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# Capital Requirements and Systematic Risk in Banking

Dmytro Holod[a] and Yuriy Kitsul[b]

WORK IN PROGRESS

**Abstract**

In 1996, the Basel Committee on Banking Supervision amended its Capital Accord by requiring banks to hold additional capital to take account of market risk. In this study we show that although aimed at reducing a bank's individual riskiness, the new capital requirements may actually amplify the *systemic* risk of banks that are subject to those requirements. In order to investigate whether any change in systematic risk after 1996 is emanating from the introduction of the market risk-based capital requirements, we utilize the fact that only banks with high trading activities are subject to the additional capital charge. Banks that do not actively trade are unlikely to be affected by the introduction of new capital requirements. Therefore, it is the *difference* in a measure of systematic risk between high trading and low trading banks that becomes the main focus of our study. In the panel data of quarterly stock returns for 55 large publicly traded bank holding companies, we find that a higher trading activity contributes to the systematic risk of a bank since it increases the bank's exposure to market risk. However, an increase in the systematic risk due to higher trading activity is found to be the strongest for undercapitalized banks after 1996. We interpret these findings as follows. If a bank with high trading accounts falls short of capital due to any unexpected market shock, the necessity to restore its capital position to comply with the market risk-based capital requirements may induce the bank to either sell its assets or raise more capital in the financial markets. Both actions are likely to be perceived by the markets as a bad news and, therefore, are likely to negatively affect the bank's stock value. As a result, such a bank will experience a higher sensitivity to market conditions (systematic risk) after the introduction of market risk-based capital requirements. On the other hand, high trading activity contributes less to the systematic risk of well capitalized banks after 1996, compared to the pre-1996 period. These contrasting findings for poorly capitalized and well capitalized banks suggest that the effect of the market risk-based capital requirements on the systematic risk in banking is not trivial: while the capital requirements "help" well capitalized banks, they may "hurt" undercapitalized banks.

[a] College of Business, SUNY – Stony Brook, Stony Brook, NY 11794-3775, E-mail: Dmytro.Holod@sunysb.edu;
[b] Department of Economics, Georgia State University, 14 Marietta St. NW, 524, Atlanta, GA, 30302, ykitsul@gsu.edu

## Introduction

In 1996, the Basel Committee on Banking Supervision amended its Capital Accord by requiring banks to hold additional capital to take account of market risk, with the intent to provide banks with an extra layer of protection against unexpected movement of asset values in their trading accounts. The market risk capital charge is intimately related to the Value-at-Risk (VaR), a risk measure nowadays commonly used by financial institutions and capturing the level of loss to portfolio value that is expected not to be exceeded with a certain level of confidence, usually 99%. It has been argued, mostly in practitioner literature and in financial press (e.g. Persaud (2000)), that using common generalized risk management systems and metrics, such as VaR, by many financial institutions simultaneously, in spite of promoting soundness of individual institutions' balance sheets, can actually amplify the systemic risk in financial industry by forcing firms to simultaneously engage in similar behavior under certain, typically stressful and adverse, circumstances.

The structure of the argument is as follows. Consider a macro-shock that negatively affects volatility of certain types of firm assets. Some firms' critical VaR level is reached and they have to reduce their positions' riskiness or raise additional capital to protect against extra risk. The latter may not always be easy to implement. If firms start selling, they depress prices and further contribute to higher volatility, which in turn causes even more firms to liquidate their positions in response to their higher VaRs and so on. The process is sometimes referred to as the "VaR vicious circle". More specifically, in the banking context, banks' capital (K), assets (A), and capital-to-asset ratio (K/A) decrease. In order to comply with the market risk-based capital requirements,

banks may need to sell some of their assets. To the extent that such a sell-off happens simultaneously across the banks, the values of bank assets may fall further, thus exacerbating negative effects of the initial common shock. Banks' K/A ratio decreases further and so forth. The mark-to-market and fair value accounting rules have also been argued to contribute to the issue, since institutions have to mark down prices of assets remaining on their books during bad times. Arguably, a similar sequence of events occurred in Britain in 2002 - 2003, where comparatively high capital requirements contributed to life insurance companies' massively selling their equity holdings during the stock market downturn, sending the market further down as a result.

According to this logic, adherence to common market-risk-based capital requirements may increase comovement in the values of institutions' portfolios of tradable assets and, as a result, comovement in their stock returns. It is such comovement that we refer to as the *systemic* risk and study for the publicly traded bank holding companies. We measure sensitivity of individual bank stock returns to some *systematic*, or common, return-driving factors, such as returns on a broad market portfolio or a portfolio consisting of banking stocks. If stock returns of two banks comove strongly with a common factor, then they will strongly comove with one another as well. Higher sensitivity to a common factor implies, everything else equal, higher portion of systematic risk in a bank stock return's evolution, the notion commonly utilized in the asset pricing literature, and in light of our discussion can be also viewed as a higher exposure to systemic risk, a concept used in the banking and financial contagion literature.

We focus on the bank holding companies for two reasons: (1) individual institutions across the country comply to uniform regulatory capital requirements and report standardized information; (2) although trading constitutes a smaller share in commercial banks' business activities in comparison to other types of financial institutions, individual involvement in trading, and thus exposure to market or trading risk, significantly varies across banks. There are banks that hold no or very small amounts of trading assets and therefore are not subject to market-risk-based capital requirements. Comparing risk exposures of such banks to that of the banks more heavily involved in trading enables us to determine to what extent market risk capital charges contribute to systemic risk.

We investigate whether exposure to systemic risk is different for poorly and highly-capitalized banks, and banks with low and high trading activities before and after 1996. Overall, we find that maintaining higher capital-to-asset ratio decreases and having a higher fraction of tradable assets increases a bank's exposure to systemic risk. Banks maintaining low capital levels exhibit more pronounced increase in systemic risk exposure induced by higher trading activities. This effect becomes even more prominent in the post-1996 period. At the same time, for well-capitalized banks the positive effect of trading activities on systemic risk exposure does not become stronger, or even decays, in the post-1996 period.

The substantial literature on the systemic risk in banking industry investigates the issue from a point of view of a simultaneous failure of several banks and a subsequent effect on the real economic activity. De Bandt and Hartmann (2000) provide a comprehensive survey. The number of papers attempting to link risk management

practices and capital requirements to comovement in banks' portfolio values and their stock returns is rather limited. Jorion (2005), the closest work to ours in terms of motivation, examines correlation between trading revenues and market risk capital charges of large US commercial banks. Lehar (2005) utilizes the data on stock prices and debt levels of a number of international banks to estimate values of their asset portfolios, and then uses recovered values of asset portfolios to estimate various correlation-based measures of systemic risk. One of the ways Bartram, Brown and Hund (2007) look at systemic risk is by examining responses to negative shocks of stock returns of banks that had no direct exposure to these shocks. In their theoretical work, Acharya (2001) and Acharya and Yorulmazer (2008) show that the likelihood of information contagion induces banks to endogenously undertake correlated investments. De Nicolo and Kwast (2002) although are not concerned with risk management and capital requirements, examine evolution of correlations between banks' stocks prices to study effects of consolidation in the banking industry on systemic risk.

Finally, there is a vast literature studying implications of bank capital regulation on banks' lending practices and effects of monetary policy. VanHoose (2007) provides a thorough review of this literature. Although this literature does not focus on risk management aspects, it is related to our work and papers mentioned above in a sense that it also examines implications of constraints induced by bank capital regulation and their ultimate effect on economic stability.

## Specification and Hypotheses

Our study focuses on the effect of risk-based capital requirements introduced in 1996 on the systematic risk in the banking industry. We realize, however, that just observing an increase (decrease) in systematic risk after 1996 may not necessarily imply that such an increase (decrease) is driven by the new capital requirements. In order to investigate whether any change in systematic risk after 1996 is emanating from the introduction of the market risk-based capital requirements, we utilize the fact that only banks with high trading activities are subject to the additional capital charge. Banks that do not actively trade are unlikely to be affected by the introduction of new capital requirements. Therefore, it is the *difference* in a measure of systematic risk between high trading and low trading banks that becomes the main focus of our study. In general, we expect a higher trading activity to contribute to the systematic risk of a bank due to its higher exposure to market risk. However, an increase in the systematic risk due to higher trading activity will be the strongest for undercapitalized banks after 1996. We hypothesize that if a bank with high trading accounts falls short of capital due to any unexpected market shock, the necessity to restore its capital position to comply with the market risk-based capital requirements may induce the bank to either sell its assets or raise more capital in the financial markets. Both actions are likely to be perceived by the markets as a bad news and, therefore, are likely to negatively affect the bank's stock value. As a result, such a bank will experience a higher sensitivity to market conditions (systematic risk) after the introduction of market risk-based capital requirements.

More formally, our main hypothesis is as follows:

*Hypothesis: The strongest effect of the bank trading activity on the systematic risk should be observed for undercapitalized banks after 1996.*

To test our hypothesis we use panel data with the following specification:

$$R_{it} = \alpha + \beta_1 * R_{M_t} + \beta_2 * R_{M_t} * HTA_{it} + \beta_3 * R_{M_t} * HKA_{it} + \beta_4 * R_{M_t} * HTA_{it} * HKA_{it} + \text{After1996} * \left(\phi + \beta_5 * R_{M_t} + \beta_6 * R_M * HTA_{it} + \beta_7 * R_{M_t} * HKA_{it} + \beta_8 * R_{M_t} * HTA_{it} * HKA_{it}\right) + \varepsilon_{it} \quad (1)$$

The dependent variable is an individual bank's quarterly holding period return ($R$). The explanatory variables include the holding period return of the banking industry portfolio ($R_m$), the dummy variable *HTA* that takes a value of one if the ratio of a bank's trading assets to its total assets is greater than 50-th percentile of trading assets, and the dummy variable *HKA* that takes a value of one if a bank's capital-to-assets ratio is above 8%. To distinguish between the effects of trading activity on systematic risk for well capitalized and poorly capitalized banks, we interact *HTA* and *HKA* dummy variables. To further distinguish between the estimated coefficients for the periods before and after 1996, we interact all of our variables with the dummy variable *After1996*, which takes a value of one for the period starting from the first quarter of 1996.

Table 1 below summarizes possible combinations of the coefficients corresponding to the estimated systematic risk for different groups of banks in different time periods. As we mentioned above we expect trading activity to contribute to the banks systematic risk ($\beta_2>0$, $\beta_2 + \beta_4>0$, $\beta_2 + \beta_6>0$, and $\beta_2 + \beta_4 + \beta_6 + \beta_8>0$). However, we expect the effect of trading activity on systematic risk to be the strongest for undercapitalized banks after 1996. In other words, we expect the systematic risk "gap" between high trading and low trading undercapitalized banks to widen after 1996. As a result, our main hypothesis in terms of the coefficients of equation (1) is that $\beta_6 > 0$.

**Table 1. Systematic risk for different groups of banks**

| | *Before 1996* | |
|---|---|---|
| | Low KA | High KA |
| Low TA | $\beta_1$ | $\beta_1 + \beta_3$ |
| High TA | $\beta_1 + \beta_2$ | $\beta_1 + \beta_2 + \beta_3 + \beta_4$ |
| Difference (High TA – Low TA) | $\beta_2$ | $\beta_2 + \beta_4$ |
| | *After 1996* | |
| | Low KA | High KA |
| Low TA | $\beta_1 + \beta_5$ | $\beta_1 + \beta_3 + \beta_5 + \beta_7$ |
| High TA | $\beta_1 + \beta_2 + \beta_5 + \beta_6$ | $\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7 + \beta_8$ |
| Difference (High TA – Low TA) | $\beta_2 + \beta_6$ | $\beta_2 + \beta_4 + \beta_6 + \beta_8$ |

## Data and Sample Selection

Our unit of observation is a Bank Holding Company (BHC). Although each individual subsidiary of a BHC is subject to the capital requirements, we cannot utilize the subsidiary-level data, since individual subsidiaries are not traded on the market, which makes it impossible to estimate their systematic risk. Instead we use consolidated bank holding company financial statements (Y-9 forms) to identify a BHC-level trading assets and capital. We then identify the publicly traded BHCs and match their balance sheet data with the data on their returns, using CRSP database. Given that CRSP series are monthly while our balance sheet data are quarterly, we construct quarterly holding period returns for our BHCs as $R_q = (1 + r_1)*( 1 + r_2)*( 1 + r_3) – 1$, where $r_1$, $r_2$, and $r_3$ are monthly returns for the first, second, and third month of a given quarter.

We experiment with two measures of the market return. First we use bank portfolio return, obtained from ***where?***. We then try the return on S&P 500 index, obtained from CRSP to check the robustness of our results.

The BHC balance sheet data are publicly available starting from the first quarter of 1986. Therefore, our sample period runs from 1986:Q2 to 2007:Q4. For the purposes

of our analysis it is crucial to have a balanced panel. Therefore, we restricted our sample to only 53 publicly traded BHCs, for which all the data are available consistently through the entire sample period. As a result, our panel includes 87 quarters of data for 53 BHCs, which results in a total of 4,611 observations.

## Results

We first estimate equation (1) using bank portfolio return as a measure of the market rate of return. The results are shown in Table 2.

**Table 2. Results of estimating the equation (1)**
**Bank portfolio return as a measure of $R_m$**

| | Dependent variable: R |
|---|---|
| Constant | 0.014*** |
| | (0.00) |
| $R_m$ | 0.726*** |
| | (0.00) |
| $R_m$*HTA | 0.181*** |
| | (0.00) |
| $R_m$*HKA | -0.122** |
| | (0.02) |
| $R_m$*HTA*HKA | -0.080 |
| | (0.39) |
| After1996 | -0.007** |
| | (0.04) |
| After1996* $R_m$ | -0.125* |
| | (0.06) |
| After1996* $R_m$*HTA | 0.162* |
| | (0.06) |
| After1996* $R_m$*HKA | 0.206** |
| | (0.02) |
| After1996* $R_m$*HTA*HKA | -0.156 |
| | (0.22) |
| # of observations | 4,611 |
| Adj. R – sqared | 0.370 |

Notes: *p*-values in parentheses; *** - significant at 1%, ** - significant at 5%, * - significant at 10%

As revealed by Table 2, we find support for our main hypothesis. The contribution of higher trading activity to the systematic risk of low capital banks increases after 1996. The coefficient on *After1996* $R_m$*HTA* ($\beta_6$) is positive and significant at 10% level. To better understand how the effect of trading activity on the systematic risk changes across

different groups of bank and different time periods, we summarize our estimates of systematic risk in Table 3. All of the entries in Table 3 are derived from the estimated coefficients in Table 2.

**Table 3. Estimates of the systematic risk for different groups of banks**
**Bank portfolio return as a measure of $R_m$**

| | *Before 1996* | |
|---|---|---|
| | Low KA | High KA |
| Low TA | 0.726*** (0.00) | 0.604*** (0.00) |
| High TA | 0.907*** (0.00) | 0.705*** (0.00) |
| Difference (High TA – Low TA) | 0.181*** (0.00) | 0.101 (0.20) |
| | *After 1996* | |
| | Low KA | High KA |
| Low TA | 0.601*** (0.00) | 0.685*** (0.00) |
| High TA | 0.944*** (0.00) | 0.792*** (0.00) |
| Difference (High TA – Low TA) | 0.343*** (0.00) | 0.107** (0.04) |

Notes: *p*-values in parentheses; *** - significant at 1%, ** - significant at 5%, * - significant at 10%

As one can see from Table 3, higher trading activity contributes to systematic risk across all bank groups. This is not surprising, given that trading activity exposes a bank to a market risk. However the difference in the systematic risk between high and low trading banks is the highest for undercapitalized banks after 1996. In fact, for the period after 1996, the beta coefficient is more than 50% higher for undercapitalized banks with high trading assets, compared to otherwise similar banks with low trading assets. In absolute terms this gap amounts to 0.343 and is significant at 1% level. To compare, the gap between high and low trading undercapitalized banks before 1996 was only 0.182, which is almost twice as small as that gap after 1996. As was shown in Table 2 the difference in the gap ($\beta_6$) is equal to 0.162 and is statistically significant at 10% level.

Interestingly, the effect of trading activity on the systematic risk of well capitalized banks did not change after 1996. This finding suggests that the introduction

of market risk-based capital requirements did not affect the systematic risk of well capitalized banks. It only "penalized" undercapitalized banks by imposing a new (binding) constraint on their behavior.

To see if our results are robust to the inclusion of an alternative common factor, we estimated our specification using the quarterly return on the S&P 500 index instead of the bank portfolio return as a measure of the market return. The results, shown in Table 4, are consistent with our previous findings. Notably, the coefficient on *After1996* $R_m$*HTA* ($\beta_6$) is larger than that in Table 2 and statistically significant at 5% rather than 10% level. Thus, with the return on the S&P 500 index as a measure of the common factor we get a stronger support for our main hypothesis.

**Table 4. Results of estimating the equation (1)**
**Return on S&P 500 index as a measure of $R_m$**

| | Dependent variable: R |
|---|---|
| Constant | 0.017*** |
| | (0.00) |
| $R_m$ | 0.885*** |
| | (0.00) |
| $R_m$*HTA | 0.196** |
| | (0.02) |
| $R_m$*HKA | -0.139 |
| | (0.14) |
| $R_m$*HTA*HKA | 0.066 |
| | (0.69) |
| After1996 | 0.002 |
| | (0.67) |
| After1996* $R_m$ | -0.542*** |
| | (0.00) |
| After1996* $R_m$*HTA | 0.263** |
| | (0.04) |
| After1996* $R_m$*HKA | 0.251** |
| | (0.05) |
| After1996* $R_m$*HTA*HKA | -0.454** |
| | (0.03) |
| # of observations | 4,611 |
| Adj. R – sqared | 0.187 |

Notes: *p*-values in parentheses; *** - significant at 1%, ** - significant at 5%, * - significant at 10%

We now summarize our estimates of systematic risk in Table 5. We still observe that trading activity contributes to the systematic risk for all groups of banks. However,

the effect is the strongest for undercapitalized banks after 1996. Furthermore, the gap in the systematic risk between high and low trading undercapitalized banks more than doubled after 1996 compared to the pre-1996 period. As was shown in Table 4, the difference in the gap ($\beta_6$) is equal to 0.263 and is statistically significant at 5% level.

**Table 5. Estimates of the systematic risk for different groups of banks**
**Return on S&P 500 index as a measure of $R_m$**

| | *Before 1996* | |
|---|---|---|
| | Low KA | High KA |
| Low TA | 0.885***<br>(0.00) | 0.746***<br>(0.00) |
| High TA | 1.081***<br>(0.00) | 1.008***<br>(0.00) |
| Difference<br>(High TA – Low TA) | 0.196**<br>(0.02) | 0.262*<br>(0.07) |
| | *After 1996* | |
| | Low KA | High KA |
| Low TA | 0.343***<br>(0.00) | 0.455***<br>(0.00) |
| High TA | 0.801***<br>(0.00) | 0.525***<br>(0.00) |
| Difference<br>(High TA – Low TA) | 0.458***<br>(0.00) | 0.070<br>(0.33) |

Notes: *p*-values in parentheses; *** - significant at 1%, ** - significant at 5%, * - significant at 10%

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