$ for several reasons. First, it appears to be the most accurate measure of risk for this study since it estimates risk in a manner that captures changes in management policy with regard to the risk profile of the bank at any point in time. Moreover, the expected negative correlation between risk and capital (see Table 3) is only evident when the $RISK$ measure is adopted. Hence, we assume that this measure dominates others as disccussed previously.

We therefore proceed to the 'full information' estimations whereby we estimate (11.) and (12.) as a system of simultaneous equations. As a robustness check, we additionally pool the cross-sectional data over the entire sample period and adopt the 3SLS instrumental variable approach that uses a linear combination of all exogenous and predetermined variables as instruments for endogenous regressors. This procedure assumes that unobserved heterogeneity (ie. bank-specific effects) is unimportant. If this assumption is incorrect, then the returned coefficients are biased. We include this test and present the results here since this is the most commonly adopted approach for testing the bank capital and moral hazard models in the literature and therefore provides a means to assess the validity of the GMM approach here.

4.1.1 Full information estimations

Many of the variables included in our analysis are significant in at least one of the equations. The speeds of risk and capital adjustment, as proxied by the lagged dependent variables BUF_{it-1} and $RISK_{it-1}$, are in both cases positive and highly significant. Our finding is in line with the view that the costs of capital adjustment are an important explanation of the holding of large capital buffers confirming that BHC's appear to adjust towards their optimal buffer level rather quickly. The speed of risk adjustment $RISK_{it-1}$ is significantly slower than the adjustment of capital buffers over the sample period. The effect of ΔRISK on ΔBUF is negative and highly significant as is the effect of ΔBUF on ΔRISK. The fact that both ΔBUF and ΔRISK are significant indicates that this negative relationship appears to be a two-way relationship between the variables. $CHARTERVAL$ is highly significant in both cases, confirming the importance of the franchise value of the bank predicted by the capital buffer theory. Interestingly, the charter value is negative for the buffer equation and positive for the risk equation. In both cases, this is in contrast to our expectations and indicates that banks with a relativiley higher charter value will hold a smaller capital buffer and will have a greater incentive to increase their level of risk taking. As per the limited information equations, the $SIZE$ of a bank appears to have a significant negative effect on changes in capital, while the relationship is positive, however not significant between the $SIZE$ of the bank and its changes in $RISK$. Moroever, we note that ROA has a significantly positive effect on the level of capital buffer, signifying that BHCs will generally rely heavily on retained earnings in order to increase their capital buffer levels. This finding is in line with Aggarwal and Jacques (2001) who conduct a similar study for the US, however their sample is limited to commercial banks. $LOANLOSS$ is positive and significant at the five percent level in both the risk and the capital equations. This finding indicates that banks with greater expected losses raise their buffers of capital in order to comply with regulatory requirements and to mitigate solvency risk, while banks with higher loan losses, surprisingly, tend to exhibit higher levels of portfolio risk. The coefficients on the $LIQUIDITY$ variables carry the expected signs but are not significant at any level. Finally, the cycle is positively related to both adjustments in capital as well as adjustments in risk. During economic upturns, banks will act to increase their buffers of capital when it is cheaper and easier to do so. Similarly, they will simultaneously adjust their risk upwards.

The most important findings can be outlined as follows. BHCs appear to adjust their buffers of capital faster than they adjust their risk. Moreover, we find that adjustments in capital and risk are *negatively* related and that the relationship appears to be two-way ie. buffer decisions will be influenced by the amount of portfolio risk taken on, and, similarly, the amount of risk the bank will take will be influenced by the amount of capital buffer held by the bank.

Moreover, we see that whether the equations are estimated via a 3SLS or a GMM approach, the coefficients on the variables affecting the capital and risk relationship have the same sign. Some variables however are notably less significant.

4.2 Further Investigation

Our findings above indicate that capital buffer and risk level adjustment has been a negative and significant two-way relationship throughout our sample period. While these findings are largely contrary to previous research in this field (see Shrieves and Dahl, 1992; Jacques and Nigro, 1997; Aggarwal and Jacques, 2001; Rime, 2001; Heid et al., 2004) the driving force behind this relationship still remains unclear. Several differences that exist between this and other studies can explain this contrast in findings. In particular, the sample period here is far longer than that adopted in previous studies of this nature. Previous work has concentrated on a few years of data following the change in the regulation in the beginning of the 1990s. Moreover, the data sample includes a set of bank holding companies, while authors previously studying adjustments in capital and risk have focussed solely on commercial bank activitiy. In addition, the proxy adopted for capturing risk has largely been the non-performing loans measure. Here we make use of a composite index constructed to act as a more accurate measure of risk capturing changes in risk management policy. Finally, additionaly variables included as explanatory variables have been extended here.

The rest of the analysis therefore focusses on determining whether simultaneous adjustments are dependent on institutional characteristics among banks in our sample, and whether or not the relationship uncovered above remains consistent over time. In this section we try to uncover some further information relating to the driving force behind the negative risk-capital relationship.

4.2.1 Rolling GMM:

Under the GMM approach adopted above, fixed coefficients are estimated so as to capture an average effect that each regressor will have on the dependent variable over the time period analysed. Here, any changes to economic structure, such as changes in a policy regime etc. will not be captured directly, but rather effects will be averaged out to provide an average estimate over time. Particularly, in the US, during out sample period, banks were faced with three differenct changes to requirements in capital holdings. Therefore, to capture the effects of these regulatory changes, as well as possible shifts in importance of buffers of capital (risk) on risk (capital buffers) over time, we obtain a set of rolling coefficients ϑ for (11.) and (12.). We achieve this by estimating a series of rolling GMM equations over our sample period providing a continuous picture of the buffer-risk relationship.

For this type of estimation, we are faced with a trade off with respect to the window Size. Due to the properties of the GMM, the robustness of the results will increase with the sample size. Therefore, to detect potential changes in buffer level determinants, we prefer small sample sizes that can be assumed to be more sensible to possible shifts. We begin with windows of 1 year, including 4 time period observations in each window. This will give us one coefficient for each year. These estimations are conducted only on the above-average loan loss provision banks.

Results for the buffer and risk equations are presented in Tables 9 and 10 respectively. We find that the relationship between risk and capital adjustments have changed significantly over time. In the beginning of our sample (between 1986 and 1993), the relationship between capital buffers and risk is a one-way, positive relationship running from capital to risk. This means that BHCs appear to have increased their portfolio risk taking when their buffers of capital were high. Risk however doesnt appear to have any significant relationship on the determination of the level of capital buffer held. This positive relationship found so early in the sample, confirms many of the previous findings in the literature. These studies concentrated on assessing adjustments in capital and risk directly following the introduction of the PCA measures in the US.

After 1993, the relationship changes. In particular, the relationship becomes negative at this time, but remains a one-way relationship. This shift in the relationship coincides with the changes in capital requirement regulations which came in 1990 and again in 1992. Since the new rules required banks to hold capital dependent on the amount of risk weighted assets, as well as made it more costly for banks to fall below the required minimum, it seems natural that from this point point, bank risk and capital policies might have been revised. A final change is evident in 2001, when the relationship moves to a two-way relationship. Here, adjustments in capital became dependent on the level of portfolio of the bank and vice verse. The relationship then remains unchange until the end of the sample in 2006.

5 Discussion

This paper examines the relationship between US BHC capital buffer and risk level adjustments over time. We build a panel of BHC and commercial bank data, using quarterly balance sheet data between 1986 and 2006. Controlling for various determinants of capital buffers and risk levels put forward by the theoretical and empirical literature in this field, we adjustments in optimal bank capital buffers and risk over time.

During much of the 1990s, (a large portion of the time frame during which we conduct this analysis), the regulatory restrictions imposed on BHC's changed significantly. Basel I was initially introduced in 1990 which, for the first time in history, defined a minimum amount of capital that banks were required to hold. These rules were subsequently ammended slightly in 1992. Moreover, the FDIC improvement act came into force in 1991 which included a set of correctative actions that increased the cost of violating the regulatory minimum. Moreover, restrictions on permissible bank activities were removed allowing BHC's to select from a broader array of potential risk exposures[27] The typical BHC's risk exposure consequently increased, as the diversification effects of new business activities were outweighed by the higher risks associated with the new lines of business.

Our results identify a negative and significant relationship between capital buffer and risk adjustments over time. Our findings are in contrast to the capital buffer theory perdictions which assume banks adjust their buffer capital and risk levels positively. Our findings are confirmed by a set of limited information as well as full information GMM equations. Moreover, we estimate the time varying nature of the relationship. We find that the relationship has changed significantly over time. In particular, the negative relationship uncovered in the global GMM estimations appears to be driven by data in the latter part of the sample. Before 1993, adjustments in capital and risk appear to be positively related, while after this time, the relationship becomes negative. Moreover, we see that risk only became a significant driver of buffer levels after 2001. Before this time, it was capital that drove decisions on risk taking.

Our findings have implications for the changing regulatory framework in the US. The positive relationship between capital and risk adjustments suggest that introducing a more risk-sensitive capital regulation (Basel II) is unlikely to affect US bank holding companies to a large extent. Essentially, what we see is that BHC appear to account for the true value of their risk when making capital buffer decisions. Banks appear to be replicating their true risk profile in a more efficient manner than the risk weights proposed under the Basel I regime. These findings are in line with the hypothesis that financial institutions throughout the world have been developing frameworks for "economic capital management" in response to the diversification of banking businesses, rapid progress in financial engineering, and the implementation of Basel II. The objective

[27] see Stiroh (2004).

has been to develop precise measures of the various risks that financial institutions are exposed to, and to actively utilize such assessments in determining capital adequacy and in formulating business strategies.

6 Tables and Figures

Table 1: BHC Tier 1 and Total Capital Ratios.

	Tier 1 Capital		*Total Capital*	
	ratio	buffer	ratio	buffer
1986	7.55		9.55	2.55
1987	7.68		9.68	2.68
1988	7.33		9.33	2.33
1989	7.29		9.29	2.29
1990	7.45	4.20	9.45	2.20
1991	7.67	4.42	9.67	2.42
1992	8.54	5.29	9.87	2.62
1993	9.10	5.09	11.10	3.10
1994	9.88	5.88	13.44	5.44
1995	9.45	5.45	13.65	5.65
1996	9.33	5.33	13.33	5.33
1997	9.66	5.65	13.53	5.53
1998	9.33	5.32	13.53	5.53
1999	9.34	5.34	13.60	5.60
2000	9.25	5.26	13.64	5.64
2001	9.26	5.25	13.36	5.36
2002	9.80	5.79	13.57	5.57
2003	10.14	6.14	13.75	5.75
2004	10.08	6.07	13.43	5.43
2005	9.88	5.88	13.76	5.76
2006	9.74	5.74	13.55	5.55

Note: Tier 1 capital refers to the banks core capital, including equity and disclosed reserves and can absorb losses without a bank being required to cease trading. Total capital is Tier 1 + Tier 2 capital. Buffer refers to the amount of capital held in excess of the regulatory requirements.

Figure 1: Evolution of Tier 1 and Total Capital Ratios.

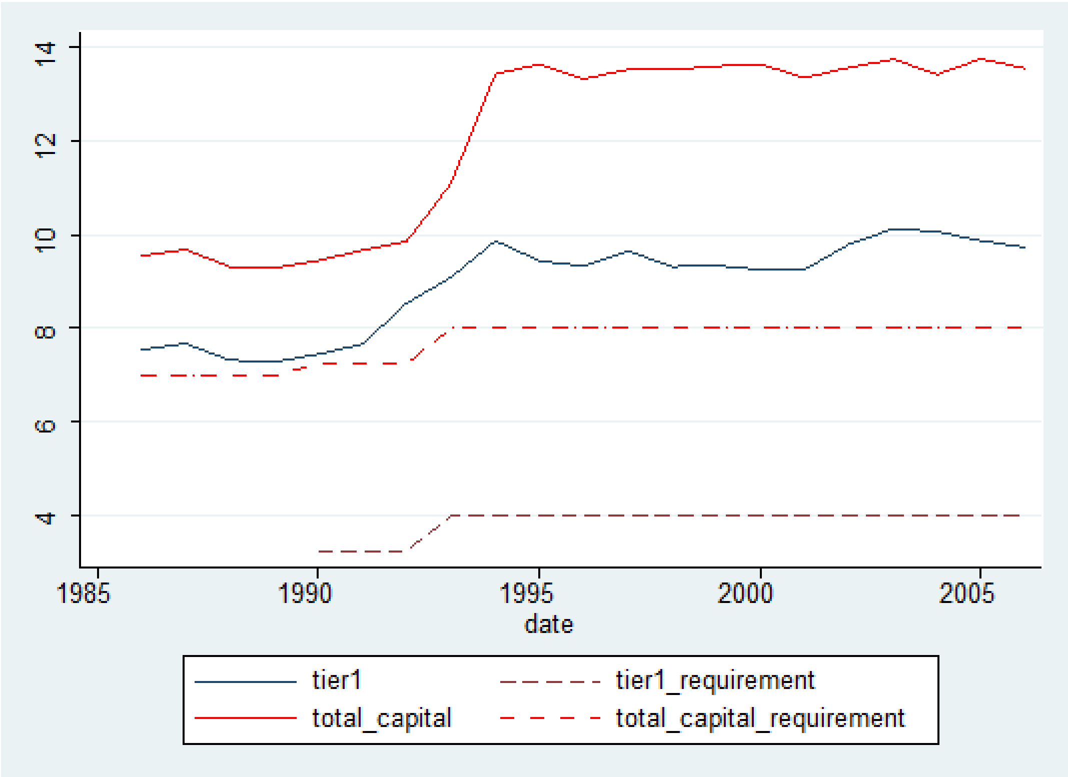

Table 2: Description of Variables and Summary Statisitics.

		Expected Sign	
Variable	Description	Buffer Equation	Risk Equation
ΔBUF	Change in the total capital ratio minus regulatory required minimum.		
ΔRISK	Change in the weighted sum of assets amounts as defined in Section		
RWA/TA	Ratio of risk weighted asets to total assets.		
NPL	Ratio of non-performing loans to total loans and credits.		
CIRATIO	Ratio of commercial and industrial loans to total loans.		
CHARTERVAL	Ratio of the market to book value of bank assets.	+	-
SIZE	Log of total assets.	ambiguous	ambiguous
ROA	Return on assets.	+	
LOANLOSS	Ratio of new provisions to total assets.	+	-
LIQUIDITY	Cash plus securities over total assets.	-	+
CYCLE	GDP growth.	ambiguous	ambiguous

Table 3: Variable Correlation Matrix in Levels.

	BUF	RISK	RWA/TA	NPL	CIRATIO	CHARTERVAL	SIZE	ROA	LOANLOSS	lIQUIDITY	GDP
BUF	1										
RISK	-0.47***	1									
RWA/TA	0.34***	0.37***	1								
NPL	0.32***	0.19*	0.23***	1							
CIRATIO	0.29***	0.26**	0.36***	0.27***	1						
CHARTERVAL	-0.48***	0.31***	0.25***	-0.14**	0.15***	1					
SIZE	-0.34*	0.43***	0.41***	0.41**	0.36***	0.51***	1				
ROA	0.25	0.32***	0.43**	0.22**	0.38*	0.14*	0.32*	1			
LOANLOSS	-0.19**	0.39***	0.34**	0.34***	0.24**	-0.24***	0.25***	-0.23**	1		
LIQUIDITY	0.45*	0.35***	-0.44***	-0.33***	0.21***	0.21*	0.31**	-0.17**	0.09*	1	
GDP	0.08*	0.13***	0.04**	0.03***	0.02**	0.01*	0.08**	-0.10**	0.12*	0.39***	1

Note: *, **, *** denote significance at the ten, five and one percent levels of significance respectively.

Table 4: Limited Information GMM: Buffer Equation

	Model I	*Model II*	*Model III*	*Model IV*	*Model V*	*Model VI*
α_1	0.01 (4.11)***	0.07 (2.30)**	0.04 (5.30)***	0.03 (3.00)***	0.06 (4.20)**	0.05 (2.39)**
BUFit-1	0.27 (5.56)***	0.34 (1.99)**	0.26 (2.22)**	0.35 (2.96)***	0.22 (9.74)**	0.25 (7.94)**
ΔRISK				-0.88 (13.39)***		-0.09 (10.85)***
ΔRWA/TA	-0.21 (3.06)***			0.02 (1.98)**		
ΔNPL		0.11 (2.02)**		0.66 (1.85)*		-0.48 (2.99)***
ΔCIRatio			-0.08 (2.23)**			
CHARTERVAL	-0.32 (2.43)**	-0.25 (1.76)*	-0.41 (2.79)***	-0.34 (2.18)**	0.43 (0.99)	0.36 (3.20)
SIZE	-0.05(1.46)*	-0.09 (0.86)	-0.00 (1.05)	-0.04(2.16)**	0.02 (0.87)	4.85(1.21)
ROA	0.43(1.68)*	0.76 (1.97)**	0.04(1.03)	1.04(2.22)**	0.68 (2.09)**	0.15(1.72)*
LOANLOSS	0.34(1.79)*	0.87 (4.22)***	0.28 (0.66)	-0.63(2.17)**	-0.23(1.67)*	0.34(2.02)**
LIQUIDITY	-0.14(0.09)	-0.23 (0.18)	-0.56 (1.20)	1.20(0.73)	-0.20(1.99)**	-0.13(1.98)**
GDP	0.19(2.69)***	0.26 (2.18)**	0.16 (1.77)*	0.21(1.85)*	0.68(2.85)***	1.95(2.01)***
Sargan	45.83 (0.64)	34.76 (0.74)	23.64 (0.34)	45.34 (0.73)	29.84 (0.36)	39.05 (0.36)
a(1)	2.14 (0.00)	-3.24 (0.00)	4.53 (0.00)	5.34 (0.00)	-2.10 (0.00)	3.59 (0.00)
a(2)	4.34 (0.94)	2.10 (0.84)	34.49 (1.20)	3.48 (0.94)	-1.39 (0.73)	-2.18 (0.52)

Note: Dependent variable is ΔBUFit. Other variables as defined in Table 2. T-values presented in parentheses. a(1) and a(2) represent first and second order residual tests. *, **, *** denote significance at the ten, five and one percent levels of significance respectively.

Table 5: Limited Information GMM: Risk Equation

	Model I	*Model II*	*Model III*	*Model IV*
α_2	0.04 (3.59)***	0.11 (1.99)**	0.10 (2.59)**	0.08 (5.39)***
RISKit-1	0.47(2.69)***	0.53 (2.40)**	0.51 (1.98)**	0.50 (7.40)***
ΔBUF	-1.20(1.71)*	2.98 (2.19)**	-2.87 (1.78)*	-1.84 (5.40)***
CHARTERVAL	1.13(2.01)**	1.39 (3.49)***	1.48 (3.00)***	0.63 (2.10)**
SIZE	0.09 (0.93)	0.59 (1.64)*	0.08 (2.10)**	0.01 (0.96)
LOANLOSS	0.55 (5.48)***	0.44 (1.69)*	0.40 (2.58)***	0.94 (1.78)*
LIQUIDITY	0.30(0.31)	-0.45 (0.04)	0.39 (1.07)	0.11 (0.95)
GDP	0.30(1.84)*	0.45 (2.04)**	0.74 (1.12)	3.20 (4.20)***
Sargan	22.59(0.39)	33.34 (0.33)	24.30 (0.45)	21.49 (0.50)
a(1)	2.43(0.00)	3.20 (0.00)	-1.30 (0.00)	-2.39 (0.00)
a(2)	-3.20(0.64)	1.49 (0.08)	3.20 (0.36)	2.30 (0.19)

Note: Dependent variable is ΔRWA/TA, ΔNPL, ΔCIRatio and ΔRISK for Model I, II,III and IV respectively. Other variables as defined in Table 2. T-values presented in parentheses. a(1) and a(2) represent first and second order residual tests. *, **, *** denote significance at the ten, five and one percent levels of significance respectively.

Table 6: Full Information GMM and 3SLS Estimations

	GMM		*3SLS*	
	ceofficient	T-value	coefficient	T-value
capital equation				
α_1	0.07	(3.09)***	0.01	(6.40)***
BUFit-1	0.29	(4.50)***	0.33	(5.53)***
ΔRISK	-0.45	(7.83)***	-0.05	(3.20)***
CHARTERVAL	-0.07	(2.97)***	-0.53	(1.99)**
SIZE	-0.39	(2.30)**	0.04	(1.64)*
ROA	0.19	(1.79)*	0.34	(2.02)**
LOANLOSS	0.03	(2.21)**	0.06	(1.96)**
LIQUIDITY	-0.26	(0.95)	-0.37	(1.69)*
GDP	0.31	(1.98)**	-0.37	(1.72)*
Sargan	16.54	(4.73)		
a(1)	3.96	(0.00)		
a(2)	3.40	(0.78)		
R2			0.34	
risk equation				
α_2	0.02	(4.20)***	0.12	(3.20)**
RISKit-1	0.51	(3.11)***	0.53	(2.15)**
ΔBUF	-2.43	(3.86)***	-1.30	(1.27)
CHARTERVAL	0.62	(2.40)**	0.43	(1.75)*
SIZE	0.39	(0.07)	0.38	(0.76)
LOANLOSS	0.04	(1.98)**	0.00	(0.83)
LIQUIDITY	0.30	(1.03)	0.09	(0.99)
GDP	0.67	(1.99)**	-0.52	(1.09)
Sargan	4.30	(2.98)		
a(1)	4.30	(0.00)		
a(2)	2.48	(0.98)		
R2			0.37	

Note: Dependent variables are ΔBUF and ΔRISK for the buffer and risk equations respectively. Other variables as defined in Table 2 .a(1) and a(2) represent first and second order residual tests. *, **, *** denote significance at the ten, five and one percent levels of significance respectively.

Table 7: GMM Time Varying Coefficients Estimation: Buffer Equation.

	α_1	BUFit-1	ΔRISK	CHARTERVAL	SIZE	ROA	LIQUIDITY	GDP	SARGAN	A(1)	A(2)
1986	0.08 (1.99)**	0.73 (0.09)	6.30 (0.38)	-0.34 (1.67)*	27.34 (2.12)**	0.01 (1.83)*	1.32 (1.79)*	0.21 (2.02)**	27.22 (1.31)	0.00 (1.22)	-0.04 (0.99)
1987	0.03 (0.97)	0.82 (1.02)	3.49 (0.96)	-0.22 (1.02)	15.49 (2.40)**	-0.04 (1.34)	0.93 (1.64)*	-0.35 (1.99)**	24.33 (0.84)	-0.07 (1.99)	-0.01 (1.02)
1988	0.05 (2.40)**	0.63 (1.64)*	-6.49 (0.74)	0.23 (1.73)*	15.49 (1.04)	-0.02 (1.23)	-1.11 (1.70)*	-0.36 (2.19)**	29.64 (0.87)	0.05 (1.23)	-0.01 (1.00)
1989	-0.07 (1.86)*	0.44 (0.69)	4.29 (1.20)	-0.39 (2.34)**	29.58 (0.84)	0.07 (2.24)**	-0.08 (1.96)**	-0.12 (3.00)***	29.77 (0.96)	0.12 (1.82)	-0.05 (0.94)
1990	-0.01 (2.40)**	0.64 (1.11)	7.49 (0.83)	0.32 (2.01)**	-12.34 (1.48)	0.10 (1.87)*	1.24 (1.75)*	0.32 (2.19)**	31.26 (1.28)	-0.09 (0.94)	0.07(0.62)
1991	0.06 (3.20)***	0.29 (1.72)*	7.49 (0.85)	0.30 (1.84)*	-28.42 (1.73)*	-0.21 (1.94)*	-2.29 (1.76)*	0.43 (1.89)*	26.19 (1.08)	0.00 (1.11)	-0.11 (1.15)
1992	0.08 (2.01)**	0.54 (1.74)*	1.54 (0.56)	0.49 (2.10)**	-13.57 (0.75)	1.12 (2.23)**	-0.33 (1.67)*	0.23 (2.10)**	23.33 (1.67)	0.04 (0.95)	-0.15 (1.34)
1993	-0.02 (0.96)	0.48 (2.00)**	-5.39 (1.06)	-0.49 (3.03)***	12.49 (1.74)*	0.84 (0.64)	-0.03 (1.15)	0.32 (4.13)***	21.43 (0.97)	-0.03 (1.15)	0.00 (1.67)
1994	-0.01 (0.75)	0.43 (2.97)***	-7.40 (1.29)	-0.30 (2.39)**	0.49 (1.99)**	-0.15 (1.79)*	-3.11 (1.26)	0.26 (2.10)**	33.51 (1.26)	0.02 (1.74)	-0.02 (0.96)
1995	0.05 (2.40)**	0.37 (2.85)***	-4.20 (0.76)	0.20 (0.85)	0.95 (2.11)**	-0.94 (1.99)**	-2.00 (1.92)*	-0.59 (0.56)	32.27 (2.17)	-0.07 (1.23)	-0.01 (0.59)
1996	0.07 (4.30)***	0.34 (1.77)*	-3.30 (1.64)*	0.09 (1.11)	0.39 (0.99)	-0.21 (0.94)	-1.95 (2.00)**	0.32 (1.72)*	27.63 (2.39)	0.10 (1.35)	-0.09 (1.96)
1997	0.05 (4.92)***	0.19 (2.76)***	-1.29 (0.96)	-0.30 (2.32)**	0.48 (0.86)	-0.08 (1.78)*	-3.19 (1.99)**	0.36 (2.99)***	22.19 (1.59)	0.09 (1.65)	-0.21 (2.00)
1998	0.09 (1.97)**	0.29 (2.13)**	-1.35 (1.03)	-0.20 (2.01)**	0.29 (3.18)**	-0.21 (1.95)*	-9.67 (1.65)*	0.27 (2.04)**	29.67 (1.65)	-0.12 (1.74)	-0.18 (0.70)
1999	0.07 (1.76)*	0.25 (2.18)**	-2.39 (1.30)	-0.30 (3.59)***	0.39 (2.93)***	-0.18 (1.74)*	1.44 (1.79)*	0.36 (1.99)**	25.44 (1.79)	0.06 (1.87)	-0.04 (0.67)
2000	0.04 (1.89)*	0.28 (4.30)***	-2.84 (0.39)	-0.20 (5.00)***	0.02 (5.51)***	-0.24 (2.10)**	-2.18 (0.88)	0.58 (2.10)**	32.18 (0.88)	0.03 (1.77)	-0.11 (1.95)
2001	-0.08 (0.39)	0.29 (2.97)***	-2.39 (1.95)*	-0.30 (4.30)***	0.38 (1.73)*	0.10 (1.37)	-0.66 (1.86)*	-0.47 (1.46)	27.66 (1.29)	0.09 (1.49)	-0.16 (2.11)
2002	-0.02 (0.39)	0.32 (3.12)***	-2.49 (2.17)**	-0.20 (1.99)**	0.28 (1.99)**	0.36 (1.94)*	-4.26 (1.78)*	0.48 (1.99)**	26.26 (1.78)	0.08 (1.86)	-0.10 (1.34)
2003	0.04 (4.30)***	0.33 (2.94)***	-5.39 (4.30)***	-0.40 (1.86)*	0.29 (2.67)***	0.21 (1.79)*	-2.11 (1.07)	0.27 (3.00)***	29.46 (1.07)	0.06 (1.66)	-0.05 (1.54)
2004	0.02 (5.29)***	0.36 (4.12)***	-6.30 (5.40)***	-0.30 (5.40)***	0.39 (0.22)	0.31 (2.19)**	-2.45 (2.62)***	0.73 (0.09)	42.45 (0.62)	0.01 (1.09)	-0.04 (1.68)
2005	0.08 (2.49)**	0.19 (3.85)***	-7.32 (3.11)***	-0.30(5.30)***	0.29 (0.75)	0.35 (1.78)*	-3.12 (2.47)**	0.61 (1.96)*	31.12 (0.47)	0.05 (0.94)	-0.08 (1.79)
2006	0.04 (1.98)**	0.26 (4.02)***	-5.83(1.99)**	-0.59 (3.99)***	0.82 (0.84)	0.21 (1.52)	-4.48 (1.66)*	0.58 (2.10)**	40.48 (1.66)	0.09 (1.61)	-0.06 (1.89)

Note: Dependent variable is ΔBUFit. Other variables as defined in Table 2. a(1) and a(2) represent first and second order residual tests. *, **, *** denote significance at the ten, five and one percent levels of significance respectively.

Table 8: GMM Time Varying Coefficients Estimation: Risk Equation.

	α_2	RISKit-1	ΔBUF	CHARTERVAL	SIZE	LIQUIDITY	GDP	SARGAN	A(1)	A(2)
1986	0.02 (1.65)*	0.48 (0.95)	2.42 (1.73)*	0.63 (1.84)*	0.75 (1.74)*	-0.53 (0.96)	0.98 (2.86)***	34.66 (1.42)	0.00 (1.51)	-0.01 (1.32)
1987	0.05 (1.99)**	0.52 (2.01)**	3.63 (1.73)**	0.85 (1.73)*	0.22 (1.96)**	0.00 (0.98)	0.76 (1.76)*	25.21 (1.35)	-0.12 (1.67)	-0.09 (1.66)
1988	0.03 (3.59)***	0.55 (2.11)*	1.83 (2.23)**	0.59 (2.11)**	0.85 (0.98)	0.11 (1.86)*	0.42 (3.08)***	23.23 (1.34)	-0.12 (1.66)	-0.24 (1.65)
1989	0.01 (3.40)***	0.68 (1.11)	4.96 (3.05)***	-0.83 (1.03)	-0.72 (2.06)**	0.85 (1.52)*	0.74 (2.24)**	29.37 (0.35)	-0.03 (1.45)	-0.06 (0.76)
1990	-0.04 (1.89)**	0.74 (1.99)**	3.82 (0.95)	-0.27 (1.05)	-0.01 (2.11)**	0.97 (1.68)*	1.27 (1.75)*	34.29 (3.20)	-0.09 (1.23)	0.05(0.97)
1991	-0.02 (1.32)	0.74 (3.00)***	2.84 (1.99)**	0.84 (1.85)*	0.98 (1.64)*	-0.97 (0.85)	-1.24 (0.96)	36.19 (1.94)	0.00 (1.86)	-0.11 (1.29)
1992	0.07 (0.59)	0.68 (2.49)**	1.95 (4.13)***	0.73 (2.74)***	0.97 (2.27)**	0.96 (0.95)	-0.74 (1.84)*	23.33 (1.95)	0.06 (1.39)	-0.09 (1.83)
1993	-0.09 (2.12)**	0.44 (1.98)**	-2.06 (2.06)**	0.96 (3.11)**	0.97 (1.95)**	0.86 (1.23)	0.95 (1.82)*	32.64 (0.76)	0.06 (1.06)	0.00 (1.94)
1994	-0.01 (1.74)*	0.43 (2.31)**	-3.06 (2.38)**	0.73 (2.07)**	0.86 (1.79)**	0.85 (1.69)*	0.13 (2.35)**	26.73 (1.85)	-0.03 (1.84)	-0.01 (1.04)
1995	-0.02 (2.40)**	0.33 (1.83)*	-6.04 (4.95)***	0.75 (0.98)	0.06 (2.04)**	0.96 (1.67)*	0.19 (1.99)**	32.73 (1.39)	-0.06 (1.92)	0.03 (0.73)
1996	0.01 (1.96)**	0.46 (1.86)*	-7.95 (5.72)***	0.74 (0.74)	0.64 (2.33)**	0.99 (0.94)	0.29 (2.11)**	32.78 (1.88)	0.09 (0.86)	-0.31 (1.04)
1997	0.07 (2.40)**	0.53 (4.00)***	-4.99 (2.01)**	0.85 (0.84)	0.40 (2.22)**	0.31 (0.74)	0.95 (3.08)***	29.95 (1.07)	-0.09 (0.83)	-0.08 (1.11)
1998	-0.06 (1.80)*	0.46 (3.96)***	-3.93 (3.63)***	0.96 (1.20)	0.38 (1.96)**	0.74 (1.85)*	0.97 (2.16)**	41.22 (1.39)	0.03 (0.03)	-0.08 (1.33)
1999	-0.03 (2.50)**	0.74 (5.93)***	-2.17 (2.96)***	0.64 (0.78)	0.97 (1.55)	0.97 (1.73)*	0.93 (1.85)*	28.65 (1.97)	-0.05 (0.43)	-0.29 (1.32)
2000	0.08 (2.00)**	0.59 (2.99)***	3.20 (1.06)	0.85 (1.19)	0.97 (1.64)*	0.94 (2.39)**	1.00 (1.79)**	28.56 (1.87)	0.03 (0.76)	-0.09 (1.21)
2001	0.01 (0.49)	0.48 (2.38)**	-1.95 (6.94)***	0.85 (1.04)	0.96 (1.93)**	0.86 (3.07)***	0.97 (3.96)***	28.39 (1.83)	0.06 (0.93)	-0.06 (1.56)
2002	0.06 (0.83)	0.84 (1.84)*	-0.98 (3.74)***	0.06 (1.23)	0.95 (2.13)**	0.96 (7.96)***	0.75 (2.97)***	29.35 (1.46)	0.03 (0.34)	-0.02 (1.34)
2003	0.05 (3.00)***	0.42 (3.06)***	-6.86 (3.85)***	0.96 (0.85)	0.64 (2.33)**	0.96 (3.97)***	0.45 (4.86)***	-32.59 (4.30)	-0.07 (0.98)	-0.01 (1.00)
2004	-0.08 (2.10)**	0.51 (7.05)***	-4.28 (6.00)***	0.97 (1.00)	0.74 (1.99)**	0.96 (4.97)***	0.85 (1.74)*	28.40 (1.98)	-0.04 (0.76)	-0.05 (1.32)
2005	0.06 (3.50)***	0.53 (6.14)***	-2.08 (7.94)***	0.86 (0.48)	0.74 (1.74)*	0.96 (8.64)***	1.37 (2.47)**	35.19 (1.76)	0.05 (0.87)	0.08 (1.83)
2006	0.07 (4.30)***	0.54 (5.96)***	-7.53 (3.07)***	0.16 (1.17)	0.96 (2.36)**	0.85 (7.07)***	0.96 (3.96)***	24.92 (1.87)	0.02 (0.34)	0.06 (1.74)

Note: Dependent variable is ΔRISK. Other variables as defined in Table 4.2. a(1) and a(2) represent first and second order residual tests. *, **, *** denote significance at the ten, five and one percent levels of significance respectively.

7 Data Manipulations

7.1 Commercial bank dataset

All bank-level data is obtained from the Consolidated Report of Condition and Income (referred to as the Call Reports) published by the Federal Reserve Bank of Chicago. Since all insured banks are required to submit Call Report data to the Federal Reserve each quarter we are able to extract income statement and balance sheet data for around 14,000 banks. The dataset spans from $1976Q1 - 2006Q2$.

This particular dataset poses several problems for us to deal with, particularly in terms of cleaning the data and obtaining a consistent set of data series. There are several reasons for this. First, through time, definitions change for some of the variables of interest, therefore, looking merely at the Report documentation that that banks are required to fill in is not always sufficient. Therefore it is necessary, on some occasions, to join series together in order to yield sensible series through time. Moreover, most of the large banks only provide data on a consolidated foreign and domestic basis requiring the exploration of which series to use.

RCON vs. RCFD series In general, larger banks only provide data on a consolidated foreign and domestic basis. Therefore, it is necessary to use the $RCFD$ series rather than the $RCON$ series for each variable. For banks that do not have foreign operations however, it is possible to assume that the two series ($RCON$ and $RCFD$) will be identical, although it is necessary to bear in mind that foreign deposits in this case are not available.

The definition for total securities changes several times through our sample. It is there-fore necessary for us to combine various individual series through time to create a con-sistent variable to work with. Prior to 1984, it is not possible to combine all of the items that are now considered as investment securities. We therefore need to approximate the securities variable. Pre- 1984 we combine $RCFD0400$ (US Treasury securities), $RCFD0600$ (US Government agency and corporation obligations), $RCFD0900$ (obliga-tions of states & political subdivisions) and $RCFD0380$ (other bonds, stocks and securi-ties). In 1984q1 however, we are able to separately add up the items making up investment securities because a) trading account securities for sale at book value ($RCFD1000$) is replaced by 'securities for sale at market value' ($RCFD2146$) and b) there is no guarantee that the securities are held to maturity match across the break in 1984. – i.e. there is no guarantee that $RCFD0402$ (securities issued by states and political subdivisions in the

US) + $RCFD0421$ (other domestic securities) + $RCFD0413$(foreign securities) = $RCFD0900$ (obligations of states and political subdivisions) + $RCFD0950$(other securities). For the pre and post 1984 series to be consistent, these two summations must be equal. We therefore combine the series $RCFD0390$ (book value of securities) and $RCFD2146$ (assets held in the trading account) for the period 19841 to 1993q4. After this time, $RCFD0390$ (book value of securities) is no longer available. From 1994q1 we therefore proceed by summing up $RCFD1754$ (total securities held to maturity), and $RCFD1773$ (total securities available for sale).

Moreover, $RCFD1754$ (total securities held to maturity), and $RCFD1773$ (total securities available for sale) excludes securities held in the trading account, which is part of $RCFD3545$ (total trading assets). We therefore create an additional securities variable (securties2) which is the summation of $RCFD1754$ (total securities held to maturity), $RCFD1773$ (total securities available for sale) and $RCFD2146$ (assets held in trading accounts). We generally make use of the securities2 variable since this eliminates a break in the series in 1993.

For total loans, we again see that there is a break in the series in March 1984. In the third quarter of 1984, the series includes the variable $RCFD2165$ (lease financing re-ceivables). From March 1984 we adopt $RCFD1400$ (total loans & leases, gross) as our total loans variable. Prior to this however, we replace the series with a sum of $RCFD1400$ (total loans & leases) and $RCFD2165$ (lease financing receivables). Simi-larly for net loans we have $RCFD2122$ (total loans, net of unearned income) for the pe-riod between 1984q1 and 2006q2. Prior to this, we again combine $RCFD2122$ (total loans, net of unearned income) with $RCFD2165$ (lease financing receivables).

Commercial and Industrial loans has a change in definition as well. From 1976 until 1984q3, we make use of the $RCFD1600$ (commercial and industrial loans). Here, each bank's own acceptances are included. From 1984q3 however, the series starts to include holdings of bankers' acceptances which are accepted by other banks. We therefore replace this series with a combination of the $RCFD1755$ (acceptances of other banks) and $RCFD1766$ (commercial and industrial loans, other). It remains impossible to create a consistent series here that would exclude banker's acceptances.

A further change in definition occurs with the Fed Funds series. Considering first the Fed Funds Sold series. From 1976 until 2002q1 we are able to make use of $RCFD1350$ (Fed Funds Sold). However, the series discontinues thereafter. We subsequently form a continuation by summing $RCONb987$ (Fed Funds sold in domestic offices) and RCFDb989 (securities purchased under agreement to sell).

Similarly, for Fed Funds Purchased, the series $RCFD2800$ (Fed Funds Purchased) discontinues at the end of 2001. We are then able to replace the series in 2002q2 with $RCFDb993$ (Fed Funds purchased in domestic offices) summed with RCFDb995 (securities sold under agreement to repurchase).

Other issues in the commercial bank dataset In most of the graphical analysis we find a kink in the series in 1997q1. Looking closer at the cause of this disturbance in the data, we find that the number of institutions falls in 1997q1 to 8,648 from 9,772 in 1996q4. The number subsequently rises again in 1997q2 when the number of reporting institutions jumps again to 9,248. This jump is depicted in the graph below, documenting the evolution of the number of banking insti-tutions over time. Investigating the issue further, we find that there appears to be a fault in the dataset for this period. It seems that information reported for around 800 banks are all returned with 0 values. We have not corrected the data in any way to deal with this issue that is visible in all most all graphical analysis conducted here.

Dealing with mergers With respect to the treatment of bank mergers in the data, several possible alternative approaches are considered: *Option 0*: All observations affected by a merger are simply dropped from the sample. Note however,if using any lagged growth rates or differences in the model, this means dropping future observations as well as the observation when the merger takes place. This option is applied by many existing studies in the banking literature (see for example Kashyap and Stein, 2000). *Option 1*: This option is preferable when a large bank acquires a very much smaller bank. Here, all past balance sheet and income observations are rescaled, using a constant ratio, from the beginning of the sample upto the quater preceeding the merger. This ratio is equal to the increase in total assets triggered by the merger.*Option 2*: This option is preferble to Option 1 when two merging banks are of similar size. Here, the merged entities are reconstructed backwards as the sum of the merging banks. In this case a new new bank id, different from any existing id, is created and applied to all subsequent observations.

In this paper, we adopt a mixture of Options 1 and 2; When merging banks are of different sizes we adopt Option 1 while for a small number f mergers where the merging banks are of similar size, we create a new bank id as per Option 2.

Merging the Commercial and BHC datasets The following steps were undertaken to merge the holding company data with with commercial bank data from the Federal Reserve Bank of Chicago. We start with the commercial bank data set and start by identifying those banksthat belong to foreign call family:

1.

We start by generating a foreign call identity as follows:

->gen fgncall_ind = 0

->replace fgncall_ind = 1 if fgncallfamily > 0 & fgncallfamily ˜ = .

We then created a variable called ‘identifier’ which tells us the name of the financial highholder. (this is equal to the rssd9348 variable in the dataset:

->gen identifier = highholder $/* = rssd9348 * /$

If however, the higholder is a foreign call family, the variable gives the number of it instead:

->replace identifier = $fgncallfamily$ if $fgncall\_ind == 1$

2.

We then make use of the ‘identifier’ variable to collect holding company data from the BHC data.

By changing the name of $rssd9001$ to identifier in BHC data. Moreover, we drop all observations equal to 0.

3.

Finally we merge this dataset back to the commercial bank data. First we copy the commercial bank dataset and the BHC data into the same directory. Openning the commercial bank data, we type the following:

‘merge $rssd9001$ dateq using BHCpanel, unique sort $update\_merge(\_mergeBHC)$’

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