The Relationship Between Risk and Capital in Swiss Commercial Banks: A Panel Study*

Robert Bichsel and Jürg Blum
Swiss National Bank
Börsenstrasse 15
8022 Zürich
Switzerland

May 15, 2001

Abstract

In this paper we investigate the relationship between changes in risk and changes in leverage for a panel of Swiss banks. Using market data for risk and both accounting and market data for capital over the period between 1990 and 1999, we find a positive correlation between changes in capital and changes in risk, i.e., higher levels of capital are associated with higher levels of risk. Despite this positive correlation, however, we do not find a significant relationship between the default probability and the capital ratio.

1 Introduction

Since the Basel Accord of 1988 capital adequacy rules have been the focus of international banking regulation. Surprisingly, however, despite more than a decade of experience with such rules and a still growing academic literature, the question to

*We thank Bertrand Rime and workshop participants at the Swiss National Bank for helpful comments and discussions. The views expressed in this paper are entirely those of the authors and do not represent those of the Swiss National Bank. Email: robert.bichsel@snb.ch, juerg.blum@snb.ch.

what extent capital requirements have an impact on banks' riskiness is still not resolved. In this paper we try to improve the understanding of the relationship between capital and risk by providing empirical evidence for Swiss banks.

It is undisputed that – everything else being constant – a bank's probability of default decreases with the level of capital – a simple buffer stock effect. Disagreement, however, exists about the indirect incentive effects originating from the level of (required) capital. On the one hand, some people argue that capital represents the stake a bank has to lose in case of insolvency. Therefore, the bank has an incentive to incur lower risks the higher the amount of capital – similar to deductibles in insurance policies. This incentive effect reinforces the buffer effect, and banks' stability increases with their level of capital. On the other hand, it is argued that capital is very costly. In order to generate an 'adequate' return on equity, banks have to incur higher risks to receive higher risk premia on their investments the higher the level of capital. The net effect of this negative incentive effect and the buffer effect is ambiguous. It is possible that the default risk increases as the level of capital is increased.

Just like theory does not offer any clear answers, the existing empirical evidence on the relationship between leverage and the riskiness of banks is not conclusive, either. In most studies and in particular in Shrieves and Dahl (1992), Aggarwal and Jacques (1998), and Hovakimian and Kane (2000), the sign and the magnitude of the results strongly depend on both the measure of risk and the sample considered. In contrast, as was shown by Thomson (1991) and Estrella (2000) among others, the likelihood of failure tends to decrease with the capital ratio of a bank. However, this result is in particular sensitive to the time horizon considered.[1]

Our work is motivated by two observations. First, the growing concern about the increasing complexity and about the effectiveness of the current risk-weighting system has led many to favor very simple leverage restrictions. Acknowledging that there are problems with any risk-weighting scheme (most importantly so-called 'regulatory arbitrage'), a more moderate proposal is to supplement the current system with additional

[1] Also see the BIS (1999) survey of the theoretical and empirical literature on the effects of capital requirements.

leverage restrictions. While such a combination of risk-weighted and unweighted capital requirements is already in effect in the United States, most countries mainly rely on risk-weighted rules at present. Obviously, for all proposals involving simple leverage ratios, the relationship between (unweighted) capital and banks' riskiness is of central importance. Second, almost all of the available evidence is based on data from the United States. To judge whether it might be useful to introduce leverage restrictions internationally, more evidence from other banking systems is necessary.

Using monthly data covering a period of 10 years between 1990 and 1999 for a sample of 18 publicly traded Swiss banks, we examine the relationship between the leverage ratio and the risk of banks. We find a positive correlation between changes in capital and risk. Based on market data for assets, an increase in the capital ratio of 1 percent is associated with an increase of 0.95 percent in volatility of the banks' assets on average. In spite of the positive relationship between risk and capital, we do not find a significant relationship between the likelihood of failure and the capital ratio.

The paper is organized as follows. In section 2, we present the empirical design of our study. In section 3 we develop our measure of risk, and in section 4 an indicator of the default probability is derived. Section 5 describes the data, and the results of our estimations are presented in section 6. The final section discusses some limitations.

2 Empirical Design

Our specification is similar to the one adopted by Hovakimian and Kane (2000) who estimate (i) the changes in leverage ratio as well as (ii) the changes in the fair deposit insurance premium per dollar of deposits – which is monotonically related to the likelihood of default that we use – as a function of changes in the riskiness of banks assets.

We estimate the following relationships:

$$\Delta\sigma_{A_{i,t}} = \alpha_{0,i} + \alpha_1 \Delta c_{i,t} + \alpha_2 \Delta\sigma_{BSI_t} + u_{i,t}, \tag{1}$$

and

$$\Delta z_{i,t} = \beta_{0,i} + \beta_1 \Delta c_{i,t} + \beta_2 \Delta\sigma_{BSI_t} + v_{i,t}, \tag{2}$$

where $\sigma_{A_{i,t}}$ is the volatility per unit of market value of assets, $c_{i,t}$ is the capital ratio for bank i at time t, σ_{BSI_t} is the volatility of the Swiss bank stock index at time t and $z_{i,t}$ is an indicator of the likelihood of failure of bank i. This indicator will be derived in section 4. We assume that the unobservable terms $u_{i,t}$ and $v_{i,t}$ are i.i.d. normally distributed with zero mean and heteroscedastic variances $\sigma_{u,i}^2$ and $\sigma_{v,i}^2$, respectively.

In our analysis we will focus on α_1 and β_1, the coefficients of the simple unweighted capital ratio in equations (1) and (2) we include A positive value for α_1 implies that improvements of banks' capitalization tend to be correlated with increased riskiness. Such a correlation may reflect either regulatory pressures – through the risk–based capital requirements – and/or some form of market pressure, or banks' objective functions. A negative value for β_1 would imply that improvements in capitalization tend to be correlated with decreases in the likelihood of default. The capital ratio of a bank affects its likelihood of failure through three different channels, one direct and two indirect effects. The first one is a direct buffer effect. More capital implies a bigger cushion to absorb an adverse shock and hence reduces the likelihood of failure. The second channel concerns the correlation between capitalization and risk as reflected by (1). Third, if there is a trade-off between risk and return, increased riskiness implies a higher return on average, which in turn reduces the likelihood of failure. The net effect of changes in the capital ratio on the probability of failure is ambiguous. The parameter α_2 and β_2 account for the systemic component of variations in the riskiness and the likelihood of failure of bank i.

3 Measure of Risk

The true or market value of a bank's assets and, hence, the volatility of these assets σ_A are not directly observable. Following Ronn and Verma (1986) and others[2], we estimate the unobserved market value and risk of a bank's portfolio by modeling the bank's equity as a call option on the value of the assets of the bank. Therefore, letting E denote the market value of the equity of a bank, A the (implied) value of its assets,

[2] See in particular Furlong (1988) and Hovakimian and Kane (2000).

and L the book value of its liabilities, we have

$$E = Max\left[0, A - L\right].$$

Under the assumptions of the Black-Scholes option pricing formula – among others that returns on banks' assets are normally distributed – the value of the equity is given by

$$E = AN\left(d_1\right) - LN\left(d_1 - \sigma_A\sqrt{T}\right), \tag{3}$$

where

$$d_1 = \frac{\ln\left(A/L\right) + \sigma_A^2 T/2}{\sigma_A\sqrt{T}},$$

$N(.)$ is the cumulative normal distribution, and T is the time to maturity[3].

In addition, according to Ito's lemma, if A follows an generalized Wiener process with a variance of $\sigma^2 A^2$, the standard deviation of E is given by

$$\sigma_E = \frac{A}{E}\frac{\partial E}{\partial A}\sigma_A. \tag{4}$$

The values of A and σ_A are obtained by simultaneously solving equations (3) and (4) numerically using an iterative process. The contemporaneous standard deviation of equity, σ_E, is approximated using the observed returns on equity.

4 Likelihood of Failure

The likelihood of failure of banks cannot be observed directly. Hence, we assess the relationship between the capital ratio and the default probability of a bank using an indicator that is related to the probability of failure, which in turn is a function of the returns on the assets of the bank and its leverage ratio. Our indicator is similar to Furlong's (1988). However, Furlong (1988) neglects the option value of equity.

[3] Following Ronn and Verma (1986), we choose a maturity of one year. To the extent that the maturity of debt differs from one year, this will lead to a bias in the level of the implied volatility. However, since we are interested in *changes* in volatility, this does not pose a problem as long as the maturity is relatively stable.

The likelihood of failure at time t is given by the probability that the value of the assets A of a bank falls below the value of its debt D between t and $t+1$, $\Pr_t(A_{t+1} < D_{t+1})$. The value of total assets after one period is equal to the sum of the (random) gross returns on the assets in place at the beginning of the period and the gross return on the average value of exogenously added assets $\Delta A/2$ during that period,

$$A_{t+1} = (1+\tilde{r}_A)A_t + (1+\tilde{r}_A)\frac{\Delta A}{2}.$$

Similarly, the value of debt is equal to the sum of the initial value plus accrued interest and the average value of added debt plus interest,

$$D_{t+1} = (1+r_D)D_t + (1+r_D)\frac{\Delta D}{2}.$$

We assume that the interest rate on bank debt r_D is non-random. Using the above two equations and dropping the time index t, the probability of default can be written as

$$\Pr\left((1+\tilde{r}_A)A + (1+\tilde{r}_A)\frac{\Delta A}{2} < (1+r_D)D + (1+r_D)\frac{\Delta D}{2}\right).$$

If there is no exogenous change in the level of capital, such as a capital injection or a buyback of shares, $\Delta A = \Delta D$. In that case,

$$\Pr\left((1+\tilde{r}_A)A + (\tilde{r}_A - r_D)\frac{\Delta A}{2} < (1+r_D)D\right).$$

Neglecting the term $(\tilde{r}_A - r_D)\Delta A/2$ since it is small relative to the other terms, we get the following approximate formula for the default probability:

$$\Pr\left((1+\tilde{r}_A)A < (1+r_D)D\right),$$

or, using the balance sheet identity $A = K + D$ and the definition $c \equiv K/A$,

$$\Pr\left(\tilde{r}_A < (1+r_D)(1-c) - 1\right).$$

Under the assumption that the growth rates of banks' assets $\tilde{r}_A$ are normally distributed with mean μ_A and variance σ_A^2, we have

$$\frac{\tilde{r}_A - \mu_A}{\sigma_A} \sim N(0,1)$$

Hence, the probability of failure is given by $\Phi(z)$, where $\Phi(.)$ is the cumulative standard normal distribution and z is given by

$$z = \frac{(1 + r_D)(1 - c) - 1 - \mu_A}{\sigma_A}. \tag{5}$$

To estimate the (unobservable) expected return on assets μ_A using the observable return on capital μ_E, we start from the definition of the total return on capital,

$$(1 + \mu_E)K = (1 + \mu_A)A - (1 + r_D)D + (\mu_A - r_D)\frac{\Delta A}{2},$$

where as explained above, the last term is the net return on the average, exogenous change in assets, given a constant level of capital. Dividing both sides by K, and again using $(\mu_A - r_D)\Delta A/2 \simeq 0$ and $A = K + D$, we can rewrite the above definition as

$$\mu_E \simeq \mu_A \frac{A}{K} - r_D \frac{D}{K}.$$

Using the definition of c, we get

$$\mu_A \simeq c\mu_E + (1 - c)r_D.$$

Finally, inserting this approximation into (5) yields

$$z = \frac{-c(1 + \mu_E)}{\sigma_A}. \tag{6}$$

which is monotonically related to the likelihood of failure of a bank. The higher the value of z_i, the higher is the default probability of bank i between time t and $t + 1$. From (6) it follows that – as one would intuitively expect – an increase in the capital ratio c and an increase in the expected return on *capital* lead to a lower probability of default, while an increase in the volatility of *assets* leads to a higher probability of default. To estimate z, we use the implied volatility of assets, σ_A, and for each month μ_E is approximated using the average of observed daily returns on equity for that month.

5 Data

We use monthly data of 18 publicly traded Swiss banks between January 1990 and March 2000.[4] Balance sheet information is taken from the Swiss National Bank's monthly statistics on individual banks. The volatility of period t of dividend-adjusted stock returns and of the Swiss bank index are given by the annualized volatility of the nominal returns during that period.

Table 1 provides a statistical description of the variables used in the model. Two different definitions are used to compute the capital ratio. c_B is defined as the ratio between accounting capital – the balance sheet total minus total liabilities and asset value adjustments – and balance sheet total. c_M is defined as the ratio between the market value of equity – the (implied) market value of assets minus total liabilities and asset value adjustments – and the (implied) market value of assets.

It is worth noting that for almost every bank and at every point in time, the delta of the option, i.e., $\partial E/\partial A$, was one or very close to one. In other words, for most banks the likelihood of default was close to zero so that the price of the option moved one to one with the value of banks' assets. As a consequence, most of the time *total* volatility of banks' assets is simply given by *total* volatility of the banks' stock returns.

[**Insert Table 1 about here**]

6 Estimation

Equation (1) and (2) are estimated using a two-step FGLS procedure. Table 2 summarizes the results for the estimation of (1). The statistical significance of the relationship between capitalization and risk depends on the definition of capital used. When the capital ratio is computed using market information for assets and equity (Panel A), the relationship between risk and the capital ratio is almost proportional. On average, a 1% increase in the capital ratio is associated with a .95% increase in volatility. In addition, this relationship is statistically highly significant and relatively robust to changes

[4] According to the data published by the Swiss Exchange SWX, 19 Swiss banks are publicly listed. One bank – a bank holding company for which no monthly consolidated data are available – was excluded from the sample.

in the specification of (1). In particular, neither the magnitude of the relationship, nor its statistical significance are affected by the inclusion of lagged values for $\Delta\sigma_A$ in the estimation.[5] At the individual bank level, the relationship between capital and risk is positive for 16 out of 18 banks in our sample and significantly different from zero at the 5% (10%) level for 9 (12) banks. The magnitude of the relationship does not differ significantly between banks, i.e., we cannot reject the hypothesis that the coefficient for Δc_M is the same for all banks in our sample at the 10% level.[6] Finally, the relationship is rather stable over time. As can be seen from D_{95-00} and $\Delta cm * D_{95-00}$, the estimated values of the coefficients do not vary significantly between the period 1990-94 and 1995-99. These findings are partially consistent with Hovakimian and Kane (2000). Using quarterly data for US banks, they show that the market based leverage ratio is negatively correlated with asset risk for their subsamples covering the periods 1985-86 and 1992-94. However, they find a positive correlation between 1987-91.

When the capital ratio is computed using accounting information for assets and equity (Panel B), the magnitude as well as the statistical significance of the relationship between risk and capital ratio are strongly reduced. In this case, on average, a 1% increase in the capital ratio is associated with a .39% increase in volatility. But the hypothesis that there is no systematic relationship between both measures cannot be rejected at the 10% level. The statistical significance of the relationship is reduced even further if lagged values for $\Delta\sigma_A$ are included in the estimation.[7]

Table 3 summarizes the results for the estimation of (2). To allow for possible non–monotonicities in the relationship between banks' capital ratios and banks' risk, we add Δc^2 to (2). Independently of the measure of banks' capitalization, i.e., either using c_M (Panel A) or c_B (Panel B), and whether or not we include lagged values for z in the estimation, our data suggests that the relationship between capitalization and default probability is weak or nonexistent. In any case, we cannot reject the hypothesis

[5] Lags 1 to 6 and lag 9 are statistically significant at the 10% level.

[6] Under the hypothesis that all coefficients are equal, the Wald test statistic follows a $\chi^2_{17} = 24.07$, with $p\left(\chi^2_{17}\right) > 24.94 = .1$

[7] Lags 1 to 6 are statistically significant at the 10% level.

that the joint effect of Δc_t and Δc_t^2 on the likelihood of failure is 0 at the 5% level of significance. Only using the market definition of the capital ratio, this same hypothesis can be rejected at the 10% level. Given the positive sign of the coefficients, this provides weak evidence for a positive relationship between changes in capital and changes in the likelihood of failure. At the individual bank level, the relationship between Δc and the likelihood of failure is significant for only 2 and 5 banks out of 18 when Δc_M and Δc_B are used, respectively. In both cases, the sign and the magnitude of the relationship varies widely between banks.

[**Tables 2 and 3**]

7 Discussion

Our results suggest that while banks' risk and their levels of capitalization are positively correlated, there doesn't seem to be a significant relationship between changes in the capital ratio and the default probability of banks. While these results seem to indicate that simple leverage restrictions may not be a sufficient regulatory instrument to ensure the stability and soundness of banks, some qualifying comments about our analysis are in order.

First, our estimates of the asset values and the asset volatilities are based on a Black-Scholes interpretation of bank equity, which may not be appropriate. In particular, the options approach requires an efficient markets environment. Especially in the context of banking this assumption is questionable. One primary reason for banks' existence is precisely the presence of market frictions and inefficiencies. In other words, the options approach is somewhat paradoxical. Since banks are opaque, risks and true values are not directly observable. In order to circumvent that problem, we deduce these quantities from observed market values – under the assumption that 'the market' is somehow able to assess the true values fairly accurately, despite the banks' opaqueness.

Second, the fact that both the asset values and the asset volatilities are estimated by solving two equations simultaneously may introduce correlations by construction. This may at least partially explain the highly significant relationship between risk and market-based measures of capital, while the relationship between risk and accounting measures of capital is only weak. Another explanation of these differing results is that the accounting data reflects the actual valuations only poorly, and that the market valuations are much more accurate.

Third, the equations we estimate do not incorporate any other variables that may both affect the capital ratio and the riskiness of banks, potentially leading to biased estimates. In addition, as mentioned by Hovakimian and Kane (2000), in such a setting, the variables in the regression equation are generated synthetically. That is, links between the equations solved may introduce non-zero correlation between the errors in left-hand and right-hand variables of our equation which may render OLS estimators inconsistent. While in principle this could be solved using two-stage least squares, the lack of adequate instruments available on a monthly basis prevents us from doing such a correction.

Fourth, by assuming that banks have sufficient leeway to freely choose their leverage, we have implicitly neglected the impact of risk-weighted requirements. It may well be that in our sample changes in unweighted capital ratios are in fact strongly correlated with changes in risk-weighted capital ratios, or are even 'caused' by them. In that case, the observed correlation between unweighted capital ratios and risk would in fact be the consequence of the underlying relationship between risk-weighted capital and the level of risk. As a consequence, our results would over-estimate the impact of simple leverage ratios on the level of risk.

Finally, Swiss banks are currently not subject to any leverage restrictions. The question is, whether our measured relationship between leverage and risk would still hold if banks were facing a mandatory leverage requirement. In general, we would expect behavior to be affected by the introduction of a new rule. To the extent, however, that the observed combinations of risk and leverage that we observe now are chosen voluntarily, imposing a certain leverage would be equivalent to the regulator picking one particular risk-leverage combination out of all the feasible possibilities. Within the range of our sample, therefore, behavior should not be affected substantially. In contrast, if banks were required to maintain leverage ratios that are well outside the range of values observed in our sample, changes in behavior are quite possible. For instance, Kim and Santomero (1988) have shown that banks that face a strictly binding capital requirement may have an incentive to increase their risk to compensate for the higher level of capital they have to hold. This implies that our results have to be interpreted with caution when trying to make predictions about the impact of any potential leverage requirements.

References

[1] Aggarwal Raj, Jacques Kevin T. (2000): 'Assessing the Impact of Prompt Corrective Action on Bank Capital and Risk', Federal Reserve Bank of New York Economic Policy Review, October, 23–32.

[2] Bank for International Settlements (1999): 'Capital Requirements and Bank Behaviour: The Impact of the Basle Accord', Basle Committee on Banking Supervision Working Papers 1.

[3] Estrella, Arturo, Sangkyun Park and Stavros Peristiani (2000): 'Capital Ratios as Predictors of Bank Failure', Federal Reserve Bank of New York Economic Policy Review, July, 33-51.

[4] Furlong, Frederik F. (1998): 'Changes in Bank Risk-Taking', Federal Reserve Bank of San Francisco Economic Review.

[5] Hwang Dar-Yeh, Cheng Lee F., Liaw Thomas K. (1997): 'Forecasting Bank Failures and Deposit Insurance Premium', International Review of Economics and Finance 6(3), 317-334.

[6] Hovakimian Armen, Kane Edward J. (2000): 'Effectiveness of Capital Regulation at U.S. Commercial Banks, 1985 to 1994, Journal of Finance 55(1), 451–468.

[7] Kim, Daesik and Anthony Santomero (1988): 'Risk in Banking and Capital Regulation', Journal of Finance 43, 1219-1233.

[8] Ronn Ehud I, Verma Avinash K. (1986): 'Pricing Risk-Adjusted Deposit Insurance: An Option-Based Model', Journal of Finance, 41(4), September 871–95.

[9] Shrieves, Ronald E. and Dahl Drew (1992): 'The relationship between risk and capital in commercial banks', Journal of Banking and Finance 16(2), 439-457.

[10] Thomson, James B. (1991): 'Predicting bank failures in the 1980s', Federal Reserve Bank of Cleveland Economic Review Q1, 9-20.

Table 1

	Mean	s.e.	Min.	Max.
Market value of assets (V_M)	38136.22	130124.4	460.31	1320165
Accounting value of assets (V_B)	36449.49	123847.4	424.28	1254900
Market value of kapital (k_M)	3343.947	13511.58	20.89	138698.3
Accounting value of kapital (V_B)	1657.22	4355.628	27.15	29975.42
Market value of capital ratio ($c_M = k_M/V_M$)	.106	.125	.003	.569
Accounting value of capital ratio ($c_B = k_B/V_B$)	.075	.073	.016	.487
Annualized std. dev of rate of return on assets (σ_A)	.019	.031	.000	.326
Annualized std. dev of bank stock index (σ_{BSI})	.004	.003	.001	.021

Number of observations: 2013

Correlation between c_M and c_B is .71.

Table 2

Two stage FGLS regressions relating changes in the riskiness of banks' assets ($\Delta\sigma_{A_{i,t}}$) to changes in the capital ratio ($\Delta c_{i,t}$) and changes in the volatility of the Swiss bank stock index ($\Delta\sigma_{BSI_t}$). c_M is the ratio between the market value of equity – the (implied) market value of assets minus total liabilities and asset value adjustments – and the (implied) market value of assets. c_B the ratio between accounting capital – the balance sheet total minus total liabilities and asset value adjustments – and balance sheet total. $\sum_{j=1}^{12} \gamma_j \Delta\sigma_{A_{i,t-j}}$ are lagged values of the riskiness of banks' assets. D_{95-00} is a dummy variable that takes value 1 when between January 1995 and March 2000. Data run from January 1990 to March 2000. Number of observations is 1891 when no lags are included and 1677 when lags are included. 18 banks are included. Average number of observations by bank is 110 without lags and 98 when lags are included. Constants do not differ significantly across banks.

Model	Panel A: capital ratio = c_M	
	$\Delta\sigma_{A_{i,t}} = \alpha_{0,i} + \alpha_1 \Delta c_{i,t} + \alpha_2 \Delta\sigma_{BSI_t} + u_{i,t}$	$\Delta\sigma_{A_{i,t}} = \alpha_{0,i} + \alpha_1 \Delta c_{i,t} + \alpha_2 \Delta\sigma_{BSI_t} + \sum_{j=1}^{12} \gamma_j \Delta\sigma_{A_{i,t-j}} + u_{i,t}$
Δc_M	0.95*** (6.593)	1.14*** (8.589)
$\Delta\sigma_B$	0.32*** (11.733)	0.23*** (8.370)
$D_{95-00} * \Delta c_M$	0.91 (0.661)	-1.15 (-0.957)
Constant	-0.002 (-0.126)	-0.005 (-0.262)
D_{95-00}	0.003 (0.106)	0.03 (1.299)
	Panel B: capital ratio = c_B	
Δc_B	0.39 (1.595)	0.10 (0.45)
$\Delta\sigma_B$	0.30*** (10.713)	0.21*** (7.526)
$D_{95-00} * \Delta c_B$	3.89 (1.112)	3.29 (1.118)
Constant	-0.001 (-0.033)	0.003 (0.179)
D_{95-00}	0.01 (0.505)	0.03 (1.310)

*, **, *** Indicate values significantly different from zero at the 10 percent, 5 percent and 1 percent levels, respectively. Coefficient $t-$statistics are reported in parentheses.

Table 3

Two stage FGLS regressions relating changes in the indicator for the likelihood of default ($\Delta\sigma_{A_{i,t}}$) to changes in the capital ratio ($\Delta c_{i,t}$) and changes in the volatility of the Swiss bank stock index ($\Delta\sigma_{BSI_t}$). c_M is the ratio between the market value of equity – the (implied) market value of assets minus total liabilities and asset value adjustments – and the (implied) market value of assets. c_B the ratio between accounting capital – the balance sheet total minus total liabilities and asset value adjustments – and balance sheet total. $\sum_{j=1}^{12}\gamma_j\Delta\sigma_{A_{i,t-j}}$ are lagged values of the risk of banks' assets. D_{95-00} is a dummy variable that takes on the value 1 when the date is between January 1995 and March 2000. Data run from January 1990 to March 2000. Number of observations is 1891 when no lags are included and 1677 when lags are included. 18 banks are included. Average number of observations by bank is 110 without lags and 98 when lags are included. Constants do not differ significantly across banks.

Model	$\Delta z_{i,t}=\beta_{0,i}+\beta_1\Delta c_{i,t}+\beta_2\Delta c_{i,t}^2+\beta_3\Delta\sigma_{BSI_t}+v_{i,t}$	$\Delta z_{i,t}=\beta_{0,i}+\beta_1\Delta c_{i,t}+\beta_2\Delta c_{i,t}^2+\beta_3\Delta\sigma_{BSI_t}+\sum_{j=1}^{12}\gamma_j\Delta\sigma_{A_{i,t-j}}+v_{i,t}$
	Panel A: capital ratio = c_M	
Δc_M	63.71 (1.442)	75.98 (1.378)
Δc_M^2	1630.64 (1.524)	1876.03 (1.596)
$\Delta\sigma_B$	1665.53*** (9.488)	1241.65*** (6.162)
$D_{95-00}*\Delta c_M$	-24.92 (-0.467)	-53.14 (-0.847)
Constant	-0.39 (-0.644)	-0.28 (-0.369)
D_{95-00}	0.52 (0.631)	0.48 (0.525)
	Panel B: capital ratio = c_B	
Δc_B	119.54 (1.516)	120.43 (1.206)
Δc_B^2	3786.43 (1.264)	5991.11* (1.673)
$\Delta\sigma_B$	1631.56*** (9.633)	1201.99*** (6.350)
$D_{95-00}*\Delta c_B$	-74.35 (-0.522)	-96.10 (-0.657)
Constant	-0.34 (-0.580)	-0.19 (-0.259)
D_{95-00}	0.44 (0.543)	0.36 (0.397)

*, **, *** Indicate values significantly different from zero at the 10 percent, 5 percent and 1 percent levels, respectively. Coefficient $t-$statistics are reported in parentheses.