Capital Constraints and Systematic Risk

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Abstract

The amendment of the Basel Accord with the market-risk-based capital requirements, introduced in 1996 and officially implemented in the U.S. in 1998, can be considered as an additional capital constraint for banking organizations, which, everything else equal, could make a balance-sheet amplification mechanism more pronounced during periods of market stress. We study how sensitivity of bank equity returns to common factors, or bank systematic risk, has changed once this new regulation had been introduced. In particular, we focus on the systematic risk *gap* between high and low trading banks, since only banks with sufficiently high trading activities are subject to the additional capital charge, while distinguishing between low and high capital banks to approximate for how close a bank is to hitting its capital constraint. In the panel data of quarterly stock returns for large publicly traded bank holding companies, we find that, after controlling for a number of bank characteristics, a contribution of a bank's trading activity to its systematic risk becomes stronger after 1998, a period when new regulation was in place, but this increase is stronger for low capital banks. Our findings are consistent with the conjecture that capital-constrained banks are more sensitive to market conditions because they need to make additional balance sheet adjustments in response to market shocks, and that these adjustments can have implications for other banks with initially non-binding capital constraints.

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Introduction

As is discussed in Brunnermeier (2009), the recent crisis demonstrated yet again how initial price and liquidity shocks can induce financial institutions to engage in "fire-sale" liquidations leading to vicious cycles affecting institutions originally not in trouble. Krishnamurthy (2010) refers to one of the candidate mechanisms of such amplification as a balance-sheet amplification mechanism, according to which institutions are forced to make adjustments when their balance sheet constraints become tighter.

Balance sheet constraints may exist in several forms, such as constraints on capital, equity or leverage. A hedge fund's investors, for instance, may withdraw financing, if a fund's equity falls below a certain level. Commercial banks, by contrast, are explicitly subject to regulatory capital requirements. For example, the Basel Committee on Banking Supervision amended its Capital Accord in 1996 by requiring banks to hold additional capital to take account of market risk, with the intent of providing banks with an extra layer of protection against unexpected movement of asset values in their trading accounts. The amendment officially came into effect in the United States in the first quarter of 1998.[1]

The introduction of market risk-based capital requirements for commercial banks may be viewed as a shock to adequate capital levels. Everything else equal, higher required capital would mean tighter capital constraints and, potentially, stronger balance sheet amplification. Stronger balance sheet amplification implies, in turn, more pronounced comovement of banks' asset values with market-wide shocks. In this paper, we investigate the effect of the additional regulatory capital constraints in banking on the sensitivity of bank equity returns to common factors and discuss our results' implications for financial stability.

[1] See Hirtle (2003) for more details on the market risk capital amendment.

Insights from such an exercise are important in their own right. Amplification of initial shocks is an example of the kind of systemic implications that are at the center of the current policy debate on future capital regulation. Insufficient attention to those implications could be perhaps one of the most important limitations of the traditional paradigm, as for example Kashyap, Rajan and Stein (2008) argue. These insights, however, may also be relevant for other financial institutions facing similar constraints, be it capital regulation or margin requirements from investors.

In the context of banking, the balance-sheet amplification mechanics would work as follows. Consider a macro-shock that increases the volatility of certain types of a bank's assets or reduces their prices. The bank can then become balance-sheet constrained for two reasons. First, its capital-to-asset ratio (K/A) falls because of the falling asset prices. Second, its desired K/A ratio increases because its risk models indicate that the critical Value-at-Risk (VaR) level is reached.[2] To maintain desired leverage, the bank may need to sell some assets or raise more capital. Raising capital may be costly on short notice and thus sluggish (Myers, 1977; Myers and Majluf, 1984; Kashyap, Rajan and Stein, 2008), and so the bank may turn to selling. To the extent that such a sell-off happens simultaneously across banks, the asset values and K/A ratios may fall and asset volatility and VaRs may rise further, exacerbating the negative effects of the initial common shock, and so forth. The mark-to-market and fair value accounting rules, it is often argued, contribute to the issue, since institutions have to mark down prices of assets on their books during bad times. Therefore, the asset values of banks that are not short on capital and that are initially not forced into fire-sales may also be affected. If true, such amplification

[2] The two amplification channels are in the spirit of *loss spiral* and *margin spiral* in the theoretical work of Brunnermeier and Pedersen (2008).

dynamics affect many institutions or even the entire financial system through falling asset prices and higher volatility and, as such, present systemic risk.

Everything else equal, if under the new regulation a number of banks find their capital constraints to be binding during periods of market stress, then the effect of a negative common shock will induce a bigger fall in banks' trading asset values than before, because the amplification mechanism will now be stronger. The fall in the value of trading assets is further accompanied by a fall in the bank's market equity value[3] and its stock price, which again should be more pronounced than before the introduction of the market-risk based capital requirements. It is important to note here, however, that such balance sheet amplification dynamics during bad times would be triggered by unfavorable market conditions and not the capital requirements per se, which just potentially cause banks to make additional adjustments to their balance sheets when such conditions prevail.

In asset pricing models, such as CAPM and APT, sensitivity of a stock return to a common (market-wide) factor is referred to as beta and captures *systematic* risk of this stock. In this paper, we study the sensitivity of bank stock returns with respect to market return, which captures general business and economic conditions. An overall increase in the sensitivity of the institutions to common factors, or higher systematic risk[4], would imply an increase in riskiness of the system and would impair financial stability in general.

According to this logic, the systematic risk of bank stocks should increase on average after 1998, ceteris paribus. However, individual bank involvement in trading, and thus exposure to market risk, varies substantially across banks. Some banks are barely involved in trading

[3] Huang, Zhou and Zhu (2009) provide a discussion, motivated by work of Hull and White (2004), of the conditions linking changes in asset values and equity returns.
[4] We do not study any implications of common exposure for cross-section of expected returns. We are just concerned with how responsive individual returns are to some common state variables and use the term systematic risk for convenience, regardless of whether the common exposure is priced in.

activity and therefore are not subject to market-risk-based capital requirements. We use the regulatory threshold level of trading activity as an identifying characteristic of whether a bank is affected by the introduction of the market risk capital regulation in 1998.

We hypothesize that the exposure of the low-trading banks' equity values to trading asset shocks and amplification mechanism to be weaker relative to their high-trading counterparts, which are subject to market-risk-based capital requirements. Therefore, we contrast systematic risks of high- and low-trading activity banks and associate this *gap* with the banks' market risk exposure, which the regulation in question aims to cover. Focusing on the gap also enables us to isolate the effects of other structural factors, beyond new capital requirements, that could have moved the overall level of systematic risk of banking stocks. We hypothesize that the gap in systematic risk due to trading activity becomes stronger after 1998, the period when the new capital requirements were in effect and the amplification mechanism induced by the capital constraints became stronger.

We further recognize that the new capital requirements may have a more pronounced impact on banks for which the capital constraint is more likely to be binding. The reason is that these banks are more likely to sell assets into the falling markets. Although such fire-sales could affect asset values of other banks via the amplification mechanism and mark-to-market accounting rules, banks that do engage in sales reveal to the markets that they are likely to be short of capital, which depresses their stock prices even further. We, therefore, also distinguish between low- and high-capital banks.

In a panel of publicly traded bank holding companies (BHC)[5] we find that having a higher fraction of trading activity tends to increase a BHC's systematic risk and, more

[5] In our analysis, the unit of observation is a BHC, but in the text we use the terms "BHC" and "bank" interchangeably for readability.

importantly, this effect tends to become stronger after the introduction of the market risk-based capital requirements in 1998. However, we also find that the post-1998 increase in the systematic risk gap between high and low trading banks varies significantly across banks with different capital ratios. It is much stronger for low capital banks, which is consistent with our hypothesis that banks that are closer to a capital constraint are more responsive to capital requirements. A possible channel is that asset sales or capital raising activities by these banks reveal to the markets their balance-sheet constraints.

We next examine whether our findings can be attributed to those characteristics of banks with various trading activities and capital ratios that are not captured in our baseline specification. We find that our results are not driven by the bank holding company size effect. They are also robust to a choice of alternative sample period, which allows us to control for the effect of the fair value accounting rules[6] on comovement of bank equity returns with common factors. The results also hold after we control for a number of variables aiming to capture banks' overall risk profiles and involvement in non-traditional banking activities. Among the control variables are non-performing loans, non-interest fee income and a variable reflecting banks' involvement into activities allowed under the Gramm-Leach-Bliley act of 1999. It can be the case that our finding of the post-1998 increase in the contribution of trading activity to systematic risk are driven by the presence of some severe crises in the second half of our sample. While it is difficult to control directly for exposure of individual banks to crises due to lack of data on their trading positions, we hope that variables measuring non-traditional banking activities also capture, at least partially, banks' exposure to crises. We also experiment with the alternative definition of a common risk factor, and show that our findings are qualitatively

[6] Heaton, Lucas and McDonald (2010) examine how such accounting rules enter into computations of required regulatory capital and investigate implications of these interactions for social welfare.

unchanged. In addition, upon running regressions in quantiles of bank return distribution, we determine that our results are especially strong for underperforming banks, consistent with the hypothesis that banks that experience losses in asset values become closer to hitting their capital constraints.

Our finding of the post-1998 increase in contribution of trading activity to bank sensitivity to common factors points to the potential of higher systemic risk in banking induced by additional capital constraints. Yet, the fact that within a group of high capital banks we find a smaller post-1998 increase in the contribution of trading activity to banks' sensitivity to common shocks is consistent with the regulation's intent – to provide more protection against losses via a capital cushion.

I. Related Literature

Our work is related to several strands of the literature. Extensive literature studies capital-charge cyclicality in banking. The idea is that in bad times banks are forced to hold more capital per dollar of a given asset portfolio due to asset value losses and higher riskiness of assets, for example due to credit rating downgrades. Kashyap and Stein (2004) provide a summary of the research on the topic. A closely related branch of literature considers how constraints induced by bank risk capital regulation affect banks' lending practices and monetary policy transmission. A notable example is Thakor (1996). VanHoose (2007) provides a thorough review of this literature, with an emphasis on implications for monetary policy. This literature examines implications of credit risk capital requirements for loan provisions and, therefore, is related to our work in a sense that it examines implications of capital constraints for economic and financial stability.

The balance sheet amplification mechanism, which motivates our empirical exercise, appears in academic studies[7] in various forms and under different names, as is discussed in Krishnamurthy (2010). For example, Brunnermeier and Pedersen (2008) develop a theoretical model in which adverse shocks to funding liquidity force financial intermediaries to engage into “margin” and “loss” spirals, which in turn have implications for market liquidity of financial instruments. In this example, the amplification mechanism is triggered by institutions becoming close to violating their collateral or margin requirements, which conceptually encompass the capital charge for commercial banks as a special case. Despite the popularity of the mechanism as a modeling tool and voluminous anecdotal evidence, there are few empirical studies, perhaps due to scarcity of sufficiently detailed data on trading portfolios of financial institutions. Jorion (2006), Adrian and Shin (2010) and Adrian and Brunnermeir (2009) are the examples of empirical studies in this direction. Jorion (2006) finds little correlation between trading revenues of large US commercial banks, which he interprets as evidence against bank “position herding,” a precondition necessary to induce the amplification mechanism. Adrian and Shin (2010) document the procyclicality of the mark-to-market leverage and link changes in aggregate repo positions of major security dealers to future financial market conditions measured using the VIX index. Adrian and Brunnermeir (2009) develop a measure of an individual institution’s contribution to the VaR of the financial industry and study to what extent leverage, maturity mismatch, and size predict this measure for individual institutions. Our study differs in its focus on sensitivity of bank equity returns to market-wide shocks before and after the introduction of capital *market-risk-based* requirements and across banks with different trading and capital characteristics. To our knowledge, ours is the first study that attempts to do that.

[7] References to such amplification mechanisms or “vicious cycles” are also abundant in popular accounts and in the financial press (e.g. Persaud, 2000).

The research, which studies specifically the link between risk and capital requirements, explores how regulations change individual risk-taking behavior of banks[8], e.g. Hellmann, Murdock and Stiglitz (2001) and Hovakimian and Kane (2000). These studies usually do not directly address issues related to *overall* financial stability. One important exception is Acharya (2001)[9], which examines conditions under which banks endogenously undertake correlated investments and shows that capital requirements can sometimes amplify such systemic risk concerns. A study by Berger and Bouwman (2009), an example of research concentrating on importance of overall capital, investigates to what extent holding more capital helps a bank to survive a financial crisis, although it does not examine the interplay between capital requirements and systematic risk.

II. Market Risk-Based Capital Requirements: Background

The market risk capital charge (MRC) applies to those banks and bank holding companies whose positions in trading accounts (trading assets plus trading liabilities) exceed $1 billion or 10% of total assets. The charge can also be applied at the discretion of regulatory supervisor. The MRC is reported indirectly on schedule HC-R of a form Y-9C by means of the “market risk equivalent assets”, which are linked to MRC in such a way that the ratio of total capital (including Tier 3 capital) to the sum of “Risk Weighted Assets”, accounting for credit risk, and “Market Risk Equivalent Assets”, adjusted for market risk, is at least 8%. This rule is represented by the following formula:

(Tier1 + Tier2+ Tier3)/(Risk Weighted Assets + Market Risk Equivalent Assets) = 8%.

[8] A related string of papers studies the effect of the VaR-based risk management systems on risk taking, and accuracy of the VaR statistics reported by financial institutions. For example, see Basak and Shapiro (2001) and Berkowitz and O’Brien (2002).

[9] Acharya and Yorulmazer (2008) is a related work studying the relationship between the likelihood of information contagion and correlated investments.

Capital of any tier can be used to cover the market risk charge. Even though Tier-3 capital may be the "cheapest" option to cover the charge, looking at just Tier -3 capital to assess MRC may be misleading.

To determine its market risk equivalent assets, a bank first computes a measure of its market risk by calculating a 1 (99) percent VaR of its trading portfolio over a 10-day horizon using at least one year of historic daily data (updated at least once a quarter). The market risk measure is then computed as a sum of a maximum of 60-day average VaR, scaled by a factor of at least 3, or the VAR on the most recent day, plus some specific risk charge. Banks are allowed to use their internal models to compute VaR. The scale factor can be increased, if VaR estimates miss corresponding percentiles of the realized P&L distribution. The market risk equivalent assets are then calculated as the product of a measure of the market risk and a factor of 12.5. The market risk equivalent assets are added to other risk weighted assets to form the basis for the minimum capital requirement (see formula above).

We compute the MRC ratio as the ratio of market risk equivalent assets to the total risk weighted assets (risk weighted assets + market risk equivalent assets). The ratio captures the share of additional risk-based capital in the total risk-based capital (Tier 1 + Tier2 + Tier 3) that should be supplied by a BHC with exposure to market risk in order to maintain the same risk-based capital ratio as a BHC with no exposure to market risk. Table 1 shows the summary statistics for the MRC ratio as well as its distribution. Note that we consider only those BHCs that are subject to the market risk-based capital requirements, and we consider only post-1998 period. As we can see from Table 1, on average, the market risk charge represents 2.56% of a BHC's total risk-based capital. However, the MRC can become quite substantial in the right tail of the distribution. In particular, for the top 10% of bank-quarter observations, the MRC contributes more than 5.56% to the total risk-based capital, and for the top 5% of observations, the MRC's share in the total risk-based capital is more than 9.83%.

Although the extant literature tends to view the market risk capital charge as inconsequential (e.g. Hirtle (2003), Jorion (2002), Berkowitz and O'Brien (2002)), we posit that even though on average the MRC is only a small portion of the overall capital, it is sufficiently important for at least some banks, and it may force those banks to make necessary balance-sheet adjustments during unfavorable market conditions.

III. Specifications and Hypotheses

Our study focuses on the effect of risk-based capital requirements introduced in 1996 and fully implemented in 1998 on the bank systematic risk. We refer to the sensitivity of a bank's equity return to a factor, which is common across all banks, as a measure of an individual bank's systematic risk. We employ the return on market portfolio, measured by the return on the S&P 500 index, as a proxy for a common factor or state variable.[10]

We realize that just observing an increase (decrease) in systematic risk after 1998 may not necessarily imply that such an increase (decrease) is driven by the new capital requirements. Other relevant structural and institutional changes could have occurred. In order to investigate whether any change in systematic risk after 1998 is associated with the implementation of the market risk-based capital requirements, we first need to identify banks that are affected by such regulatory changes and then study whether being subject to additional capital requirements affects systematic risk. We exploit the fact that only banks with sufficiently high trading activity

[10] We also experiment with the return on a portfolio of banking stocks as an alternative proxy for a common factor, and obtain qualitatively similar results.

are subject to the additional capital charge. Banks that do not actively trade do not have to supply any additional capital to cover their market risk exposure.

In general, we expect a higher trading activity to contribute to the systematic risk of a bank. However, we hypothesize that the effect of trading activity on a bank's systematic risk increases after 1998. The rationale is that after 1998 higher trading activity is not only associated with higher risk, but also entails being subject to the additional capital requirement, which is conjectured to make amplification of shocks to asset values stronger. In other words, we begin our analysis by formulating the following first hypothesis:

H1: The systematic risk gap between high and low trading banks increases after 1998.

To test this hypothesis we estimate the following panel regression with fixed effects:

$$R_{it} = \gamma_i + \alpha_1 * f_t + \alpha_2 * f_t * HTA_{it-1} + After98_t * (\mu + \alpha_3 * f_t + \alpha_4 * f_t * HTA_{it-1}) + \varepsilon_{it} \qquad (1)$$

In this equation, the dependent variable is an individual bank's[11] quarterly holding period equity return, R. The specification includes fixed (bank) effects to control for unobservable (time invariant) characteristics. Among the explanatory variables are the common factor, f (measured by the holding period return on the S&P 500 index), the dummy variable *After98*, which takes a value of one for the period starting from the first quarter of 1998, and the lagged value of the dummy variable *HTA*, which takes a value of one if a bank has high trading activity. To capture the contribution of trading activity to systematic risk, we allow for the slope coefficient to vary with trading activity by interacting the dummy variable *HTA* with a common factor.

We consider a bank to have high trading activity if the sum of its trading assets and liabilities is higher than $1 billion or higher than 10 per cent of its total assets. This definition is used by the regulators to determine whether a bank should be subject to an additional capital

[11] In our analysis we utilize data for bank holding companies (BHCs). We use the terms "BHC" and "banks" interchangeably throughout the paper.

charge to cover its market risk. Note that we use a dummy variable rather than a continuous variable because we want to identify the BHCs that are subject to new capital requirements and compare them to those that are not.

Panel A of Table 2 highlights the meaning of various combinations of parameters in equation (1). The systematic risk gap between high and low trading banks is represented by α_2 and $\alpha_2+\alpha_4$ for the periods before and after 1998, respectively. We expect such a gap to be higher during the post-1998 period. Therefore, we rewrite our first hypothesis in the following form: *H1*: $\alpha_4 > 0$.

We also recognize that the new capital regulation may have different effects on links between trading activity and systematic risk for banks with different capital ratios. Low capital banks, whose capital constraint is close to be binding, are more likely to respond to adverse shocks by selling their assets. Although fire-sales may affect asset values of non-selling high capital banks as well via the amplification mechanism and mark-to-market accounting rules, banks that do engage in sales reveal to the markets that they are likely to be short of capital, which depresses their stock prices even further. We, therefore, distinguish between low and high capital banks, and test whether an increase in the post-1998 effect of trading activity on a bank's systematic risk is stronger (weaker) for low (high) capital banks. Hence, our second hypothesis is as follows:

H2: A post-1998 increase in the systematic risk gap between high and low trading banks is weaker for high capital banks.

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

$$\begin{aligned} R_{it} = {} & \psi_i + \beta_1 * f_t + \beta_2 * f_t * HTA_{it-1} + \beta_3 * f_t * HKA_{it-1} + \beta_4 * f_t * HTA_{it-1} * HKA_{it-1} + \\ & After98_t * (\phi + \beta_5 * f_t + \beta_6 * f_t * HTA_{it-1} + \beta_7 * f_t * HKA_{it-1} + \beta_8 * f_t * HTA_{it-1} * HKA_{it-1}) + \eta_{it} \end{aligned} \quad (2)$$

Specification (2) includes the same variables as equation (1), plus the lagged value of dummy variable *HKA* that takes a value of one if a bank has high capital-to-asset ratio.

To distinguish between well and poorly capitalized banks we use a 7% capital-to-assets ratio threshold.[12] As a result, banks with capital-to-assets ratio above 7% are deemed to be high capital banks. We chose to use a dummy variable rather than the actual capital-to-assets ratio because we want to identify banks, for which capital constraint is close to be binding, and compare them to banks, for which that constraint is non-binding.

To contrast the effects of trading activity on systematic risk for well capitalized and poorly capitalized banks we interact the lagged values of *HTA* and *HKA* dummy variables. To further distinguish between the estimated coefficients for the periods before and after 1998, we interact each of our variables with the dummy variable *After98*. Finally, the specification includes fixed (bank) effects.

Panel B of Table 2 summarizes possible combinations of the coefficients from equation (2) corresponding to the estimated systematic risk for different groups of banks in different time periods. For low capital banks, a post-1998 increase in the systematic risk gap between high and low trading banks is represented by the β_6 coefficient, while such an increase for high capital banks is equal to $\beta_6 + \beta_8$ coefficient. In the presence of the market risk based capital requirements, having enough capital cushion becomes particularly important for high trading banks, allowing them to better absorb any negative shocks to their asset values, compared to high trading banks with low capital. As a result, we expect a post-1998 increase in the systematic risk gap between high and low trading banks to be smaller for well capitalized banks. Hence, our second hypothesis can be expressed as follows:

[12]According to the Prompt Corrective Action law, a bank is considered to be significantly undercapitalized if its capital-to-assets ratio is less than 6%. We start our analyses, however, with a 7% threshold to capture the banks that are close to the critical capital level. We then show that our results become stronger when we use a 6% cut-off point.

H2: $\beta_8<0$.

We also examine how the relationships between our variables of interest vary in the tails of bank return distribution by running quantile regressions introduced by Koenker and Basset (1978). The idea behind q^{th} quantile regression is that the regression coefficients are computed by minimizing a sum of weighted residuals in such a way that a regression surface represents q^{th} quantile of the lefthand-side-variable conditional on the values that right-hand-side variables take. For example, in the 25^{th} (75^{th}) quantile regression residuals are given the weight of 0.75 (0.25) if they are below and the weight of 0.25 (0.75) if they are above the regression surface, respectively. The 50^{th} quantile regression surface is drawn in such a way that a half of the data points is above and a half is below the surface, so that it represents a median of the conditional distribution of the dependent variable, as opposed to the conditional mean given by the OLS regression surface.

The specification remains very similar to that in equation (2) with the exception that the intercept does not have a subscript *i*, since we utilize a pooled quantile regression. We conjecture that the effects outlined in hypotheses *H1* and *H2* will be stronger in lower quantiles of bank returns or for banks under-performing relative to the average. The rationale is that banks' poor performance will either lead to capital erosion or higher risk capital charge, either of which would make the capital constraint more binding.

Note that our baseline specifications do not include other common control variables that capture key bank characteristics. We do it for presentation purposes. Having only dummy variables interacted with a measure of a common factor allows us to estimate return sensitivities for each group of banks in each sub-period and present the results in the format of Table 2. Having other control variables in the specifications makes bank return sensitivities dependent on the values of those controls, thus significantly complicating the presentation of the results. We defer this presentation till Section V, in which we describe the control variables and show that our results are not qualitatively affected by their inclusion.

IV. 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 publicly traded, which makes it impossible to estimate their systematic risk. Instead we use consolidated bank holding company financial statements (Y-9 forms) to identify BHC-level trading assets, trading liabilities and capital. 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.

Since we are interested in the measures of the systematic market risk, we restrict our sample to publicly traded BHCs only. In order to identify publicly traded BHCs, we expand Holod and Peek's (2007) list of publicly traded banking organizations by matching the data from Y-9 forms with the data on BHC 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 $R_q = (1 + r_{q,1})*(1 + r_{q,2})*(1 + r_{q,3}) – 1$, where $r_{q,1}$, $r_{q,2}$, and $r_{q,3}$ are monthly returns for the first, second, and third month of a given quarter. We construct the quarterly series for the return on S&P 500 index in a similar way.

Table 3 shows our key variables – trading activity and capital ratios – for BHCs of different size categories. There are two patterns that can be observed in Table 3. First, smaller BHCs do not trade much. In fact, only when the BHC size reaches $5 billion the trading activity gains a meaningful share in the total BHC assets. As the size grows to above $10 billion, the trading activity becomes even more important, representing more than 3% of the total bank assets. Second, the smaller BHCs are better capitalized, which is not surprising, given their restricted access to the external funds and, therefore, the need to hold additional buffer stock of capital. These two patterns suggest that any differences between high and low trading BHCs as well as high and low capital BHCs may merely reflect the differences between large and small BHCs. To mitigate this issue, we restrict our initial sample to relatively large BHCs only, those with real assets above $5 billion. Although there is still a substantial size variation even within this bank size category, it is not as dramatic as in the full sample. To verify the robustness of our results we further experiment with alternative size cut-off points, as well as including size as a control variable directly.

To summarize, our initial regression sample includes BHCs with real (2007 $) assets above $5 billion, and contains 8,060 observations. The summary statistics of the variables used in our analysis are shown in Table 4.

V. Results

The results of the estimation of equations (1) and (2) are shown in Panels A and B of Table 5. To better understand how the effect of trading activity on the systematic risk changes across different time periods, we summarize our estimates of systematic risk in Panels A and B of Table 6. All of the entries in Table 6 are derived from the estimated coefficients of Table 5.

As we can see from Panel A of Table 6 we generally observe that higher trading activity contributes to systematic risk. More importantly, even though the systematic risk itself decreases for some groups of banks after 1998, the systematic risk *gap* between high and low trading banks widens after 1998, and an increase in such a gap is statistically significant ($\alpha_4 > 0$). In fact, the gap increases 3.5 times from 0.13 in the pre-1998 period to 0.46 in the post-1998 period. Hence, we find a strong support for our first hypothesis of the post-1998 increase in the systematic risk gap induced by the trading activity.

We now explore whether an increase in the systematic risk gap between high and low trading banks varies across banks with differing capital ratios. If such an increase is driven by the introduction of the new capital requirements, we should observe a stronger impact on the low capital banks, since their capital constraint is more likely to be binding. The results of the estimation of equation (2) are shown in Panel B of Table 5, and the parameters of interest are summarized in Panel B of Table 6.

It is evident from Panel B of Table 6 that low capital banking organizations experience a significantly larger post-1998 increase in the systematic risk gap between high and low trading banks. In particular, we observe that for low capital banks the gap widens from approximately 0.11 to 0.82, and this seven-fold increase is statistically significant (β_6 coefficient). High capital banks, on the other hand, experience a more moderate increase in the contribution of trading activity to the systematic risk after 1998. In particular, the gap between high and low trading banks increases from 0.16 to 0.31, and this increase is statistically insignificant ($\beta_6 + \beta_8$ coefficient). Such a disparity between high and low capital banks is summarized by the β_8 coefficient, which is equal to -0.56 and is statistically significant. These findings provide support for our second hypothesis, suggesting that capital requirements have stronger impact on undercapitalized banking organizations.

Alternative size threshold

As we observed in Table 3, larger BHCs have much higher level of trading activity and lower capital compared to the smaller BHCs. To make sure that our results are not driven by the differences between large and small BHCs, we initially restrict our sample to a group of relatively large BHCs with assets above $5 billion. However, even within this subset of BHCs, there is a substantial size variation. To further confirm that our results are not driven by the size differences, we estimate the equations (1) and (2) for a sample of BHCs that have assets above $10 billion. The results are shown in Panels A and B of Table 7.

Even within a sub-sample of BHCs with assets above $10 billion we find evidence in support of our hypotheses. In particular, we observe an overall post-1998 increase in the systematic risk gap between high and low trading banks as evidenced by the positive and statistically significant α_4 coefficient (Panel A of Table 7). Moreover, an increase in the systematic risk gap appears to be weaker for high capital banks, which is reflected in a negative and statistically significant β_8 coefficient (Panel B of Table 7). The fact that our results hold in a sub-sample of the largest BHCs indicates that our findings are unlikely to be driven by the BHC size differences.

Mark-to-market accounting rules

One of the alternative explanations for our findings is that they may be driven by the mark-to-market accounting rules implemented in the early 90s. In 1991, the Financial Accounting Standards Board (FASB) introduced the Statement of Financial Accounting Standards No. 107 (SFAS 107), which required all entities to *disclose* certain types of their financial instruments at their fair market values. In 1993, FASB further modified the reporting standards with the introduction of SFAS 115, which expanded and more clearly defined the types of assets that had to be reported at the fair values. In particular, SFAS 115 developed the breakdown of assets into the “Held-to-maturity securities”, “Available-for-sale securities”, and “Trading securities” categories. More importantly, SFAS 115 required all entities to *recognize* unrealized gains and losses from “Trading securities” in the income statement, and those from “Available-for-sale securities” in a separate component of shareholder’s equity, respectively. The fair value accounting of trading positions and the recognition of unrealized gains and losses from trading activity in the earnings may be responsible for our observed post 1998 increase in the systematic risk gap between high and low trading banks.

To address this concern, we now concentrate on the period, during which fair value accounting rules were in effect, thus controlling for the accounting environment. If our results for the pre- and post 1998 periods still hold within a period of fully implemented fair value accounting, we can claim that our results are not driven by the change in the accounting rules, and, therefore, are more likely to be attributed to the change in the capital regulation. To identify the period associated with the fair value accounting, we take a conservative approach by focusing on a period when both disclosure of fair values and recognition of unrealized gains and losses were required. In other words, we focus on a period when both SFAS 107 and SFAS 115 were in effect. Although introduced in 1993, SFAS 115 was adopted by the banking organizations beginning after January 1st, 1994. Therefore, we now restrict our sample to the 1994:Q1 – 2007:Q4 period and estimate our baseline regressions, thus comparing 1994:Q1 – 1997:Q4 and 1998:Q1 – 2007:Q4 sub-periods.[13] The results of the estimation of equations (1) and (2) are shown in Table 8.

[13] We experimented with the 1991:Q1 as an alternative beginning date for the period of fair value accounting. Our results were qualitatively unchanged.

Our results indicate that even within a period when fair value accounting rules were in place, the systematic risk gap between high and low trading banks increased after 1998, compared to the 1994:Q1 – 1997:Q4 period. The α_4 coefficient is positive and statistically significant (Table 8, Panel A). The overall post 1998 increase in the gap appears to be driven primarily by the low capital banking organizations, as indicated by the positive and statistically significant β_6 coefficient in Panel B of Table 8. In contrast, such an increase for low capital banks ($\beta_6 + \beta_8$) is statistically insignificant and smaller than that for high capital banks, although the difference (β_8) is statistically insignificant. The fact that most of our results still hold within a sub-period when fair value accounting rules were in place indicates that our findings for the full sample are unlikely to be driven by the adoption of the fair value accounting in early 90s.

Alternative capital-to-assets ratio threshold

One of our main arguments is that the new capital regulation will have a stronger impact on those banking organizations, for which the capital constraint is closer to be binding. We now further explore this relationship by changing our threshold capital-to-assets ratio threshold to 6%, expecting that the observed differences between high and low capital banks should get stronger with this alternative definition of high and low capital banks.

The results of estimating equation (2) with a 6% capital-to-assets ratio threshold are shown in Table 9. We now observe a very sharp post-1998 increase in the systematic risk gap induced by trading activity for low capital banks. For such banks, the gap increases from 0.06 to 1.08, which constitutes an eighteen-fold increase. For high capital banks, on the other hand, an increase in the gap is much smaller, which is reflected in large (in absolute value) and statistically significant β_8 coefficient (-0.74). Most importantly, the difference in gap increases between high and low capital banks appears to be more pronounced when we use a 6% capital-to-assets ratio threshold (β_8 coefficient in Tables 9), compared to that when a 7% threshold is used (β_8 coefficient in Table 6), suggesting that the difference is indeed related to capital constraints.

Quantile Regressions

We next examine how our findings differ in the tails of bank return distribution by running quantile regressions based on the pooled (no fixed effects) version of specification (2). We utilize a panel of banks with real assets above $5 billion to run pooled regressions based on quantiles of the individual bank equity returns conditional on the right-hand-side variables of specification (2). We use a 6% capital-to-assets ratio threshold for our definitions of high and low capital banks to concentrate on a lower tail of capital ratio distribution. Results of 25th, 50th and 75th quantile regressions are presented in Table 10, which for the sake of brevity contains only parameters capturing contribution of trading activity to systematic risk, a post-1998 change in such contribution for low capital (β_6) and high capital ($\beta_6 + \beta_8$) banks and their difference (β_8).

We first note that for the post 1998 period the contribution of trading activity to systematic risk is the highest in the regression for the lowest (25th) percentile and monotonically decreases as we move into higher percentiles. This means that after 1998 the contribution of trading activity to systematic risk is the strongest for banks whose equity returns underperform relative to the mean. As is further shown in Table 10, the overall post-1998 *increase* in the contribution of trading activity to systematic risk, as well as the difference in such an increase between high and low capital banks, is the strongest when more weight is assigned to observations in the lower 25th percentile of return distributions. For example, the post-1998 increase in the systematic risk gap between high and low trading banks is 0.93 in the 25th percentile and 0.50 in the 75th percentile for low capital banks (β_6) and 0.19 in the 25th percentile and 0.11 in the 75th percentile for high capital banks ($\beta_6 + \beta_8$). The difference between high and low capital banks in the post 1998 increase in the gap (β_8) is -0.74 and -0.39 in the 75th and 25th percentiles respectively.

Our interpretation is that banks that are in poor shape, as captured by their low equity returns, have experienced a decrease in their asset values and are, therefore, closer to hitting their capital constraint, compared to other banks. Low returns may also be associated with higher volatility and, consequently, higher capital charges and tighter capital constraint. As a result, after the market-risk-based capital requirements were introduced, such banks would be more likely to engage into forced fire-sales in bad times, which would increase their return sensitivity to common factors relative to that of banks not subject to the requirements.

Adding Control Variables

We now verify if our main results are robust to the inclusion of the control variables in the specifications. Our goal is to confirm that the observed differences between high and low trading banking organizations as well as high and low capital banking organizations are not driven by the differences in other characteristics, not related to the risk-based capital requirements. We estimate the following two equations:

$$\begin{aligned} R_{it} &= \gamma_i + \alpha_1 * f_t + \alpha_2 * f_t * HTA_{it-1} + After98_t * (\mu + \alpha_3 * f_t + \alpha_4 * f_t * HTA_{it-1}) + \\ &\mathbf{A}_{\mathbf{Controls}} * f_t * \mathbf{Controls_{it}} + After98_t * \mathbf{A}_{\mathbf{Controls,\ After98}} * f_t * \mathbf{Controls_{it}} + \varepsilon_{it} \end{aligned} \tag{3}$$

$$\begin{aligned} R_{it} &= \psi_i + \beta_1 * f_t + \beta_2 * f_t * HTA_{it-1} + \beta_3 * f_t * HKA_{it-1} + \beta_4 * f_t * HTA_{it-1} * HKA_{it-1} + \\ &After98_t * (\phi + \beta_5 * f_t + \beta_6 * f_t * HTA_{it-1} + \beta_7 * f_t * HKA_{it-1} + \beta_8 * f_t * HTA_{it-1} * HKA_{it-1}) + \\ &\mathbf{B}_{\mathbf{Controls}} * f_t * \mathbf{Controls_{it}} + After98_t * \mathbf{B}_{\mathbf{Controls,\ After98}} * f_t * \mathbf{Controls_{it}} + \eta_{it} \end{aligned} \tag{4}$$

The control variables are interacted with a common factor (f_t) because we are interested in their effects on a bank's return *sensitivity* to a common factor rather than their direct effect on a bank's return. We also interact the product of each of the control variables and a common factor with the dummy variable *After98*, to allow for the differential effect of the control variables on a bank's return sensitivity to a common factor after 1998. In what follows we describe each of our control variables.

We include the lagged value of a BHC's capital-to-asset ratio (KA_{it-1}) to control for the effect of leverage on a BHC's sensitivity of a common factor. The inclusion of the level of the capital-to-asset ratio in the regressions ensures that our HKA dummy captures the effect of being well capitalized (being farther from the regulatory capital constraint) rather than just a mechanical effect of leverage on a bank's sensitivity to a common factor.

A potential alternative interpretation of our findings is that high trading banking organizations are the ones that take excessive risk, and, as a result are more likely to experience higher sensitivity to the market conditions, regardless of the capital regulation. Although such an interpretation may not fully explain why the effect of trading activity on a bank's market sensitivity increases after 1998, and why such an increase is more pronounced for low capital banks, we still want to address this issue by including some of the bank characteristics that may be correlated with the level of trading activity but capture other sources of bank risk. In particular, high trading banks may also have riskier loan portfolio, which may result in more sensitive earnings. To control for such a possibility we include the lagged value of a BHC's non-performing loans-to-total loans ratio (NPL_{it-1}) in the regressions.

High trading banks are also more likely to engage into non-traditional banking activities such as investment banking, securitization, fiduciary activities etc. Unlike traditional interest income, non-interest earnings may be more sensitive to market conditions and affect overall sensitivity of a bank's return to a common factor. On the other hand, a banking organization that combines different types of activities may benefit from the diversification effect, and, therefore, be less sensitive to the market conditions, compared to a more focused institution. We control for a BHC's engagement into non-banking activities in two ways. We include the lagged value of the ratio of non-interest income to total income ($NonIntInc_{it-1}$) as a variable in our regressions to control for the overall reliance of a BHC's earnings on the non-traditional income. We also recognize that with the passage of the Gramm-Leach-Bliley Act (GLBA) in 1999, banking organizations were formally allowed to combine commercial banking with investment banking and insurance activities by forming Financial Holding Companies (FHCs).[14] To control for such a change in the regulation and its effect on the estimates of the bank systematic risk, we interact our common factor with the lagged value of a dummy variable that takes a value of one if a BHC elected to become an FHC in accordance with the GLBA (FHC_{it-1}). Note that we do not interact the product of FHC_{it-1} and a common factor with the dummy variable *After98*, because BHCs had the option to become FHCs only after 1999.

Finally, as we observed in Table 3, high trading banking organizations tend to be larger. We partially address this issue by restricting our sample to the BHCs with the consolidated real assets above \$5 billion, and then \$10 billion. Nevertheless, even within a group of relatively large banking organizations, there is a substantial size variation that may potentially provide an alternative explanation for our results. To control for the size effect, we include the lagged value of the logarithm of the consolidated real BHC assets in the specifications (LogRAssets_{it-1}).

[14] Prior to 1999, the BHCs were able to conduct certain security activities through so called "Section 20 subsidiaries". With the passage of the GLBA, however, the scope of the allowed activities was expanded substantially.

The results of the estimation of specifications 3 and 4 are shown in Table 11, panels A and B correspondingly. As we can see from Table 11, non-performing loans ratio and BHC size have positive and statistically significant effects on a bank's return sensitivity during the pre-1998 period. However, the effects of these two variables are weakened after 1998. The FHC dummy has negative and statistically significant effect on a bank's return sensitivity, suggesting that becoming an FHC and thus combining banking and non-banking activities is associated with lower systematic risk. Interestingly, regardless of the specification, the capital-to-asset ratio does not affect a bank's return sensitivity in either pre- or post-1998 periods. This finding indicates that in our sample the level of leverage does not linearly affect sensitivity in and of itself. Instead, it is being close to the regulatory capital threshold, and being subject to an additional capital charge that increases bank sensitivity to a common factor, which is consistent with our findings for low capital high trading banking organizations.

Most importantly, however, the main results of this study hold even in the presence of the control variables in the regressions. Table 12 shows the contribution of trading activity to the bank systematic risk before and after 1998 (High TA – Low TA), as well as the difference in such a contribution between the post- and pre-1998 periods, obtained by estimating equations (3) and (4).[15] As one can see from Panel A of Table 12, the affect of trading activity on the bank systematic risk increases after 1998 ($\alpha_4>0$), which supports our first hypothesis. Interestingly, trading activity reduces the systematic risk before 1998, while it increases if after 1998. A possible explanation is that once we control for other bank characteristics, we capture the diversification effect of trading before 1998, and that after 1998 this effect is outweighed by the

[15] We don't show the estimates of the systematic risk for different groups of banks because they now depend on the values of the control variables. The effects of trading activity, however, are independent of the values of the control variables and can be tested for statistical significance. Given that it is the contribution of trading activity to the systematic risk that is the focus of our study, we show only those differential effects in Table 11.

effect of the market risk-based capital requirements. As revealed by Panel B of Table 12, a post-1998 increase in the systematic risk gap between high and low trading banks is weaker for high capital banks ($\beta_8<0$). Thus, we also find support for our second hypothesis.

Alternative Measure of a Common Factor

We now experiment with an alternative measure of the banking-system-wide common factor. Instead of using a broad market index, we now focus on a measure of a factor that is more specific to the banking industry. In particular, we use the bank portfolio return, obtained from Kenneth French's web-site, which is formed from the stocks of publicly-traded depository institutions, such as commercial banks, S&Ls and others, selected based on their SIC codes. In other words, we aim to capture sensitivity of individual bank returns to conditions in financial industry rather than overall business conditions, as was captured by the market return.

The differences in the systematic risk between high and low trading banking organizations, obtained from the estimation of equations (3) and (4) with bank portfolio return as a common factor, are shown in Panels A and B of Table 13. As we can see from Panel A, the systematic risk gap between high and low trading banking organizations widens after 1998 ($\alpha_4>0$). Moreover, an increase in such a gap is primarily driven by the low capital banking organizations, which is evidenced by the negative β_8 coefficient. Thus, we find support for both of our hypotheses when we use an alternative measure of a common factor.

VI. Conclusion

Even though the market-risk-based capital requirements were aimed at reducing riskiness of an individual bank's balance sheet, according to some opponents their introduction might have actually amplified the systemic risk in banking via additional capital constraints. The argument is that falling asset prices, in conjunction with mark-to-market accounting rules and balance sheet constraints, induce financial institutions to engage into asset sales. Not only such sales affect involved institutions directly, for example through market signaling, but, if massive enough to cause a fire-sale spiral, they may also affect net worth of those institutions that did not originally experience balance-sheet constraints. As a result, under such an argument comovement of affected banks' returns with common factors, also called bank systematic risk, is expected to increase, everything else equal.

We examine the empirical validity of such an argument. We find that the systematic risk gap between high and low trading banks tends to widen after 1998, the period when the new capital requirements were introduced. However, it is the group of undercapitalized banks that experiences a disproportionately higher increase in the systematic risk exposure from trading activity after 1998. The systematic risk gap between high and low trading undercapitalized banks dramatically (and statistically significantly) increases after the introduction of the new capital requirements, while the change is weaker and in some cases statistically insignificant for the well capitalized banks.

Our interpretation is that at the time of high market stress the market risk based capital requirements force those high trading banks with inadequate capital to take actions necessary to comply with those requirements. Such actions, in turn, would signal to the markets that those banks experience capital problems. On the other hand, well capitalized banks, not experiencing a regulatory constraint and having enough capital cushion, are better positioned to withstand fluctuations in their trading accounts.

Such additional capital constraints may become particularly important if many banks become unexpectedly undercapitalized after a severe market shock. In addition, the amplification mechanism and "fire-sale" externalities may be stronger for those types of financial institutions, for which trading activities play a more important role, such as hedge funds or security dealers. These concerns may be relevant for future regulatory initiatives. In particular, our findings lend support to a case for the introduction of time varying capital requirements and capital insurance, as discussed by Kashyap, Rajan and Stein (2008) and Flannery (2005).

Table 1. Market risk capital charge as a percentage of the total risk-based capital

The MRC ratio is calculated as Market Risk Equivalent Assets/(Risk Weighted Assets + Market Risk Equivalent Assets). The MRC ratio captures the share of additional risk-based capital in the total risk-based capital (Tier 1 + Tier2 + Tier 3) that a BHC with exposure to market risk needs to maintain the same risk-based capital ratio as a BHC with no exposure to market risk.

	MRC ratio (%)
Mean	2.56
S.D.	3.51
Min	0.00
Max	21.99
Percentile:	
25^{th}	0.35
50^{th}	1.15
75^{th}	3.37
90^{th}	5.56
95^{th}	9.83

Table 2. Systematic risk for different groups of banks using equations (1) and (2)

The table shows how parameters of equations (1) and (2) are used to compute sensitivities of bank equity returns to a common factor for banks with low and high trading activities (Low TA, High TA) and low and high capital ratios (Low KA, High KA) during the periods of 1986:Q2-1997:Q4 and 1998:Q1-2007:Q4.

	Panel A: Equation (1)	**Panel B: Equation (2)**	
	Before 1998	*Before 1998*	
		Low KA	High KA
Low TA	α_1	β_1	$\beta_1 + \beta_3$
High TA	$\alpha_1 + \alpha_2$	$\beta_1 + \beta_2$	$\beta_1 + \beta_2 + \beta_3 + \beta_4$
High TA – Low TA	α_2	β_2	$\beta_2 + \beta_4$
	After 1998	*After 1998*	
		Low KA	High KA
Low TA	$\alpha_1 + \alpha_3$	$\beta_1 + \beta_5$	$\beta_1 + \beta_3 + \beta_5 + \beta_7$
High TA	$\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4$	$\beta_1 + \beta_2 + \beta_5 + \beta_6$	$\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7 + \beta_8$
High TA – Low TA	$\alpha_2 + \alpha_4$	$\beta_2 + \beta_6$	$\beta_2 + \beta_4 + \beta_6 + \beta_8$
Δ(High TA – Low TA)	α_4	β_6	$\beta_6 + \beta_8$
Hypotheses	$\alpha_4 > 0$	$\beta_8 < 0$	

Table 3. Trading activity and capital ratios by BHC size

	Assets (2007 $ millions)				
	< 500	500 – 1,000	1,000 – 5,000	5,000 – 10,000	> 10,000
# of observations	5,808	6,946	11,269	2,775	5,285
Trading Activity/Assets (%)	0.07	0.15	0.19	0.36	3.04
Capital/Assets (%)	9.45	8.79	8.39	8.48	7.64

Table 4. Summary statistics

The table shows summary statistics of the following variables: (1) the dependent variable, which is an individual bank's quarterly holding period return, R_{it}; (2) the explanatory variables, which include the common factor, f_t (measured by the return on the S&P500 index), the lagged value of dummy variable *HTA* that takes a value of one if a bank has high trading activity, the lagged value of dummy variable *HKA* that takes a value of one if a bank has high capital-to-asset ratio, and the dummy variable *After98*, which takes a value of one for the period starting from the first quarter of 1998. The sample includes BHCs with real assets above $5 billion.

Variable	Mean	Std. Dev.	Min	Max
R_{it}	0.035394	0.152833	-0.822485	1.733333
f_t	0.024196	0.077065	-0.232266	0.208670
HTA_{it-1}	0.138462	0.345405	0	1
HKA_{it-1}	0.619603	0.485515	0	1
$After98_t$	0.437593	0.496121	0	1
# of obs: 8,060				

Table 5. Results of estimating the equations (1) and (2)
BHCs with real assets above $5 billion

The table shows results of the following panel regressions with fixed effects:

$$R_{it} = \gamma_i + \alpha_1 * f_t + \alpha_2 * f_t * HTA_{it-1} + After98_t * (\mu + \alpha_3 * f_t + \alpha_4 * f_t * HTA_{it-1}) + \varepsilon_{it} \qquad (1)$$

$$R_{it} = \psi_i + \beta_1 * f_t + \beta_2 * f_t * HTA_{it-1} + \beta_3 * f_t * HKA_{it-1} + \beta_4 * f_t * HTA_{it-1} * HKA_{it-1} + After98_t * (\phi + \beta_5 * f_t + \beta_6 * f_t * HTA_{it-1} + \beta_7 * f_t * HKA_{it-1} + \beta_8 * f_t * HTA_{it-1} * HKA_{it-1}) + \eta_{it} \qquad (2)$$

The dependent variable is an individual bank's quarterly holding period return, R_{it}. The explanatory variables include the common factor, f_t (measured by the return on the S&P500 index), the lagged value of dummy variable *HTA* that takes a value of one if a bank has high trading activity, the lagged value of dummy variable *HKA* that takes a value of one if a bank has high capital-to-asset ratio, and the dummy variable *After98*, which takes a value of one for the period starting from the first quarter of 1998.

Dependent variable: R_{it} – bank return

	Panel A: Equation (1)	*Panel B: Equation (2)*
Constant	0.0160***	0.0166***
	(0.00)	(0.00)
f_t	1.0974***	1.1143***
	(0.00)	(0.00)
f_t*HTA_{it-1}	0.1260	0.1142
	(0.15)	(0.23)
f_t*HKA_{it-1}		-0.0528
		(0.37)
$f_t*HTA_{it-1}*HKA_{it-1}$		0.0482
		(0.83)
$After98_t$	-0.0092**	-0.0100**
	(0.03)	(0.02)
$After98_t*f_t$	-0.5998***	-0.5281***
	(0.00)	(0.00)
$After98_t*f_t*HTA_{it-1}$	0.3306***	0.7047***
	(0.00)	(0.00)
$After98_t*f_t*HKA_{it-1}$		-0.0549
		(0.58)
$After98_t*f_t*HTA_{it-1}*HKA_{it-1}$		-0.5566**
		(0.04)
# of observations	8,060	8,060
R – squared	0.2083	0.2100

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

Table 6. Estimates of the systematic risk using equations (1) and (2)
BHCs with real assets above $5 billion

The parameters presented in this table are based on the results of the panel data regression with fixed effects given in equations (1) (Panel A) and (2) (Panel B), and capture sensitivities of bank equity returns to a common factor (the market portfolio) for banks with low and high trading activities (Low TA, High TA) during the periods of 1986:Q2-1997:Q4 and 1998:Q1-2007:Q4. In both panels, "High TA – Low TA" represents the contribution of trading activity to systematic risk. In Panel A, α_4 represents a post-1998 increase in the contribution of trading activity to the systematic risk. In Panel B, β_6 and $\beta_6 + \beta_8$ represent post-1998 increase in the contribution of trading activity to systematic risk for low and high capital banks respectively. β_8 captures the difference in the two increases

	Panel A: Equation (1)	*Panel B: Equation (2)*	
	Before 1998	*Before 1998*	
		Low KA	High KA
Low TA	1.0974*** (0.00)	1.1143*** (0.00)	1.0615*** (0.00)
High TA	1.2234*** (0.00)	1.2285*** (0.00)	1.2239*** (0.00)
Difference (High TA – Low TA)	0.1260 (0.15)	0.1142 (0.23)	0.1624 (0.42)
	After 1998	*After 1998*	
		Low KA	High KA
Low TA	0.4976*** (0.00)	0.5862*** (0.00)	0.4785*** (0.00)
High TA	0.9542*** (0.00)	1.4051*** (0.00)	0.7890*** (0.00)
Difference (High TA – Low TA)	0.4566*** (0.00)	0.8189*** (0.00)	0.3105*** (0.00)
α_4	0.3306*** (0.00)	-	-
β_6	-	0.7047*** (0.00)	-
$\beta_6 + \beta_8$	-	-	0.1481 (0.50)
β_8	-	-0.5566** (0.04)	

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

Table 7. Estimates of the systematic risk using equations (1) and (2)
BHCs with real assets above $10 billion

The parameters presented in this table are based on the results of the panel data regression with fixed effects given in equations (1) (Panel A) and (2) (Panel B), and capture sensitivities of bank equity returns to a common factor (the market portfolio) for banks with low and high trading activities (Low TA, High TA) during the periods of 1986:Q2-1997:Q4 and 1998:Q1-2007:Q4. In both panels, "High TA – Low TA" represents the contribution of trading activity to systematic risk. In Panel A, α_4 represents a post-1998 increase in the contribution of trading activity to the systematic risk. In Panel B, β_6 and $\beta_6 + \beta_8$ represent post-1998 increase in the contribution of trading activity to systematic risk for low and high capital banks respectively. β_8 captures the difference in the two increases

	Panel A: Equation (1)	*Panel B: Equation (2)*	
	Before 1998	*Before 1998*	
		Low KA	High KA
Low TA	1.1682*** (0.00)	1.1850*** (0.00)	1.1217*** (0.00)
High TA	1.2292*** (0.00)	1.2311*** (0.00)	1.2385*** (0.00)
Difference (High TA – Low TA)	0.0610 (0.47)	0.0461 (0.62)	0.1168 (0.55)
	After 1998	*After 1998*	
		Low KA	High KA
Low TA	0.5032*** (0.00)	0.6357*** (0.00)	0.4813*** (0.00)
High TA	1.0207*** (0.00)	1.4064*** (0.00)	0.8730*** (0.00)
Difference (High TA – Low TA)	0.5175*** (0.00)	0.7707*** (0.00)	0.3917*** (0.00)
α_4	0.4565*** (0.00)	-	-
β_6	-	0.7246*** (0.00)	-
$\beta_6 + \beta_8$	-	-	0.2750 (0.20)
β_8	-	-0.4496* (0.10)	

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

Table 8. Estimates of the systematic risk for the 1994:Q1 – 2007:Q4 period, using equations (1) and (2) BHCs with real assets above $5 billion

The parameters presented in this table are based on the results of the panel data regression with fixed effects given in equations (1) (Panel A) and (2) (Panel B), and capture sensitivities of bank equity returns to a common factor (the market portfolio) for banks with low and high trading activities (Low TA, High TA) during the periods of 1994:Q1-1997:Q4 and 1998:Q1-2007:Q4. In both panels, "High TA – Low TA" represents the contribution of trading activity to systematic risk. In Panel A, α_4 represents a post-1998 increase in the contribution of trading activity to the systematic risk. In Panel B, β_6 and $\beta_6 + \beta_8$ represent post-1998 increase in the contribution of trading activity to systematic risk for low and high capital banks respectively. β_8 captures the difference in the two increases

	Panel A: Equation (1)	*Panel B: Equation (2)*	
	Before 1998	*Before 1998*	
		Low KA	High KA
Low TA	0.8889*** (0.00)	0.8252*** (0.00)	0.8947*** (0.00)
High TA	1.0472*** (0.00)	1.1037*** (0.00)	1.0455*** (0.00)
Difference (High TA – Low TA)	0.1583 (0.30)	0.2785 (0.26)	0.1508 (0.46)
	After 1998	*After 1998*	
		Low KA	High KA
Low TA	0.4964*** (0.00)	0.5829*** (0.00)	0.4778*** (0.00)
High TA	0.9611*** (0.00)	1.4242*** (0.00)	0.7929*** (0.00)
Difference (High TA – Low TA)	0.4647*** (0.00)	0.8413*** (0.00)	0.3151*** (0.00)
α_4	0.3064** (0.05)	-	-
β_6	-	0.5628** (0.04)	-
$\beta_6 + \beta_8$	-	-	0.1643 (0.44)
β_8	-	-0.3985 (0.25)	

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

Table 9. Estimates of the systematic risk, using equation (2) with K/A = 6% as a threshold capital ratio BHCs with real assets above $5 billion

The parameters presented in this table are based on the results of the panel data regression with fixed effects given in equation (2) and capture sensitivities of bank equity returns to a common factor for banks with low and high capital ratios (Low KA, High KA) and low and high trading activities (Low TA, High TA) during the periods of 1986:Q2-1997:Q4 and 1998:Q1-2007:Q4. "Difference (High TA – Low TA)" represents the contribution of trading activity to systematic risk. β_6 and $\beta_6 + \beta_8$ represent post-1998 increase in the contribution of trading activity to systematic risk for low and high capital banks. β_8 captures the difference in the two increases.

	Before 1998	
	Low KA	High KA
Low TA	1.2094*** (0.00)	1.0451*** (0.00)
High TA	1.2730*** (0.00)	1.1244*** (0.00)
Difference (High TA – Low TA)	0.0636 (0.57)	0.0793 (0.59)
	After 1998	
	Low KA	High KA
Low TA	0.4140*** (0.00)	0.5034*** (0.00)
High TA	1.4902*** (0.00)	0.8600*** (0.00)
Difference (High TA – Low TA)	1.0762*** (0.00)	0.3566*** (0.00)
β_6	1.0126*** (0.00)	-
$\beta_6 + \beta_8$	-	0.2773* (0.09)
β_8	-0.7353*** (0.01)	

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

Table 10. Estimates of the systematic risk using quantile regressions
BHCs with real assets above $5 billion; K/A = 6% as a threshold capital ratio

The parameters presented in this table are based on the results of quantile regressions based on pooled version of equation (2) and capture the impact of trading activity on sensitivity of bank equity returns to a common factor for banks with low and high capital ratios (Low KA, High KA) and low and high trading activities (Low TA, High TA) during the periods of 1986:Q2-1997:Q4 and 1998:Q1-2007:Q4. β_6 and $\beta_6 + \beta_8$ represent post-1998 increase in the contribution of trading activity to systematic risk of low and high capital banks. β_8 captures the difference in the two increases. Results for the 25th, 50th and 75th quantiles of bank equity returns are shown.

	Quantile					
	25		50		75	
	Before 1998		*Before 1998*		*Before 1998*	
	Low KA	High KA	Low KA	High KA	Low KA	High KA
Difference (High TA – Low TA)	0.0954 (0.53)	0.1938 (0.20)	0.1832* (0.07)	0.2068 (0.11)	0.2177* (0.06)	0.2213 (0.17)
	After 1998		*After 1998*		*After 1998*	
	Low KA	High KA	Low KA	High KA	Low KA	High KA
Difference (High TA – Low TA)	1.0268*** (0.00)	0.3863*** (0.00)	0.9017*** (0.00)	0.3628*** (0.00)	0.7181*** (0.01)	0.3313*** (0.00)
β_6	0.9314*** (0.00)	-	0.7185*** (0.00)		0.5004* (0.08)	
$\beta_6 + \beta_8$	-	0.1925 (0.26)		0.1560 (0.30)		0.1100 (0.57)
β_8	-0.7389** (0.03)		-0.5625** (0.03)		-0.3904 (0.26)	

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

Table 11. Results of estimating the equations (3) and (4)
BHCs with real assets above $5 billion

The table shows results of the following panel regressions with fixed effects:

$$R_{it} = \gamma_i + \alpha_1 * f_t + \alpha_2 * f_t * HTA_{it-1} + After98_t * (\mu + \alpha_3 * f_t + \alpha_4 * f_t * HTA_{it-1}) + \mathbf{A}_{\mathbf{Controls}} * f_t * \mathbf{Controls}_{\mathbf{it}} + After98_t * \mathbf{A}_{\mathbf{Controls,\ After98}} * f_t * \mathbf{Controls}_{\mathbf{it}} + \varepsilon_{it} \quad (3)$$

$$R_{it} = \psi_i + \beta_1 * f_t + \beta_2 * f_t * HTA_{it-1} + \beta_3 * f_t * HKA_{it-1} + \beta_4 * f_t * HTA_{it-1} * HKA_{it-1} + After98_t * (\phi + \beta_5 * f_t + \beta_6 * f_t * HTA_{it-1} + \beta_7 * f_t * HKA_{it-1} + \beta_8 * f_t * HTA_{it-1} * HKA_{it-1}) + \mathbf{B}_{\mathbf{Controls}} * f_t * \mathbf{Controls}_{\mathbf{it}} + After98_t * \mathbf{B}_{\mathbf{Controls,\ After98}} * f_t * \mathbf{Controls}_{\mathbf{it}} + \eta_{it} \quad (4)$$

The dependent variable is an individual bank's quarterly holding period return, R_{it}. The explanatory variables include the common factor, f_t, the lagged value of dummy variable *HTA* that takes a value of one if a bank has high trading activity, the lagged value of dummy variable *HKA* that takes a value of one if a bank has high capital-to-asset ratio, and the dummy variable *After98*, which takes a value of one for the period starting from the first quarter of 1998. In addition, vector **Controls** includes lagged values of the capital-to-asset ratio (KA_{it-1}), non-performing loans-to-total loans ratio (NPL_{it-1}), noninterest income-to-total income ratio ($NonIntInc_{it-1}$), the logarithm of real assets ($LogRealAssets_{it-1}$), and a dummy variable that takes a value of 1 if a BHC elected to become a Financial Holding Company in accordance with the Gramm-Leach-Bliley Act of 1999 (FHC_{it-1})

	Dependent variable: R_t – bank return	
	Panel A: Equation (3)	*Panel B: Equation (4)*
Constant	0.0184***	0.0184***
	(0.00)	(0.00)
f_t	-1.3370**	-1.3007**
	(0.04)	(0.04)
f_t*HTA_{it-1}	-0.2851**	-0.3107***
	(0.02)	(0.01)
f_t*HKA_{it-1}		-0.0124
		(0.88)
f_t*HTA_{it-1}*HKA_{it-1}		0.1660
		(0.46)
$After98_t$	-0.0134***	-0.0134***
	(0.00)	(0.00)
$After98_t$* f_t	1.1276	1.2260
	(0.16)	(0.13)
$After98_t$*f_t*HTA_{it-1}	0.5734***	0.9569***
	(0.00)	(0.00)
$After98_t$*f_t*HKA_{it-1}		-0.0582
		(0.62)
$After98_t$*f_t*HTA_{it-1}*HKA_{it-1}		-0.6514**
		(0.02)
f_t*KA_{it-1}	0.0178	0.0170
	(0.40)	(0.55)
f_t*NPL_{it-1}	0.0705***	0.0715***
	(0.00)	(0.00)
f_t*$NonIntInc_{it-1}$	0.0055	0.0055
	(0.17)	(0.17)

f_t*$LogRealAssets_{it-1}$	0.1257***	0.1240***
	(0.00)	(0.00)
f_t*FHC_{it-1}	-0.2061***	-0.1726***
	(0.00)	(0.01)
$After98_t$*f_t*KA_{it-1}	-0.0223	-0.0173
	(0.31)	(0.55)
$After98_t$*f_t*NPL_{it-1}	-0.1175***	-0.1101***
	(0.00)	(0.00)
$After98_t$*f_t*$NonIntInc_{it-1}$	0.0073	0.0069
	(0.11)	(0.13)
$After98_t$*f_t*$LogRealAssets_{it-1}$	-0.0921**	-0.0977**
	(0.05)	(0.04)
# of observations	7,906	7,906
R – squared	0.2090	0.2104

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

Table 12. Estimates of the differences in the systematic risk between High and Low trading banking organizations using equations (3) and (4), which include control variables
BHCs with real assets above $5 billion

The parameters presented in this table are based on the results of the panel data regression with fixed effects given in equations (3) (Panel A) and (4) (Panel B), and capture the differences in sensitivities of bank equity returns to a common factor between banks with high and low trading activities (High TA, Low TA) during the periods of 1986:Q2-1997:Q4 and 1998:Q1-2007:Q4. In both panels, "High TA – Low TA" represents the contribution of trading activity to systematic risk. In Panel A, α_4 represents a post-1998 increase in the contribution of trading activity to the systematic risk. In Panel B, β_6 and $\beta_6 + \beta_8$ represent post-1998 increase in the contribution of trading activity to systematic risk for low and high capital banks respectively. β_8 captures the difference in the two increases

	Panel A: Equation (1)	*Panel B: Equation (2)*	
	Before 1998	*Before 1998*	
		Low KA	High KA
Difference (High TA – Low TA)	-0.2851*** (0.01)	-0.3107*** (0.01)	-0.1448 (0.50)
	After 1998	*After 1998*	
		Low KA	High KA
Difference (High TA – Low TA)	0.2883*** (0.01)	0.6462*** (0.00)	0.1607 (0.15)
α_4	0.5734*** (0.00)	-	-
β_6	-	0.9569*** (0.00)	-
$\beta_6 + \beta_8$	-	-	0.3055 (0.21)
β_8	-	-0.6514** (0.02)	

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

Table 13. Estimates of the differences in the systematic risk between High and Low trading banking organizations using equations (3) and (4) with bank portfolio return as a common factor BHCs with real assets above $5 billion

The parameters presented in this table are based on the results of the panel data regression with fixed effects given in equations (3) (Panel A) and (4) (Panel B), and capture the differences in sensitivities of bank equity returns to a common factor between banks with high and low trading activities (High TA, Low TA) during the periods of 1986:Q2-1997:Q4 and 1998:Q1-2007:Q4. In both panels, "High TA – Low TA" represents the contribution of trading activity to systematic risk. In Panel A, α_4 represents a post-1998 increase in the contribution of trading activity to the systematic risk. In Panel B, β_6 and $\beta_6 + \beta_8$ represent post-1998 increase in the contribution of trading activity to systematic risk for low and high capital banks respectively. β_8 captures the difference in the two increases

	Panel A: Equation (1)	*Panel B: Equation (2)*	
	Before 1998	*Before 1998*	
		Low KA	High KA
Difference (High TA – Low TA)	-0.1382** (0.04)	-0.1555** (0.03)	-0.0594 (0.61)
	After 1998	*After 1998*	
		Low KA	High KA
Difference (High TA – Low TA)	0.1630*** (0.04)	0.2897** (0.02)	0.0816 (0.35)
α_4	0.3012*** (0.00)	-	-
β_6	-	0.4452*** (0.00)	-
$\beta_6 + \beta_8$	-	-	0.1410 (0.34)
β_8	-	-0.3042* (0.08)	

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

REFERENCES

Acharya, Viral, 2001, "Theory of Systemic Risk and Design of Prudential Bank Regulation," *London Business School working paper.*

Acharya, Viral and Tanju Yorulmazer, 2008, "Information Contagion and Bank Herding," *Journal of Money, Credit and Banking* 40(1), 215-231.

Adrian, Tobias, and Hyun Song Shin, 2010, "Liquidity and Leverage," *Journal of Financial Intermediation* 19(3), 418-437.

Adrian, Tobias and Markus Brunnermeir, 2009, "CoVaR", working paper.

Basak, Suleyman and Alex Shapiro, 2001, "Value-at-Risk Based Risk Management: Optimal Policies and Asset Prices," *Review of Financial Studies* 14, 371-405

Berger, Allen and Christa Bouwman, 2009, "Bank Capital, Survival, and Performance Around Crises," working paper.

Berkowitz, Jeremy, and James O'Brien, 2002, "How Accurate Are Value-at-Risk Models at Commercial Banks?" *Journal of Finance* 57, 1093-1111.

Brunnermeier, Markus K., 2009, "Deciphering the 2007-08 Liquidity and Credit Crunch," *Journal of Economic Perspectives* 23(1), 77-100.

Brunnermeier, Markus K. and Lasse H. Pedersen, 2008, "Market Liquidity and Funding Liquidity," *Review of Financial Studies* 22(6), 2201-2238.

Flannery, Mark J., 2005, "No Pain, No Gain? Effecting Market Discipline via Reverse Convertible Debentures", Chapter 5 of Hal S. Scott, ed., *Capital Adequacy Beyond Basel: Banking Securities and Insurance*, Oxford: Oxford University Press.

Heaton, John, Lucas, Deborah, and Robert McDonald, 2010, "Is Mark-to-Market Accounting Destabilizing? Analysis and Implications for Policy," *Journal of Monetary Economics* 57(1), 64-75.

Hellmann, Thomas, Murdock, Kevin and Joseph Stiglitz, 2001, "Liberalization, Moral Hazard in Banking and Prudential Regulation: Are Capital Requirements Enough?," *American Economic Review* 90(1), 147-165.

Hirtle, Beverly, 2003, "What Market Risk Capital Reporting Tells Us About Bank Risk," Federal Reserve Bank of New York *Economic Policy Review*, September 2003, 37-54.

Holod, Dmytro, and Joe Peek, 2007, "Asymmetric Information and Liquidity Constraints: A New Test," *Journal of Banking and Finance* 31(8), August, 2425-2451.

Hovakimian, Armen, and Edward J. Kane, 2000, "Effectiveness of Capital Regulation at U.S. Commercial Banks1985 to 1994," *Journal of Finance* 55, 451–468.

Huang, Xin, Zhou, Hao, and Haibin Zhu, 2009, "A Framework for Assessing the Systemic Risk of Major Financial Institutions," *Journal of Banking and Finance* 33, 2036-2049.

Hull, J. and A. White, 2004, "Valuation of a CDO and an n-th to Default CDS without Monte Carlo Simulation," *Journal of Devivatives* 12, 8-23.

Jorion, Philippe, 2006, Bank Trading Risk and Systemic Risk*, The Risk of Financial Institutions,* NBER publication.

Kashyap, Anil, Rajan Raghuram and Jeremy Stein, 2008, "Rethinking Capital Regulation," in *Maintaining Stability in a Changing Financial System*, Federal Reserve Bank of Kansas City, 431-471.

Kashyap, Anil, 2004, "Cyclical Implications of the Basel-II Capital Standards," *Federal Reserve Bank of Chicago Economic Perspectives*, 28-Q1, 18-31.

Koenker, Roger and Gilbert Bassett, 1978."Regression Quantiles," *Econometrica* 46(1), 33-50.

Krishnamurthy, Arvind, 2010, "Amplification Mechanisms in Liquidity Crises," *American Economic Journal - Macroeconomics*, forthcoming.

Myers, Stewart, 1977, "Determinants of Corporate Borrowing," *Journal of Financial Economics* 5, 147-175.

Myers, Stewart and Nicholas Majluf, 1984, "Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have," *Journal of Financial Economics* 13, 187-221.

Persaud, Avinash, 2000, "Sending the Herd Off the Cliff Edge: The Disturbing Interaction between Herding and Market-Sensitive Risk Management Practices," *Journal of Risk Finance* 2, 59-65.

Thakor, Anjan, 1996, "Capital Requirements, Monetary Policy, and Aggregate Bank Lending: Theory and Empirical Evidence," *Journal of Finance* 51(1), 279-324.

VanHoose, David D., 2007, "Bank Capital Regulation, Economic Stability, and Monetary Policy: What Does the Academic Literature Tell Us?" *Atlantic Economic Journal* (36), 1–14.