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Regulation of Bank Capital and Behavior of Banks: Assessing the US and the EU-15 Region Banks in the 2000-2005 Period

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Regulation of Bank Capital and Behavior of Banks: Assessing the US and the EU-15 region Banks in the 2000-2005 period

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Abstract:
In recent years, regulators have increased their focus on the capital adequacy of banking institutions to enhance their stability, hence the stability of the whole financial system. The purpose of this paper is to assess and compare how American and European banks adjust their level of capital and portfolio risk under capital regulation, whether and how they react to constraints placed by the regulators. In order to do this, we estimate a modified version of the simultaneous equations model developed by Shrieves and Dahl. This model analyzes adjustments in capital and risk at banks when they approach the minimum regulatory capital level. The results indicate that regulatory requirements have the desired effect on bank behavior. Both American and European banks that are close to minimum requirements simultaneously increase their capital. In addition, the US banks decrease their portfolio risk taking.

Keywords: banking regulation, Basel Capital Accord, capital adequacy, banks, simultaneous equations model

JEL: C30, G18, G21.

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1. Introduction

Regulation of financial markets has become one of the most discussed topics by both academics and practitioners in last years. The terms such as Basel II, Solvency II, MiFID are widely used by financial market players. This paper intends to contribute to these discussions as it tries to evaluate regulatory pressure on selected banks around the world.

The basic aim of the paper is to assess the behavior of American and European banks and to analyze their reaction to regulatory pressure (one of the form of banking regulation). We try to answer two key questions: Does regulatory pressure induce the American and the European banks to increase their capital? Does strengthening of capital requirements induce them to increase or decrease their portfolio riskiness?

To answer the key questions we estimate a modified version of the simultaneous equations model developed by Shrieves and Dahl (1992). In the model, regulatory pressure is one of the explanatory variables and the dependent variables are changes in risk and capital. The model is modified in two main aspects; we use more advanced approaches towards the regulatory pressure variable (we model the regulatory pressure variable in three different ways) and we include also year dummy variable to capture year-specific effects. There are many methods that can be used to estimate the model; we have chosen the method of two-stage least squares (2SLS) and three-stage least squares (3SLS) estimates in order to test for the robustness of the results.

Data for our research were obtained from BankScope, a database which has statement data on more than 11,000 banks worldwide. We take into consideration panel data for 1,240 American and European banks from the 2000-2005 period.

As we discuss later in the paper, conclusions of our research contribute to the literature by providing empirical support to the theories provided by Shrieves and Dahl (1992), Kim and Santomero (1988) and Koehn and Santomero (1980).

This paper is organized as follows. The second part gives a theoretical background of banking regulation. The following part provides a theoretical framework for the research. The fourth part describes the model and data used. The fifth part discusses the results of our research and compares them with the findings of other authors. Finally, the sixth part concludes the paper and state final remarks.

2. Background of banking regulation

Increased regulation of bank capital, when compared to other entrepreneurship entities stems basically from the fact that a bank balance sheet differs significantly from a balance sheet of a common company. The main difference is that bank capital[1] represents just a small portion of assets while the portion of liabilities to assets is large. This is because the majority of a bank´s sources[2] are comprised of outside resources, mainly from customer deposits and deposits from

[1] Here we have on our mind a firm's value which is equal to assets minus liabilities.
[2] Total sources are composed from shareholders´ equity and total liabilities.

banks. On the other hand, bank assets are composed mainly of loans, leases to customers, and securities. From this, it follows that a bank is more vulnerable when compared to a company since it has a higher share of liabilities. Therefore, unexpected losses which a bank may face may not be well covered by its capital if it is too low. This is why regulators force banks to increase their capital to a minimum level so the banks can cover their potential losses and this risk is not transferred to bank customers. Financial services, especially banking, play an important role in the economy of every country. It is natural then to regulate the financial risks because a bank's failure may affect the entire country's economy. The main aim of bank regulation is to avoid failures and protect all bank customers in order to secure a stable and healthy banking system and thus also secure a stable currency.

Until the mid 1970s there was no international institution which would coordinate domestic and international bank regulation. As the amount of international financial flows grew and the number of banks with worldwide activities also grew, the need for international cooperation became greater than ever. As banks tried to access foreign markets, the question arose: Who was to be responsible for bank regulation and bank policy? Was it the rules of a "parent" country or a host country? The transnational banking system was becoming more interconnected and different dangers arose as a result of different legal requirements. For example, when there was a country which imposed less restriction on the domestic banks with international activities, it could be a danger for the second country with more restriction if a bank from the first country came to this second country. The stability of the financial system with stricter policy was exposed to more risks than before and it became more vulnerable.

The significant decline in capital adequacy has been widely observed throughout the 1970s. There were serious disturbances in the international currency and banking markets. In December 1981, in an attempt to reverse further decline, the bank regulators issued explicit capital standards for banks (and bank holding companies in the United States), which required them to hold a minimum amount of capital equal to a fixed percentage of their total assets. Although these minimum regulatory standards have been given credit for increasing bank capital levels, the 1980s saw the number of bank failures rise to a level not seen since the Great Depression.

Thus the regulators in the following years focused more on the capital adequacy of banking institutions in order to enhance the stability of financial systems. A major step in that direction was the 1988 agreement amongst the central banking authorities from 12 countries on the minimal capital requirements for internationally active banks. These countries formed a standing committee called the Basel Committee on Banking Supervision. This committee proposed a set of minimal capital requirements for banks. Their implementation started in 1989 and was completed in 1993. These standards are often referred to as the Basel Accord (BCA or Basel I).

The Basel I standards have achieved a wide degree of acceptance, extending beyond the member countries of the Basel Committee, and have thus acquired a scope which reaches beyond internationally active banks. At present, they are implemented in both domestic and international institutions in over 100 countries.

However, despite its many achievements, in recent years it has become clear that Basel I requires a radical update due to accelerating market innovations and the development of new risk management techniques. In response to criticism of Basel I, a number of changes were made, culminating in the final document of the new capital accord (NBCA or Basel II) being released in June 2006 and valid since January 1, 2007. The overall objective of Basel II is to increase the safety and soundness of the international financial system by i) making capital requirements for banks more risk sensitive while, ii) maintaining the same level of overall average regulatory capital in the banking system.[3]

[3] For more information about Basel I and Basel II see Matejašák (2006), Teplý (2006) or Teplý et al. (2007).

3. Theory review

Several opinions on regulating bank capital exist. For instance, Santos (2000) noted that moral hazard problems and the potential externalities resulting from bank failures. In addition he stated that insurance schemes have proven successful in protecting from bank runs, but at a cost that this leads to moral hazard. By offering a guarantee that depositors are not subject to loss, the providers of deposit insurance bear the risk that they would otherwise have born. As a result, it diminishes depositors' incentive to monitor banks and to demand an interest payment adequate to the risk profile of a bank. Further, when the insurance scheme charges to banks a flat rate premium, the banks then do not fully internalize the full cost of risk and therefore it has an incentive to take on more risk. Then there is a concern that a bank may hold less capital than is socially optimal relative to the risks that the bank takes (Rim, 2001). This may endanger bank stability. Hence, regulation plays an important role in preserving financial stability.

There is much literature dealing with the capital and risk relationship; we can find a number of different theories giving conflicting predictions of whether more stringent capital regulation curtails or promotes bank performance and stability. One branch of literature introduces the stabilizing effects of capital requirements. The stabilizing effects are based on the option-pricing model. In this model, an unregulated bank takes excessive portfolio and leverage risks in order to maximize its shareholder value at the expense of deposit insurance (see Furlong and Keeley (1989), Keeley and Furlong (1990)). While capital requirements cannot eliminate these moral hazard incentives, they can reduce them by forcing banks to absorb a larger part of potential losses. Therefore, the value of the deposit insurance option decreases and the incentives for excessive risk taking diminish. Thus, capital regulation leads to more capital and less risk taking, and hence to lower probability of a bank default. In addition, Bichsel and Blum (2002) note that capital represents the stake a bank has to lose in case of insolvency. Therefore, the bank has an incentive to incur lower risks and a higher amount of capital. Hence, this incentive effect reinforces the banks' stability. Under these conditions, changes in capital and risk will be negatively correlated. In addition, Jacques and Nigro (1997) argue that there is a negative relationship between changes in risk and capital. They claim that an undercapitalized bank can meet the risk-based requirement by raising capital, reducing portfolio risk, or both while a well-capitalized bank may decrease capital or increase risk.

Another branch of literature gives different predictions. Kim and Santomero (1988), Koehn and Santomero (1980) agree with the above theory that more stringent capital requirements force banks to increase their level of capital, but they argue that capital is very costly. Using the maximizing mean-variance framework they formally show that more stringent capital requirements lead to an increase in risk taking as the forced increase in expensive capital financing reduces the expected rate of return. To counter this, the bank tries to increase its rate of return by investing into riskier assets. Thus, when the increase in risk overcompensates the increase in capital, increased regulatory capital standards may have the unintended effect of causing utility-maximizing banks to increase portfolio risk, and hence increasing the probability of bank default. Under these conditions, changes in capital and risk will be positively correlated.

Shrieves and Dahl (1992) give a different rationale why banks that have built up capital have, at the same time, also increased their risk. They argue this is consistent with a number of hypotheses (bankruptcy cost avoidance, managerial risk aversion, etc) which are not mutually exclusive, meaning that each may underlie capital and risk decisions at any point in time in some subset of banks. The "Bankruptcy cost avoidance" hypothesis states that expected bankruptcy costs are an increasing function of the probability of a bank default. Therefore, banks tend to increase their capital if there is an increase in their portfolio risk and vice versa. Alternatively, the "managerial risk aversion" hypothesis states that bank managers, as agents of stockholders, may have an incentive to reduce the risk of bank insolvency more than is desired by stakeholders, since managers have a great deal to lose personally in the event of a bank's insolvency. Thus, managers whose banks have increased their portfolio risk may compensate it by setting a high capital level, thus giving rise to a positive relationship between changes in capital and risk.

On the other hand, Heid, Porath and Stolz (2003) argue that the assumptions of the above theories are not realistic, as these theories abstract from rigidities and adjustment costs. However, the reality is somewhat different from the theory because banks may not be able to instantaneously adjust capital or risk due to adjustment costs or illiquid markets. They also note that breaking the minimum regulatory requirements may be very costly for a bank. The breach of the rules may lead to repeated regulatory penalties and in some cases even to a closure of a bank. As noted by Lindquist (2003), a poorly capitalized bank runs the risk of losing its reputation and confidence from customers. Hence, Heid, Porath and Stolz (2003) conclude that banks have a rather strong incentive to obey the rules. To decrease the probability of breaking the rules, banks hold more capital than is required. They hold a "capital buffer" which serves as an insurance against violating the minimum capital requirement. The authors add that the incentive to hold a "capital buffer" increases as the probability of breaking the regulatory minimum increases. For example, the probability of breaking the rules increases with higher capital ratio volatility. Finally, in contrast to the above theories, the "capital buffer theory" predicts that the capital and risk adjustments depend on the size of the capital buffer. The banks with a high capital buffer will try to maintain it on a safe level, while the banks with a small capital buffer are more likely to break the minimum rules, so they will try to increase their capital buffer until it reaches a safe level. Hence, the "capital buffer theory" predicts capital and risk adjustments will be positively related for banks with high capital buffers, while capital and risk adjustments will be negatively related for banks with low capital buffer.

More recently, Jeitschko and Jeung (2004) presented a new unified approach to investigate the relationship between bank risk taking and bank capital. They introduced a model that incorporates the incentives of three agents; the deposit insurer, the manager and the shareholder. Their results show that a bank's risk can either increase or decrease with capitalization. The final effect depends on the relative forces of the three agents.

An increasing number of papers have tried to test the above theories in order to find the empirical relationship between capital and risk adjustments. For a summary of findings we refer to Section 5.4 where we compare our results with the results of other authors.

4. Building a model

In this part we will empirically test the capital and risk behavior of US and EU banks. We will introduce the Shrieves and Dahl simultaneous equations and then we will describe the data and explain why the 2SLS and 3SLS estimation procedures are used.

4.1 Model specification

To our knowledge, we are the first to test and compare the capital and risk behavior of US and EU banks. We base our analysis of US and European banks' capital behavior on the simultaneous equations model developed by Shrieves and Dahl (1992). This model is used to assess how banks react to requirements placed by the regulator on their capital. An important aspect of the model is that it recognizes that changes in both risk and capital have endogenous (i.e. discretionary) and exogenous components. In the model, observed changes in capital and risk levels include the two components: a discretionary adjustment and a change caused by factors exogenous to the bank. When talking about exogenous changes to capital, these can be the result of enforced increases in capital required by regulators or unanticipated changes in earnings caused by fluctuations in income. With respect to risk, exogenous changes include unanticipated shocks to the national or local economy, such as the changing characteristics of a bank loan portfolio or volatility of loan collateral such as real property. Hence, the model looks like:

$$\Delta CAP_{j,t} = \Delta^{d} CAP_{j,t} + E_{j,t} \quad (1)$$

$$\Delta RISK_{j,t} = \Delta^{d} RISK_{j,t} + S_{j,t} \quad (2)$$

where $\Delta \mathrm{CAP}_{j,t}$ and $\Delta \mathrm{RISK}_{j,t}$ are the observed changes in capital and risk levels, respectively, for bank j in period t, the variables $\Delta^{d} \mathrm{CAP}_{j,t}$ and $\Delta^{d} \mathrm{RISK}_{j,t}$ are the discretionary changes in capital and risk while $\mathrm{E}_{j,t}$ and $\mathrm{S}_{j,t}$ are random shocks.

Following Shrieves and Dahl (1992), the discretionary changes in capital and risk, $\Delta^{d} CAP_{j,t}$ and $\Delta^{d} RISK_{j,t}$, are modeled using the partial adjustment framework, thereby recognizing that banks may not be able to adjust their desired capital ratio and risk levels instantaneously. In this framework, the discretionary changes in capital and risk are proportional to the difference between the target levels and the observed levels in period *t*-1:

$$\Delta^{d} CAP_{j,t} = \alpha \ (CAP^{*}_{j,t} - CAP_{j,t-1}) \quad (3)$$

$$\Delta^{d} RISK_{j,t} = \beta \ (RISK^{*}_{j,t} - RISK_{j,t-1}) \quad (4)$$

where $CAP^{*}_{j,t}$ and $RISK^{*}_{j,t}$ are bank *j* 's target capital and risk levels, respectively; α, β are parameters.

Substituting equations (3) and (4) into equations (1) and (2), the observed changes in capital and risk can be written as:

$$\Delta CAP_{j,t} = \alpha \ (CAP^{*}_{j,t} - CAP_{j,t-1}) + E_{j,t} \quad (5)$$

$$\Delta RISK_{j,t} = \beta \ (RISK^{*}_{j,t} - RISK_{j,t-1}) + S_{j,t} \quad (6)$$

This means that the observed changes in capital in period *t* is a function of the target capital in period *t* ($CAP^{*}_{j,t}$), the capital in period *t-1* ($CAP_{j,t-1}$) and random shocks $E_{j,t}$. The observed changes in risk in period *t* is a function of the target risk level in period *t* ($RISK^{*}_{j,t}$), the risk level in period *t-1* ($RISK_{j,t-1}$) and random shocks $S_{j,t}$. The target capital ratio and the risk level are not directly observable, but are assumed to be dependent on some set of observable variables describing the bank's financial condition and the state of the economy in each country. Aggarwal and Jacques (2001) give an example of exogenously determined random shock to the bank that can influence its capital level: a change in the bank´s macroeconomic environment.

4.1.1 Definitions of Capital and Risk

Shrieves and Dahl (1992), Heid, Porath and Stolz (2003), Godlewski (2004) and others used the following definition of capital (CAP); the ratio of total regulatory capital to total assets in book values (RCTA). Total capital represents total regulatory capital. It measures Tier 1 and Tier 2 capital which include subordinated debt, hybrid capital, loan loss reserves and the valuation reserves.

In this study we will follow Jacques and Nigro (1997), Murinde and Yaseen (2004) and others. We will use alternative definition of capital; the ratio of total regulatory capital to risk-weighted assets

(RCRWA). This definition has become more popular since the introduction of risk-weighted assets in Basel accords (see above). As mentioned above, total capital represents total regulatory capital; it includes Tier 1 and Tier 2.

The definition of bank risk (RISK) is quite problematic and the literature suggests a number of alternatives, all of which are subject to some criticism. In this study we opt for the ratio of risk-weighted assets to total assets. This measure is in line with the standard work in this area. It was proposed by Shrieves and Dahl (1992) and used subsequently by Jacques and Nigro (1997), Rime (2001), Aggarwal and Jacques (1997), Heid, Porath and Stolz (2003), Roy (2005b) and many others. The rationale for using this arbitrary measure is that portfolio risk is primarily determined by the allocation of assets across the different risk categories. A clear advantage of RWA, as Rime (2001) suggests, is that it reflects decisions of a bank on risk-taking with appropriate timeliness. Support for this measure can be also found in Avery and Berger (1990). They have shown that this ratio is positively correlated with risky behavior. However, as Rime (2001) notes, the reliance on this indicator supposes that the risk weightings correctly reflect the economic risk of the different asset categories which might not be necessarily valid in practice.

However, it should be pointed out that alternative (and probably even better) measures of risk (such as value at risk, economic capital or the volatility of the market price of bank assets) were not available for the sample banks during the observed period, hence it was not possible to test for robustness of the results with respect to different definitions of risk.

4.1.2 Variables Affecting Changes in Banks' Capital and Risk

The partial adjustment model, presented in equations (5) and (6), predicts that changes in capital in period t are a function of the target capital, the lagged capital and any exogenous factors while changes in risk in period t are a function of the target risk, the lagged risk and any exogenous shocks. In the following section we introduce the possible explanatory variables, which are proxies for the target capital and risk levels, and their expected impact on banks' capital and risk. All these variables have been used by Shrieves and Dahl (1992), with the exception of the profitability indicator, emphasized by Rime (2001) and Roy (2005a), and the year dummy variable, proposed by Heid, Porath and Stolz (2003) and used also by Godlewski (2004) or Roy (2005a). The explanatory variables are bank size (SIZE), profitability indicator (ROA), regulatory pressure (REG), current loan losses (LLOSS), changes in risk (ΔRISK) and capital (ΔCAP) and year dummy variable (dy2001 – dy 2005).

Size (SIZE)

Shrieves and Dahl (1992), Rime (2001) and others state that size may influence target risk and capital levels due to its relationship with risk diversification, the nature of bank investment opportunities or the bank ownership characteristics and access to equity capital. As Shrieves and Dahl (1992) note, "access to equity capital may affect the relative importance of bankruptcy cost avoidance or managerial risk aversion theories". Aggarwal and Jacques (1997) pointed out that larger banks may be willing to hold less capital owing to the fact that they have better ability to increase capital if needed when compared to other banks. In addition, as noted by Roy (2005a), large banks carry out a wider range of activities which should increase their ability to diversify their portfolio, and hence to reduce their credit risk. Thus, we will include the SIZE variable in the capital and in the risk equations to capture size effects. SIZE will be measured as the natural log of bank total assets. SIZE variable is supposed to be inversely related to changes in risk and capital.

Profitability Indicator (ROA)

Rime (2001), Roy (2005a) and others argue that current profits (which are measured here as return on assets, ROA) may have a positive effect on banks' capital as profitable banks may prefer to increase capital through retained earnings than through equity issues. Banks have to rely mainly on retained earnings to increase capital. The bank's return on assets (ROA) is included in the capital equation with an expected positive effect on capital.[4]

Current loan losses (LLOSS)

Loan loss provisions represent funds that banks set aside to cover bad loans. We will follow the definition of Roy (2005b), which was also used, by Aggarwal and Jacques (1997), and approximate these losses (LLOSS) with the ratio of loan loss provisions to total assets. We can consider this ratio as a proxy for asset quality. Banks with lower asset quality (higher LLOSS) are expected to have higher risk. Therefore, we will include LLOSS in the risk equation with an expected positive effect on risk.

Changes in risk (Δ RISK) and capital (ΔCAP)

The theories discussed in Section 3 suppose that capital and risk decisions are interdependent and determined simultaneously which suggests the inclusion of Δ RISK in equation (7) and Δ CAP in equation (8). Following Shrieves and Dahl (1992), we will include these two variables in the right part of the model in order to allow for the different relationships between them. By this inclusion we can find out whether changes in bank capital and asset risk are positively or negatively related one to another (or whether there is no relationship at all). Thus, at the end we can support one of the theory branches mentioned in Section 3.

Table 1: Expected signs of bank characteristic variables

Name of Variable	Change in Capital	Change in Risk
SIZE	-	-
LLOSS		+
ROA	+	
REG	+	?

Year dummy variables (dy2001 – dy 2005)

Heid, Porath and Stolz (2003), Roy (2005b) and others used also year dummy variable to capture further year specific effects. We will include this variable in the risk and capital equation as well. We will cover the five-year period from 2000 to 2005. We will assign a dummy variable for each reference period, except for year 2000 in order to avoid perfect collinearity. These dummy variables are added to the model specification in order to take account of macroeconomic shocks (for example changes in the volume or in the structure of loan demands) that can systematically impact bank capital and credit risk ratios.

4.1.3 Modeling regulatory pressure

The main emphasis of this study is on the regulatory pressure variable (REG). This variable is meant to capture the impact of the Basel capital requirements (the response of banks to the 8 % risk-based capital standard) as it describes the behavior of the banks that fell short of the regulatory standards. Moral hazard theory predicts that a bank approaching the regulatory minimum capital ratio may have an incentive to boost capital and reduce risk in order to avoid the regulatory costs triggered by a breach of the capital requirements. However, others argue that

[4] All the authors predict positive effect of ROA on capital, however Murinde and Yaseen, using exactly the same argument as for example Rime, predict negative coefficient of ROA. See Murinde and Yaseen (2004).

poorly capitalized banks may be tempted to take more risk in the hope that higher expected returns will help them to increase their capital. We expect that regulatory pressure has a positive impact on changes in capital. Its impact on changes in risk is the question.

i) REG –"The simple method"

The regulatory pressure can be evaluated in several ways. Shrieves and Dahl (1992) adopt a simple approach wherein the regulatory pressure variable is unity if the bank´s capital is below the minimum 8 % level and zero otherwise.

ii) REG – "Prompt Corrective Action method"

Aggarwal and Jacques (1997) measure regulatory pressure using a more advanced approach: the Prompt Corrective Action (PCA) that classifies between adequately capitalized and undercapitalized institutions. Within the PCA based approach, they build a first regulatory variable PCAU, which is unity for banks with a CAR less than 8 % and zero otherwise, and a second regulatory pressure variable PCAA, which is unity for banks with CAR comprised of between 8 and 10 % (included), and zero otherwise. To clarify, REG is replaced by two regulatory variables PCAU and PCAA and the following applies:

$$
\begin{aligned}
PCAU &= 1 \quad && \text{if } CAR < 8\ \% \\
&= 0 && \text{otherwise} \\
PCAA &= 1 && \text{if } 8\ \% < CAR < 10\ \% \\
&= 0 && \text{otherwise}
\end{aligned}
$$

iii) REG – "Gap magnitude method"

The previous two methods emphasize one aspect; there is a certain level below which a bank should be regarded as undercapitalized and hence influenced by capital adequacy rules. Some authors such as Roy (2005b) criticize such approaches because they create just a simple dummy variable that is equal to one when capital adequacy ratios are below the stated minimum level and zero otherwise. Godlewski (2004) and others take into account more information. They also take into consideration the second characteristic of supervisory pressure – the magnitude of regulatory pressure experienced by the bank, the gap between the bank's capital ratio and minimum capital level. The need to take this information into account leads us to adopt the use of the following regulatory pressure variable:

$$
\begin{aligned}
REG &= THR - CAR \quad && \text{if } CAR < THR \\
&= 0 && \text{otherwise}
\end{aligned}
$$

where CAR stands for capital adequacy ratio and THR represents the threshold level. This approach was suggested by Roy (2005a) and we will adopt it. We opt THR to represent 8%. Thus, supervisory pressure is positive whenever CAR < 8%, but decreasing as CAR approaches 8% from below. Banks with a CAR above 8% are considered to be unaffected by capital adequacy regulation.

iv) REG – "Advanced gap magnitude method"

Jacques and Nigro (1997) used a more advanced approach. Similar to the PCA approach, the regulatory pressure was divided into two variables (REGA and REGB) in order to recognize that banks with total risk-based capital ratios above and below the 8 % regulatory minimum may react to the standards in different ways.

REGA equals the difference between the inverse of individual bank capital ratio (CAR) and the inverse of the regulatory minimum risk-based ratio of 8 %. Hence, REGA equals (1/CAR– 1/8) for all banks with risk-based ratios of less than or equal to 8 %, and 0 for all banks with a total risk based ratio above the required minimum. This measure is used to recognize the non-linear relationship between the regulatory capital and either change in portfolio risk or capital ratios. These banks are under considerable regulatory pressure to increase their capital ratios as they do not meet the regulatory minimum standards.

REGB measures "distance to default" from above. It equals the difference between the inverse of the regulatory minimum risk-based ratio of 8 % and the inverse of individual bank capital ratio (CAR). Hence, REGB equals (1/8 – 1/CAR) for all banks with risk-based ratios greater than or equal to 8 %, and 0 otherwise. Although banks with capital ratios in excess of 8 % are not explicitly constrained by the regulatory minimum, they may increase their risk of portfolio assets or reduce their capital ratios. Alternatively, as noted by Furlong (1993) or Jacques and Nigro (1997), these banks may increase their capital ratios as a buffer against shocks to equity[5]. Because banks must meet the minimum regulatory standards on a continuous basis, the risk-based standards may cause these banks to increase their capital ratios or decrease portfolio risk as insulation against any uncertainty regarding whether the banks meet the regulatory minimum. In addition, increasing capital ratios and decreasing risk for these banks may serve as a signal to both market and bank regulators that these banks are in compliance.

v) REG – "Capital volatility approach"

This approach to regulatory pressure has one significant advantage when compared to the previous methods. Let us assume that we have two banks, A and B, both having the same capital ratio. The difference is that bank A's capital is more volatile than bank B's capital. Hence, the probability of possible violation of the regulatory minimum is higher for bank A than for bank B, even though both have the same capital buffers. To capture this effect we define regulatory pressure as a dummy variable which is unity if a bank's capital ratio is below the threshold level which is equal to the minimum capital requirement plus one standard deviation of the bank's own capital adequacy ratio, zero otherwise.

$$\begin{aligned} REG &= 1 \qquad \text{if } CAR < (8\ \% + \text{bank-specific standard deviation of } CAR) \\ &= 0 \qquad \text{otherwise} \end{aligned}$$

Although the choice of one standard deviation is somehow arbitrary, the rationale for using this measure is that banks build a buffer above the regulatory minimum for precautionary reasons and the amount of this buffer depends on the volatility of capital ratio, so this approach utilizes more information than previous methods as it utilizes also volatility of CAR. This approach was suggested by Roy (2005b).

Because the regulatory pressure is of our prime interest, we will estimate the model using the last three measures of regulatory pressure, the "Gap magnitude method", the "Advanced gap magnitude method" and finally "Capital volatility approach". Especially the "Advanced gap magnitude method" and "Capital volatility approach" have significant advantages when compared to the simple methods: the "Simple method" and "Gap magnitude method" completely leave out banks that are above the threshold but may get below if their results deteriorate. Those are actually interesting cases. Although under the PCA approach these banks are included (those are defined as banks with CAR between 8 % and 10 %), this approach does not fully utilize the variability of available data as it transforms a continuous variable (CAR) into three groups.

[5] There are also other reasons for which a bank may hold capital above the required minimum, for example Orgler and Taggard discussed tax considerations. Source: Orgler, Y.E. and R.A. Taggard, 1983, Implications of corporate capital structure theory for banking institutions, Journal of Money, Credit and Banking 15, p. 212-221.

The advantage of the "Gap magnitude approach" is that it utilizes the magnitude of pressure, while the advantage of the "Advanced gap magnitude approach" is that it also utilizes information on banks which are above the threshold; it measures distance to default. Last but not least, the "Capital volatility approach" utilizes volatility of CAR.

4.1.4 Specification

On the basis of the previous analysis, the model defined by equations (5) and (6) is specified as follows:

$$\Delta CAP_{j,t} = \alpha_0 + \alpha_1\ REG_{j,t-1} + \alpha_2\ ROA_{j,t} + \alpha_3\ SIZE_{j,t} + \alpha_4\ \Delta RISK_{j,t} + \alpha_5\ CAP_{j,t-1} + \alpha_6\ dy2001 + \ldots + \alpha_9\ dy2005 + \varepsilon_{j,t} \qquad (7)$$

$$\Delta\ RISK_{j,t} = \beta_0 + \beta_1 REG_{j,t-1} + \beta_2 LLOSS_{j,t} + \beta_3 SIZE_{j,t} + \beta_4 \Delta CAP_{j,t} + \beta_5 RISK_{j,t-1} + \beta_6 dy2001 + \ldots + \beta_9\ dy2005 + \upsilon_{j,t} \qquad (8)$$

where REG represents regulatory pressure defined:

(i) under the "Gap magnitude" approach used by Roy (2005) and others as:

$$REG = 8\ \% - CAR \quad \text{if } CAR < 8\ \%$$
$$= 0 \quad \text{otherwise}$$

(ii) the "Advanced gap magnitude" approach used by Jacques and Nigro (1997), REG is replaced by two regulatory pressures variables REGA and REGB and the following applies:

$$REGA = (1/CAR - 1/8) \quad \text{if } CAR \leq 8\ \%$$
$$= 0 \quad \text{otherwise}$$
$$REGB = (1/8 - 1/CAR) \quad \text{if } CAR \geq 8\ \%$$
$$= 0 \quad \text{otherwise}$$

(iii) under the "Capital volatility" approach:

$$REG = 1 \quad \text{if } CAR < (8\ \% + \text{bank-specific standard deviation of } CAR)$$
$$= 0 \quad \text{otherwise}$$

4.2 Data used

Data on the EU 15 and US banks were obtained from BankScope, a database of bank account figures. The database is a joint product of Fitch Ratings (a major rating agency) and Bureau Van Dijk (publisher of financial databases).

Banks that did not report their total capital ratio for at least two consecutive years were omitted from the data set. To obtain a homogenous sample, banks with capital ratio above 100 % were treated as outliers and excluded from the sample. However, those banks that disappeared through mergers and acquisitions do remain part of the sample because their assets and liabilities appear on the balance sheet of the acquiring bank. The figures are measured on a yearly basis which represents the highest periodicity for which data is systematically available.

All the variables used in this study were available on BankScope, except for the RISK variable. Therefore, the total capital level K = (Tier 1 + Tier 2), total assets (A) and the capital adequacy ratio (CAR) was extracted from the database in order to compute the RISK variable in two steps. In the first step risk-weighed assets were calculated (RWA) and in the second step the RISK variable was calculated.

1) $CAR = \frac{K}{RWA}$ then $RWA = \frac{K}{CAR}$

2) $RISK = \frac{RWA}{A}$

The sample consists altogether from 5,323 observations on 1,263 US and EU-15 banks which were in existence between 2000 and 2005.

Table 2: Basic Sample Characteristic

	Number of banks	Number of Observations
EU 15	580	2 116
USA	683	3 207
TOTAL	**1 263**	**5 323**

Source: Own calculations

The following table shows the mean values of the sample for some bank characteristics for both American and European banks for each of the six sub-periods.The table also includes changes in risk and capital.

Table 3: Means of bank characteristics, by year

	2000		2001		2002		2003		2004		2005		Grand average
	EU 15	USA	EU 15	USA	EU 15	USA	EU 15	USA	EU 15	USA	EU 15	USA	
CAR %	14,0	14,7	15,0	15,0	14,9	15,3	15,2	15,2	14,6	15,0	14,5	15,0	14,9
SIZE t	8,1	7,5	7,5	7,6	7,6	7,7	7,8	7,7	8,2	7,9	8,7	7,9	7,8
ROA t	0,7	1,1	0,7	1,1	0,6	1,2	0,8	1,2	0,9	1,2	1,0	1,2	1,0
LLOSS t	0,003	0,003	0,004	0,004	0,004	0,004	0,004	0,003	0,003	0,002	0,001	0,002	0,003
CAP t	14,0	14,7	15,0	15,0	14,9	15,3	15,2	15,2	14,6	15,0	14,5	15,0	14,9
RISK t	0,66	0,67	0,66	0,67	0,66	0,66	0,67	0,67	0,68	0,68	0,63	0,69	0,67
Δ CAP t	-0,05	-0,38	0,98	0,37	-0,08	0,30	0,28	-0,17	-0,53	-0,16	-0,12	-0,03	0,03
Δ RISK t	0,01	0,01	0,00	0,00	0,01	-0,01	0,01	0,01	0,00	0,01	-0,04	0,01	0,00
No. of obs.	352	633	434	612	427	572	431	533	416	450	56	407	

Source: Own calculations

For instance, we can see that average CAR of both US and European banks ranges around 15 %. Although this figure is relatively far above the required 8 % threshold, to make a well-funded statement whether the banks are sufficiently capitalized or not, one would need to run a more thorough analysis including stress tests which is beyond the scope of this paper, nor it is the aim of this study to analyze whether the banks are sufficiently capitalized.

Regarding the development in European banks, in 2000 the average CAR was 13.9% with corresponding risk-weighted ratio of 66 %. Over the period the average CAR has witnesses a small increase to 14.5 % and the risk-weighted assets ratio recording a slight decrease to 63% in

2005. Likewise the average ROA has witnessed an increase from 0.7% in 2000 to 1.0% in 2005 meaning that the profitability of the European banks increased during the examined period.

In the case of US banks, the average CAR ranged between 14.7 and 15.3% and average ROA ranged between 1.1 and 1.2 %. When profitability is measured by ROA, we can conclude that for every year American banks were more profitable than their European counterparties but the difference in profitability diminishes in time. This may be explained also by the fact the average risk-weighted assets ratio of US banks was higher or equal to the risk in EU banks in every year of the examined period. US risk-weighted ratio increased during the examined period from 66%in 2000 to 69% in 2005.

When looking at correlation matrices (not presented in the paper), the correlation matrix is for US banks similar to the matrix for the EU 15 banks. The matrices show a positive correlation between RISK variable and changes in RISK (0.340 for European banks and 0.221 for US banks). This indicates that the riskier banks increase their risk behavior more than other banks. The correlation matrices show that there is a negative size effect on capital for both US and European banks (-0.275 and -0.452 respectively) meaning that large banks hold in general less capital than smaller banks. For a summary of theories explaining this finding we refer to Section 3.1 where we in detail discuss the reasons of negative size effect on capital.

The interesting part here is that we can observe a negative cross sectional correlation between levels of CAP and RISK for both European and US banks (-0.314 and -0.521 respectively). Shrieves and Dahl (1992) argue that the negative correlation between CAP and RISK levels is due to cross-sectional variation in risk preferences: banks with high risk aversion choose high capital ratios and low risk, whereas banks with low risk aversion choose low capital ratios and high risk.

4.3 Methodology

To solve the model, we estimate the system of simultaneous equations defined by (7) and (8) using both, a two–stage least squares (2SLS) procedure and three-stage least-squares (3SLS) procedure. Both techniques are used in order to test for robustness of the results. 2SLS framework allows us to take account of the simultaneity of banks' adjustments in capital and risk. It recognizes the endogeneity of changes in capital and risk, so it is preferable to single equation models that assume either risk or capital to be an exogenous variable to the bank. 2SLS, unlike ordinary least squares (OLS), provides consistent parameter estimates.

3SLS technique also recognizes the endogeneity of changes in capital and risk. Thus, unlike OLS, it provides consistent estimates of the parameters. Moreover, it is preferable to two-stage least squares (2SLS) because 3SLS is a full information technique which estimates all parameters simultaneously. In addition, 3SLS takes into account the cross-equation correlations, so in using this technique we get estimates that are asymptotically more efficient than under 2SLS estimates. However, as noted by Intrilligator (1978), 3SLS may be sensitive to misspecification or measurement errors. This suggests the comparison of the 2SLS and 3SLS results.

2SLS, as the name suggests, is done in two steps. In the first step we estimate the reduced form equations using OLS and save the fitted values for the dependent variables. This step is done to obtain consistent parameter estimates. In the second step we estimate the structural equation using OLS but replace all endogenous variables with their fitted values from the first stage.[6]

3SLS method provides one additional step in the estimation procedure. This extra step allows for non-zero covariance between the error terms. It is asymptotically more efficient than 2SLS since

[6] From the structural equations one can derive the reduced-form equations and the associated reduced form coefficients. A reduced-form equation expresses the endogenous variable solely in terms of exogenous variables and the stochastic disturbances. For the derivation we refer to the Econometric literature listed in References.

the latter ignores any information that may be available as the errors across equations may be correlated (Zellner, 1962).

The 2SLS and 3SLS procedure were run with the SAS software package.

5. Empirical results

Estimation of simultaneous equations (7) and (8) using 2SLS produces essentially the same results as 3SLS. Therefore, the latter is retained for the remainder of the study as the 3SLS estimation method is more efficient.

5.1 "Gap magnitude method" - empirical results

We first present the empirical results for the model based on the "Gap magnitude" approach towards the REG variable. Under this approach, REG is defined as the difference between the regulatory minimum and bank capital adequacy ratio for all bans that were undercapitalized, zero otherwise. The model results are shown in the following table:

Table 4: Results - Gap magnitude approach

Estimation method	EU 15				USA			
Variables	**Δ CAP $_t$**		**Δ RISK $_t$**		**Δ CAP $_t$**		**Δ RISK $_t$**	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
ROA $_t$	0,0979	1,31			0,4481 ***	8,89		
SIZE $_t$	-0,4556 ***	-9,49	-0,0042 ***	-4,71	-0,1365 ***	-3,00	-0,0012 *	-1,67
LLOSS $_t$			2,2580 ***	5,05			0,4504 ***	4,96
REG $_{t-1}$	1,2763 *	1,84	-0,0014	-0,09	2,1363	1,23	-0,0545 *	-1,95
RISK $_{t-1}$			-0,2110 ***	-15,24			-0,1043 ***	-12,09
CAP $_{t-1}$	-0,3726 ***	-19,92			-0,1629 ***	-13,49		
Δ RISK $_t$	11,3001 ***	3,46			23,1693 ***	4,23		
Δ CAP $_t$			0,0005	0,52			0,0023 *	1,89
Dum 2001	0,4801	1,35	-0,0197 ***	-2,76	0,8880 ***	3,69	-0,0155 ***	-4,14
Dum 2002	0,4309	1,21	-0,0182 **	-2,55	1,3464 ***	5,12	-0,0244 ***	-6,29
Dum 2003	0,3291	0,94	-0,0011	-0,16	0,6201 ***	2,63	-0,0063	-1,64
Dum 2004	0,2766	0,78	-0,0054	-0,75	-0,0407	-0,17	0,0031	0,78
Dum 2005	0,7733	1,10	-0,0175	-1,23	0,2251	0,89	0,0056	1,35
Sys.weight. R^2	0,17				0,10			
No. Obs.	2 065				3 172			

*** indicates significance at the 1 % level
** indicates significance at the 5 % level
* indicates significance at the 10 % level

Before analyzing the regulatory pressure and the overall relationship between capital and risk, we discuss the signs of the remaining variables and we start by presenting the results which are essentially the same for both US and EU banks.

Banks with lower asset quality (higher LLOSS) had greater risk. SIZE has a negative and significant impact on capital, indicating that large American and European banks increased their capital less than other banks. One possible explanation is that these banks compete on international markets where they have to face fiercer competition with international banks that are in general less capitalized (Rim, 2001). Roy (2005) states that large banks have easier access to capital markets and therefore they can operate with lower amounts of capital. Alternatively, as noted by Roy (2005) or Lindquist (2003), this may be due to a diversification effect. The argument is that portfolio diversification reduces the probability of experiencing a large drop in the capital ratio. And the diversification increases with bank size. Lindquist (2003) also explains that large banks may feel less regulatory pressure due to a "too big to fail" effect. If large banks expect support from the government in the event of difficulties, while this is not, to the same extent, expected by small banks, we should expect large banks to hold lower capital buffers.

The parameter estimates on lagged capital ratios were negative and significant with the parameter estimates of -0.37 for the EU banks and -0.16 for the US banks. The parameter estimates on lagged risk ratios were also negative and significant (-0.21 for EU banks and - 0.10 for US banks.). In general, these values imply adjustments of bank capital ratios and risk to desired levels. Looking at the amplitude of the estimates we can observe that European banks are quicker in adjustment of both capital and risk to desired levels. The difference between US and European banks is that for the American banks current earnings (ROA) have a significant and positive impact on changes in capital. This means that profitable US banks can more easily increase their capital through retained earnings. The primary purpose of this study was to assess the impact of regulatory pressure on the behavior of banks, especially how it affects banks' risk taking and levels of capital. The problem of the "Gap magnitude approach" and even the "Advanced gap magnitude approach" is the very low number of officially undercapitalized institutions; this may have reduced the reliability of parameter estimates based on this approach. There are just 38 cases in the sample for European banks that actually had capital below the regulatory minimum. This represents just 2 % of the European sample. This problem exaggerates even more for US banks where the results under this approach are driven just by four cases out of 3,172. This problem led us to more advanced approaches to the definition of REG pressure, especially to the "Capital volatility approach" (for the results of which we refer to Section 5.3).

Bearing in mind the mentioned limitation, we have estimated the model for both European and American banks. Surprisingly, for the undercapitalized European banks we get the expected results. The regulatory pressure has a positive and significant impact on capital. This indicates that undercapitalized European banks improve their capital adequacy by increase in their capital. Ceteris paribus, European banks that were under regulatory requirement increased their capital by 1.28 % percentage points more than other banks. However, the risk equation for European banks indicates that regulatory pressure is not significant. This implies that European banks under the threshold do not decrease their risk. Put together, European banks that face regulatory pressure prefer to increase their capital rather than decrease their risk.

On the other hand, the REG estimates obtained for the American banks indicate a "mirror situation"; the regulatory pressure is significant in the risk and not significant in the capital equation[7]. In the risk equation, the regulatory pressure has a negative impact on bank risk taking which indicates that American banks below the regulatory minimum decreased their risk-weighted assets in their portfolio. This means that banks might have shifted their asset portfolio out of heavily weighted risky assets such us corporate bonds into zero weighted riskless assets such as government bonds. Put together, American banks that face regulatory pressure prefer to decrease their risk rather than increase their capital. We can conclude that the regulatory pressure brought about by Basel I standards was effective; undercapitalized European and US banks increased their capital or decreased their risk behavior.

We observe a predominantly positive relationship between changes in capital and risk. Table 4 illustrates that in the case of US banks, an increase of 1 percentage point in capital increased the risk by a very small amount (0.002 percentage point) while a similar increase in risk led to an increase in capital by 23.2 percentage points. In the case of European banks, increase in capital had no significant impact on risk while 1 percentage point increase in risk led to an increase of capital by 11.3. Hence, it appears that both European and US banks raise their risk and capital simultaneously.

[7] This is rather surprising result as the REG variable shows little variability in the US sample as virtually all US observations were above the threshold.

If we look back in Section 3, we find out that this result is consistent with the predictions of Kim and Santomero (1988), Koehn and Santomero (1980), Shrieves and Dahl (1992) and others. Kim and Santomero (1988), Koehn and Santomero (1980) argue that more stringent capital regulation will cause utility, maximizing banks to increase their risk. They state that a forced increase in expensive capital financing reduces the expected rate of return. To counter this, banks try to increase their rate of return by investing into riskier assets. However, our results indicate that additions to capital overcompensate the additions to risk, so the regulatory standards do not have the unintended effect of increasing the probability of bank default. Alternatively Shrieves and Dahl (1992) argue that the positive relationship between changes in risk and capital is consistent with a number of non-mutually exclusive hypotheses, including bankruptcy cost avoidance and managerial risk aversion hypothesis. Finally, the time dummies are significant in the risk equation for 2001 and 2002 for both European and American banks, so we can conclude the existence of further macroeconomic shocks which resulted in decrease of bank risk taking in these two years. Time dummies in the capital equation are all insignificant for the European sample, which suggests that target capital levels were relatively constant across years during the examined period. On the other hand, the target capital levels in the USA increased in 2001, 2002 and 2003.

These first results should be deepened; therefore we turn to the second type of REG definition.

5.2 "Advanced gap magnitude method" - empirical results

The results and conclusions from the "Advanced gap magnitude approach" are similar to the "Gap magnitude approach"; for both US and EU banks we observe similar coefficient estimates and identical signs. For the interpretation of control variables, see the previous section.

Table 5: Results - "Advanced gap magnitude approach"

Estimation method	EU 15						USA					
Variables	Δ **CAP** $_t$			Δ **RISK** $_t$			Δ **CAP** $_t$			Δ **RISK** $_t$		
	Coeff.		t-value	Coeff.		t-value	Coeff.		t-value	Coeff.		t-value
ROA $_t$	0,0535		0,70				0,4646	***	7,67			
SIZE $_t$	-0,4080	***	-8,40	-0,0056	***	-4,55	-0,1419	***	-3,08	-0,0013	*	-1,73
LLOSS $_t$				2,3100	***	5,11				0,4631	***	4,64
REGA $_{t-1}$	54,9098	*	1,93	0,1552		0,27	115,8782		1,26	-3,2284	**	-2,21
REGB $_{t-1}$	39,3652	***	4,04	-0,2583		-1,64	-7,9955		-1,00	-0,0567		-0,48
RISK $_{t-1}$				-0,2173	***	-14,99				-0,1073	***	-10,16
CAP $_{t-1}$	-0,4899	***	-14,03				-0,1407	***	-6,03			
Δ RISK $_t$	9,6567	***	3,02				24,2619	***	4,43			
Δ CAP $_t$				-0,0016		-1,14				0,0016		0,88
Dum 2001	0,5158		1,47	-0,0197	***	-2,83	0,9034	***	3,75	-0,0151	***	-4,00
Dum 2002	0,4594		1,31	-0,0182	***	-2,63	1,3763	***	5,22	-0,0237	***	-5,84
Dum 2003	0,3562		1,04	-0,0007		-0,10	0,6354	***	2,69	-0,0059		-1,49
Dum 2004	0,2464		0,71	-0,0048		-0,69	-0,0330		-0,13	0,0033		0,84
Dum 2005	0,5743		0,83	-0,0151		-1,09	0,2259		0,89	0,0060		1,43
Sys.weight. R^2	0,16						0,10					
No. Obs.	2 065						3 172					

*** indicates significance at the 1 % level
** indicates significance at the 5 % level
* indicates significance at the 10 % level

The added value of this model is the inclusion of the extra regulatory variable REGB that examines the banks that are above the threshold as this variable measures the distance to threshold. We will focus on this extra variable.

For the American banks we observe that REGB has no significant impact on both capital and risk, but the examination of the Table 5 brings rather interesting results for the European banks. The variable REGB is likewise the variable REGA positive and significant in the capital equation. This implies that banks, which had capital ratios in excess of the requirements, behave in the same way as the banks below the threshold; they increase their capital ratios. But the parameter estimate on REGB suggests that banks with capital ratios significantly above the threshold experienced smaller increases in capital than banks that were below the threshold. This means that banks below the threshold want to rebuild their capital while the banks above the threshold want to maintain their capital buffer. This conclusion is consistent with the finding of Haubrich and Wachtel (1993) who suggest that Basel I standards were effective in raising capital ratios of all banks – banks that were below the threshold, but also banks that were already in compliance with the minimum risk based standards. This result may be interpreted as "cautionary behavior". Jacques and Nigro (1997) state that very well capitalized banks have stronger desire to maintain bigger capital buffers, so this is a signal to regulators and the market that they do not only meet, but clearly exceed the minimum standards. Alternatively, Furlong (1993) argues that well capitalized banks may increase their capital ratios because they want to build a buffer against shocks to equity[8]. Because banks must meet the minimum regulatory standards on a continuous basis, these buffers are used as insulation against any uncertainty regarding whether the banks meet the regulatory minimum.

5.3 "Capital volatility approach" - empirical results

We have estimated our model using the "Capital volatility approach". Within this approach, the REG is a dummy variable that is unity if the bank's capital ratio is below the minimum level plus one bank-specific standard deviation, zero otherwise. If REG is defined in this way, we find that there were 271 European cases (13 percent of the EU sample) and 123 American cases (4 percent of the US sample) that were under regulatory pressure.

Table 6: "Capital volatility approach" - results

Estimation method	EU 15				USA			
Variables	Δ **CAP** $_t$		Δ **RISK** $_t$		Δ **CAP** $_t$		Δ **RISK** $_t$	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
ROA $_t$	0,1011	1,36			0,4187 ***	8,68		
SIZE $_t$	-0,4558 ***	-9,48	-0,0042 ***	-4,61	-0,1032 **	-2,28	-0,0015 **	-2,08
LLOSS $_t$			2,2561 ***	5,05			0,4537 ***	4,97
REG $_{t-1}$	0,6683 *	1,96	-0,0013	-0,18	3,1327 ***	7,59	-0,0477 ***	-6,71
RISK $_{t-1}$			-0,2109 ***	-15,18			-0,1029 ***	-11,76
CAP $_{t-1}$	-0,3663 ***	-18,98			-0,1501 ***	-12,93		
Δ RISK $_t$	11,5107 ***	3,52			22,3755 ***	4,24		
Δ CAP $_t$			0,0006	0,54			0,0034 ***	2,65
Dum 2001	0,4683	1,31	-0,0197 ***	-2,76	0,8566 ***	3,64	-0,0159 ***	-4,16
Dum 2002	0,3908	1,10	-0,0181 **	-2,54	1,3273 ***	5,17	-0,0254 ***	-6,43
Dum 2003	0,3125	0,90	-0,0011	-0,15	0,6615 ***	2,86	-0,0076 *	-1,92
Dum 2004	0,2749	0,77	-0,0054	-0,75	-0,0316	-0,13	0,0030	0,73
Dum 2005	0,8317	1,18	-0,0177	-1,24	0,1900	0,77	0,0058	1,38
Sys.weight. R^2	0,17				0,11			
No. Obs.	2 065				3 172			

*** indicates significance at the 1 % level
** indicates significance at the 5 % level
* indicates significance at the 10 % level

8 There are also other reasons for which a bank may hold capital above the required minimum, for example Orgler and Taggard discussed tax considerations. Source: Orgler, Y.E. and R.A. Taggard, 1983, Implications of corporate capital structure theory for banking institutions, Journal of Money, Credit and Banking 15, p. 212-221.

The results of the analysis for the control variables apart from REG variable are materially similar in both capital and risk equations to the "Gap magnitude approach" for both American and European banks. To illustrate, SIZE has a negative impact on capital suggesting that large banks increased their ratio of capital to risk-weighted assets less than other banks, LLOSS has positive and significant impact on risk which means banks with lower asset quality (higher LLOSS) had greater risk. For the case of US banks current profits (ROA) have significant and positive impact on capital indicating that profitable US banks easily improve their capitalization using retained earnings.

Table 6 shows that this approach led to significant estimates of the regulatory pressure in the capital equation for European, but also for US banks. Ceteris paribus, banks within one standard deviation of the threshold increase their capital more than other banks. European banks close to minimum regulatory requirements increased their capital to risk-weighted assets ratio by 0.7 percentage points more than other European banks. When compared to US banks, the impact of regulatory pressure is even greater in the USA. The US banks that were below the minimum requirement plus one standard deviation increased their capital to risk-weighted assets ratio by 3.1 percentage points more than other US banks. Thus, the impact of the regulatory pressure is larger in amplitude for US banks than for EU banks. One possible explanation is that European banks may have greater difficulties in adjusting their capital or that US regulators have a stricter attitude towards undercapitalized banks so that US banks fear breaking the rules more than their European counterparties.

In the risk equation, nothing new occurs; the regulatory pressure has a significant and negative impact only for US banks. I n conclusion, our findings provide basic evidence that Basel I standards have a positive effect on both US and European banks' capital adequacy ratios. Second, if under regulatory pressure, both European and US banks increase their capital. In addition, the US banks also decrease their risk.

5.4 Comparison with other findings

As presented in Section 3.1, theory provides rather rivaling predictions on the relationship between capital and riskiness of banks. As shown in the following table, the empirical studies on the issue do not provide any clear conclusions either.

Table 7: Comparison with other findings

`	Year	Sample and Period	Impact of regulatory pressure on CAP	Impact of regulatory pressure on RISK	Relationship between CAP and RISK
This study	2007	580 European banks and 683 US banks over 6 years (2000 - 2005)	+ for B (EU banks) 0 and + for B (US banks)	0 for B (EU banks) - for B (US banks)	+ for B
Roy	2005	586 banks from G10 (with assets over $100 million) over 8 years (1988-1995)	- and 0 for B	+ and 0 for B	- for B
Murinde and Yassen	2004	98 banks in 11 contries during 8 years (1995-2002)	- and + for B	- and 0 for B	- and 0
Abhiman and Ghosh	2004	27 Indian banks over 7 years (1996-2001	-for B	- for B	- for B
Heid, Porath and Stolz	2003	570 German savings banks over 8 years (1993-2000)	- and 0 for B	+ and 0 for B	0
Rime	2001	154 Swiss banks over 8 years (1989-1996)	0 for A + for U	0 for A 0 for U	0
Aggarwal and Jacques	2001	1,685 US banks (with assets over $100 million) over 6 years (1991-1996)	+ for A in 91 + for U in 91 0 for A in 92 0 for U in 92 0 for A in 93-96 0 for U in 93-96	+ for A in 91 + for U in 91 0 for A in 92 0 for U in 92 - for A in 93-96 - for U in 93-96	+ and - in 91 + and - in 92 + in 93-96
Shrieves and Dahl	1992	1,800 US banks over 3 years (1984-1986)	+ for B	- for B	+ for B

Note: **+** significantly positive, **-** significantly negative, **0** insignificant
A adequately capitalized banks, **U** undercapitalized banks, **B** banks as a whole

Although all of the authors listed in the above table based their analyses of bank behavior to large extent on the Shrieves and Dahl (1992) model, the results and conclusions differ significantly. Our results are similar to the findings of Shrieves and Dahl (1992) who analyzed the behavior of 1,800 US banks over 3 years, from 1984 until 1986, just before the Basel I requirements were implemented. Our results are similar to theirs in the key conclusions: there is a significant positive impact of regulatory pressure on capital and a negative and significant impact on risk levels; changes in risk and capital levels are positively related.

The empirical findings of other research papers go in opposing directions. Table 7 shows that some authors find that regulatory pressure positively influences capital ratios in banks, while others find a negative relationship. When it comes to the impact of regulatory pressure on risk levels, their conclusions also differ considerably. Some authors find a positive relationship while others find a negative relationship. Alternatively, some authors find no relationship. Finally, the conclusions also differ significantly when it comes to the question of the relationship between changes in risk and capital, as already mentioned in Section 3.1.

5.5 Suggestions for future research

We see several ways in which we can improve our research. Firstly, an intertemporal comparison may reveal interesting facts about regulatory pressure. However, analyzed regulatory pressure was under Basel I only, so the next step could be a comparison between Basel I conditions (i.e. until the end of 2006) and Basel II conditions (i.e. since the year 2007).

Secondly, the research can be done on a larger scale so as to include banks outside the EU and the US (i.e. banks from Africa, Asia, Australia, New Zealand etc.).

Thirdly, another methodology for measuring regulatory pressure such as seemingly unrelated regression could be applied (instead of 2SLS and 3SLS methods used in the paper).

Fourthly, we did not differentiate between banks from emerging and mature markets. For example, a comparison among EU-12 and EU-27 banks can convey interesting new results.

Finally, as a proxy for risk we used the ratio of risk-weighted assets to total assets. Other alternative measures of risk (such as value at risk, economic capital or the volatility of the market price of bank assets) can also be used. However, these measures face the challenge of limited data availability.

6. Conclusion

Bank capital requirements play a prominent role in sustaining financial stability. There are different theories that have rivaling predictions about how banks adjust their risk and capital behavior to imposed regulatory constraints. To our knowledge, we are the first to test and compare the capital and risk behavior of US banks and banks from the EU 15 region. Using the freshest data from the 2000–2005 period we have estimated a modified version of the simultaneous equation model developed by Shrieves and Dahl (1992). The model is modified in two main aspects; we use more advanced approaches towards the regulatory pressure and we include also year dummy variable to capture year-specific effects. We find that capital regulation has a significant impact on capital and risk taking for both US and EU 15 banks in several respects. We find that both European and US banks close to the minimum regulatory threshold tend to increase their capital adequacy by increasing their capital. American banks in addition reduce their risk-taking. These findings indicate that expected penalties implied by possible breach of capital obligations have the desired effect on bank behavior and that bank capital regulation is effective in binding excessive risk taking.

Moreover, we find empirical evidence that even well capitalized EU banks try to maintain their capital on a safe level. This may relate to "cautionary behavior". Finally, we observe a positive and significant relationship between capital levels and risk exposure for both US and EU banks. This means that banks raise their risk and capital simultaneously. Hence, we contribute to the literature by providing empirical support to the theories provided by Shrieves and Dahl (1992), Kim and Santomero (1988), Koehn and Santomero (1980) who all predict a positive relationship between risk and capital adjustments.

However, our results indicate that additions to capital over-compensate the increase in risk, so the regulatory standards do not have the unintended effect of increasing the probability of bank default.

7. References

Abhiman, D. and S. Ghosh (2004): The Relationship Between Risk and Capital: Evidence from Indian Public Sector Banks, Industrial Organization 0410006, Economics Working Paper, Archive EconWPA.

Aggarwal, R. and K. Jacques (2001): *The Impact of FDICIA and Prompt Corrective Action on Bank Capital and Risk: Estimates Using Simultaneous Equations Model*, Journal of Banking and Finance 25, pp. 1139-1160.

Avery, R.B. and A. N. Berger (1990): *Risk-based capital and deposit insurance reform*, Working Paper 9101, Federal Reserve Bank of Cleveland.

Barth, J.R., Caprio, G. and R. Levine (2002): Bank *Regulation and Supervision: What Works Best?,* NBER Working Papers 9323, National Bureau of Economic Research, Inc.

Basel Committee (1988): *International Convergence of Capital Measurement and Capital Standards*, Basle: Bank for International Settlement

Basel Committee (1996): *Overview if the Amendment to the Capital Accord to Incorporate Market Risks*, Basle: Bank for International Settlement

Basel Committee (2004): *History of the Basel Committee and its Membership*, Basle: Bank for International Settlement

Basel Committee (2006): *International Convergence of Capital Measurement and Capital Standards, A Revised Framework, Comprehensive Version,* Basle: Bank for International Settlement

Bhattacharya, K. (2003): *How good is the BankScope database? A cross-validation exercise with correction factors for market concentration measures*, BIS Working Papers No. 133

Bichsel, R. and J. Blum (2002): *The Relationship Between Risk and Capital in Swiss Commercial Banks:.A panel study*, Working Paper, Swiss National Bank, Zurich, Switzerland.

Boyd, J.H. and G.D. Nicolo (2003): *Bank Risk Taking and Competition Revisited*, The International Monetary Fund.

Chan-Lau, J. and Sy, A. (2006): *Distance-to-Default in Banking: A Bridge Too Far?*, The International Monetary Fund, Working Paper No. 06/215

Černohorský, J (2002): *Transformace bankovního sektoru. Hospodářská politika v tranzitivních ekonomikách III*, Sborník příspěvků z mezinárodního vědeckého semináře, Ekonomická fakulta VŠB-TU v Ostravě, Ostrava, Czech Republic

Feess, E. and U. Hege (2004): *The Basel II Accord: Internal Ratings and Bank Differentiation*, CFS Working Paper Series 2004/25, Center for Financial Studies

Georges, D. and T.M. Harchaoui (2003): *Banks' Capital, Securitization and Credit Risk: An Empirical for Canada*, Cahiers de recherche 0311, CIRPEE

Godlewski, C. (2004): *Capital Regulation and Credit Risk Taking: Empirical Evidence from Banks in Emerging Market Economies*, Finance 0409030, Economics Working Paper Archive EconWPA

Gujarati, D. (2002): *Basic Econometrics*, 4th International Edition, McGraw-Hill international editions, Boston, MA, USA

Hajko, A. (2004): Kapitálová primeranosť v obchodných bankách, Ekonomická univerzita v Bratislave, Bratislava, Slovakia

Hakenes, H. and I. Schnabel (2005): *Bank Size and Risk-Taking under Basel II*, Working Paper Series of the Max Planck Institute for Research on Collective Goods 2005_6, Max Planck Institute for Research on Collective Goods

Heid, F., D. Porath and S. Stolz (2003): *Does Capital Regulation Matter for Bank Behavior? Evidence for German savings banks*, Working Papers 1192, Kiel Institute for World Economics

Illing, M. and G. Paulinv (2004): *The New Basel Capital Accord and the Cyclical Behaviour of Bank Capital*, Working Papers 04-30, Bank of Canada.

Intrilligator, M.D. (1978): *Econometric Models Techniques and Applications*, Prentice-Hall, Englewood Cliffs, NJ, USA

Jacobson, J.T. and K. R. Lindé (2004): *Credit Risk Versus Capital Requirements Under Basel II:Are SME Loans and Retail Credit Really Di Erent?*, Departmental Working Papers 199, Tor Vergata University, CEIS.

Jacques, K. and P. Nigro (1997): *Risk-Based Capital, Portfolio Risk, and Bank Capital: A Simultaneous Equations Approach*, Journal of Economics and Business 49, pp. 533-547

Jesper Tor Jacobson & Kasper Roszbach Lindé (2004): *Credit Risk Versus Capital Requirements Under Basel II: Are SME Loans and Retail Credit Really Di Erent*?, Departmental Working Papers 199, Tor Vergata University, CEIS

Keating, C., H. S. Shin, F. Muennich, C. Goodhart and J. Danielsson (2001): *An AcademicResponse to Basel II*, FMG Special Papers sp130, Financial Markets Group.

Koehn, M., A. M. Santomero (1980): *Regulation of bank capital and portfolio risk*, Journal of Finance 35, pp. 1235-1244.

Kraeussl, R. (2003): *A Critique on the Proposed Use of External Sovereign Credit Ratings in Basel II*, CFS Working Paper Series 2003/23, Center for Financial Studies.

Lindquist, K.-G. (2003): *Banks' buffer capital: How important is risk*, Central Bank of Norway, Norway.

Maddala, M. (2001): *Introduction to Econometrics*, 3rd edition, John Wiley and Sons, Hoboken, NJ, USA

Majnoni, G., L.-G. Liu and F. Giovanni (2000): *How the proposd Basel Guidelines on rating-agency assessments would affect developing countries*, Policy Research Working Paper Series 2369, The World Bank

Marcus, A. J. (1983): *The bank capital decision: A time series cross-section analysis*, Journal of Finance 38, pp. 1217-1232.

Matejašák M. (2006): *Regulation of Bank Capital and Behavior of Banks Assessing the Slovak Banks, 2000-2004*, Master Thesis, Umeå School of Business and Economics, Umeå University, Sweden

Matejašák, M. (2007): *Regulation of Bank Capital and Behavior of Banks: Assessing the US and the EU-15 region Banks in the 2000-2005 period*, Master Thesis, Institute of Economic Studies, Faculty of Social Science, Charles Unioversity in Prague, Czech Republic

Murinde, V. and H. Yaseen (2004): *The Impact of Basle Accord Regulations on Bank Capital and Risk Behaviour: 3D Evidence from the Middle East and North Africa (MENA) Region*, University of Birmingham

Pelizzon, L. and S. Schaefer (2005): *Pillar 1 vs. Pillar 2 Under Risk Management*, NBER Working Papers 11666, National Bureau of Economic Research, Inc.

Powell, A. (2004): *Basel II and developing countries: Sailing through the sea of standards*, Policy Research Working Paper Series 3387, The World Bank

Prescott, E.S. (2004): *Auditing And Bank Capital Regulation*, Working Papers wp2004_0412, CEMFI

Revenda, Z. (1999): *Centrální bankovnictví*, Management Press, Praha, Czech Republic.

Rime, B. (2001): *Capital Requirements and Bank Behavior: Empirical Evidence of Switzerland*, Journal of Banking and Finance 25, pp. 789-805

Roy, P.V. (2005a): *Credit ratings and the standardised approach to credit risk in Basel II*, Finance 0509014, Economics Working Paper Archive EconWPA

Roy, P.V. (2005b): *The impact of the 1988 Basel Accord on banks' capital ratios and credit risk-taking:. an international study*, Finance 0509013, Economics Working Paper Archive EconWPA

Santos, J.A.C. (2000): *Bank capital regulation in contemporary banking theory: a review of the.literature*,.BIS Working papers 90, Bank for International Settlements.

Shrieves, R. E. and D. Dahl (1992): *The relationship between risk and capital in commercial banks*, Journal of Banking and Finance 16, pp.439-457

Osúch, M. (2004): *Kapitálová primeranosť bánk a bazilejské dohody*, Ekonomická univerzita v Bratislave, Bratislava, Slovakia.

Teplá, L. (2003): *Regulatorní rámec a očekávané trendy bankovního sektoru ČR. In Mena, bankovníctvo, finančné trhy,* Zborník abstraktů z medzinárodnej konverencie. Ekonomická univerzita v Bratislave, Bratislava, Slovakia.

Teplý, P. (2006): *Regulatory Risk and Issues of Basel II in Central European Economies*, Presentation at Massey University, Palmerston North, New Zealand

Teplý, P., Černohorská L., Diviš K. (2007): *Implications of the New Basel Capital Accord for European Banks* , E+M Journal, Czech Republic, 2, pp.

Ullah, A., A. Wan and T.K. Chaturvedi (2002): *Handbook of applied econometrics and statistical inference*, 1st edition, Marcel Dekker, New York, USA.

Woolbridge, J.M. (2003): *Introductory Econometrics – A Modern Approach*, 2nd edition, South-Western/Thomson Learning, Ohio, USA

Wyatt, K. (2003): *Basel II's New Standardized Approach: Possible Effects of Implementation*, Finance 0304010, Economics Working Paper Archive EconWPA.

Zellner, A. (1962): *An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias*, J. Amer. Statist. Assoc. 57, p. 348–368.

Zicchino, L. (2005): *A model of bank capital, lending and the macro economy: Basel I versus Basel II*, Bank of England working papers 270, Bank of England

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