DO THE BASEL ACCORDS HAVE THE DESIRED EFFECT?

An investigation on the effects of capital requirements on banks' risk-taking

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Abstract

This research tries to develop an answer to the question if the Basel Accords in the form of increased capital requirements have led banks to decrease the level of risk they take. As this is not a straightforward question to answer, the origin of the Basel Accords and the drivers of the level of risk a bank takes are investigated. This last element is executed by constructing a panel data set of 250 European banks over a period of 12 years; 2004 – 2015. Different regression analyses were performed on both the level of asset and credit risk a bank takes. A fixed effects estimator and LSDV estimator are used in order to come to robust findings. The strongest finding is that capital has a negative effect on the level of asset risk a bank takes. Thus, the Basel Accords, in the form of higher capital requirements do have the desired effect.

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Chapter 1: Introduction

The Basel Accords are a hot topic for public discussions throughout Europe. Will the extensions on Basel III, some even call it Basel IV, lead to more stringent capital requirements for European banks? Where these negotiations are normally held without much public attention, now all supervisory bodies seem concerned with the outcomes and implications. Sabine Lautenschläger (ECB board member) stated that "banks are way better capitalized than before the crisis of 2008" (Börsen Zeitung, 30/9/2016), so why do we need more capital requirements? This thesis investigates whether the Basel Committee is on the right track by imposing increasingly higher capital requirements to prevent future crises from happening.

If we take one step back it is important to ask why the Basel Accords were initiated in the first place. The discussions started in 1974 after the collapse of the Herstatt Bank in Germany and the Franklin National Bank in the US and every time banks failed or a crisis occurred, requirements were revised. This gives rise to the impression that capital requirements, in the form of strict capital buffers, are introduced in order to prevent large bank failures or crises from happening again. But do these rules and requirements actually contribute to a healthier financial system? If they do, then banks should take on less risk if faced with higher capital requirements. This is the main thought driving this thesis and defined in the following main research question:

Following increased capital regulations imposed by the Basel committee and national regulators, do banks actually take on less risk following stricter capital demands?

Naturally, there is no straightforward answer to this question. In order to structure this research and reach a proper answer to the main research question, three other research questions are introduced:

I. What is the history of the Basel Accords?
II. What drives regulators to increase capital demands?
III. What drives the level of capital a bank holds?
IV. What drives the level of risk a bank takes?

A lot of research has already been done on the history and implications of capital requirements, both theoretically and empirically. Chapter 2 contains an outline of the research that already has been done and lays a theoretical groundwork for the chapters following. It is found that research

is hugely divided on the implications of capital requirements. Calem and Rob (1998) even find a U-shaped relationship between capital and the level of risk a bank takes. Banks closer to the minimal requirements take on less risk whereas banks further away from the minimum take on more risk. Chapter 2 also sheds a light on the history and drivers of the Basel Accords and explains the hypotheses formed in this research.

Chapter 3 elaborates on the methods used to construct the dataset, the chosen models and variables included in the research. Moreover, different analyses test the possible drivers of the variance in total assets of banks and the net loans-to-asset ratio as proxies of asset, respectively credit risk a bank takes. The results of these analyses are shown in chapter 4 whereas chapter 5 will conclude the research with findings, concluding remarks and possibilities for future research.

Chapter 2: Literature Review

Two interesting effects of increased capital regulation are discussed in depth in this section. On the one hand, what does earlier research teach about the effect of increased capital regulation on the level of capital of banks? On the other hand, what does earlier research tell us about the effect of increased capital regulation on the risk taking within banks? As it is one of the desired effects of the Basel Accords to influence the response of banks in this perspective, it is also one of the main drivers of this research. Do banks actually take on less risk in their portfolio after new capital regulation is set in motion? The first paragraph of this chapter elaborates on the development of the Basel Accords, the fundament for capital requirements. The second and third paragraphs dive into earlier research on the determinants of the level of capital banks hold and the level of risk a bank takes, respectively. Paragraph 2.4 concludes this chapter with the hypotheses that drive the research.

2.1 Basel Accords

1974 marked a year in which two large international banks, the Herstatt Bank in Germany and the Franklin National Bank in the US, collapsed. This event triggered monetary authorities and policy makers to start thinking about a new framework of rules adapted to the modern banking system (Jablecki, 2009). This modern banking system was formed by increased globalism resulting in more cross-border activity in banking and integration of financial markets. Consequently, the aforementioned authorities[1] formed the Basel Committee on Banking Supervision under the supervision of the Bank of International Settlements in Switzerland. The main role of the Committee was to encourage the harmonization of regulatory standards throughout the world. Thus, not only form a regulatory framework in order to ensure efficient supervision of the modern banking sector, but also to align frameworks worldwide and have all banks comply to the same rules hence facing similar costs (Jablecki, 2009). Moreover, the rules are not only used to deal with the effects of globalism, but also to promote globalism and competition among banks.

The first actual contribution of the Basel Committee was the introduction of the Basel Accord in 1988. This is known as and henceforth referred to as Basel I. The main goal of this first accord was to require banks to maintain enough capital to absorb losses without causing systemic problems and to level the playing field internationally (Blundell & Atkinson, 2010). The main

[1] Central bank governors from G10 countries in cooperation with the monetary authorities of Luxembourg and Switzerland

standard on which the first Basel Accord was based is known as the Basel capital ratio, presenting the relation between the level of capital and risk-weighted assets of banks:

$$Basel\ Capital\ Ratio = \frac{Capital}{Risk\ Weighted\ Assets} \qquad (Eq.\ 1)$$

Around this capital ratio, a supervisory framework was set up which required all international banks to maintain a minimum Basel capital ratio. The level of capital is comprised of tier 1 and tier 2 capital, where tier 1 capital (or core capital) is defined as basic equity and disclosed reserves and tier 2 capital contains all the other forms of capital. The first Basel Accord requires banks to maintain a level of tier 1 and tier 2 capital of no less than 8% in relationship to their risk-weighted assets (Blundell & Atkinson, 2010). The denominator of the term above is defined as the assets of a bank weighed by risk, according to the Basel committee. Basel I groups all assets in five different types, according to the risk these asset types carry.

The period following the Basel I accord was a period in which bank capital ratios increased. Jablecki (2009) used data collected by De Nederlandsche Bank of a group of 29 OECD countries. It showed that capital-to-asset ratios increased from 8.5% to 12%. De Bondt & Prast (2000) also find an increase in the capital-to-asset ratios of banks within a group of G10 countries. But what were the drivers of these increases? Banks can, naturally, improve their capital ratio by either increasing the level of capital or lowering their risk-weighted assets. And it seems that, at least in the US, part of the increase seemed to be attributable to lowering the denominator in the capital ratios (Jablecki, 2009). This is driven mostly by the effects of securitization: the phenomenon of banks taking their assets off the balance sheets by pooling them and selling these groups of assets to a separate entity. By doing this, the level of capital needed is lowered without lowering the actual risk a bank is taking.

A different stream of research focuses on the alleged effects of the Basel I capital framework on a so-called ‘credit crunch’ and a following economic slowdown. This ‘credit crunch’ could be the result of banks shifting away their assets to government securities as a response to the demands of Basel I. For example, lower risk weights were applied to government securities than to home mortgages for example, which could explain the shift. However, such a shift could have large macroeconomic implications. It is found that American banks significantly increased their holdings of government securities (Haubrich & Wachtel, 1993). Hall (1993) also presents evidence

that banks decreased the level of their loans in the years following 1988. These studies go as far as contributing the economic slowdown to this 'credit crunch'. However, Berger & Udell (1994) do not find that the introduction of risk-based levels of capital caused the decrease in credit followed by economic slowdown. According to their study, it could also be caused by a natural shift away from debt demand or because banks naturally and voluntarily lower their risk exposure. Conclusively, it seems safe to assume that the decrease in credit is caused by a combination of all the above.

A proper new policy to supervise banks is not written in a day, and certainly not in one version of the Basel Accords. As mentioned above, the risk-weighting of assets happened in a one-size-fits-all way by assigning weights to asset types. With this method, specific asset quality is not taken into account. After all, not every mortgage carries the same risk for a bank. So, the main revision made by the Basel Committee in order to get to version two was to introduce risk-based capital requirements. These new regulations came into force in 2007.

These requirements were introduced via an IRB (internal-ratings-based) approach. According to this approach, assets weights are based on four parameters[2] which could be provided by the internal models of the banks (Kashyap & Stein, 2003). Banks could also choose for the 'light' version, where only the probability of default of an asset should be provided and the other parameters would be set by the Basel Committee. Since these internal ratings are more extensive, they align the regulatory required capital better with the economic risks a bank takes in its assets, reducing the arbitrage opportunities mentioned before (Heid, 2007). However, light was shed on a new matter: possible pro-cyclicality issues with the new regulations.

These issues arise when, in an economic downturn, the number of asset defaults of banks increase. In turn, this leads to probabilities of default (one of the four parameters) going up as well and consequently banks, via the risk-based capital system, should hold higher levels of capital in order to reach the minimum requirements. As can be reasoned, a higher level of capital means that a bank can set out lower levels of credit and so worsening the economic downturn.

Policy makers initiated talks concerning a possible third version of the Basel Accords to fend off these unwanted developments. These talks were, naturally, enforced by the banking crisis and

[2] Probability of default, loss given default, exposure at default and maturity

recession we are in since 2008. As a response to the crisis, Basel III forms an extension of Basel I and II, in the sense that the minimum requirement for tier 1 capital was raised, together with the introduction of the so-called capital conservation buffer. This last buffer requires banks to hold a buffer of 2.5% over risk-weighted assets, on top of the minimum requirements. If a bank falls within this range of 2.5% on top of the minimum requirements, the bank will face constraints for its capital distribution. With the possible pro-cyclicality issues mentioned before, the Basel Committee introduced the countercyclical buffer. This buffer can be set in the range between 0% and 2.5% of common equity and can be set, nationally, in periods with high credit growth in order to attack the possible negative effects of pro-cyclicality in periods with slow credit growth. It is hard to already draw conclusions regarding the effects of Basel III, since banks are in the middle of preparing themselves for the planned implementation in 2019. According to Cosimano & Hakura (2011), however, large banks would on average need to increase their equity-to-asset ratio by 1.3 percentage points in response to Basel III. Because this increase is at the cost of something, estimations indicate that large banks would increase their lending rates by 16 basis points resulting in a decline in loan growth. Albeit difficult to draw conclusions from the scarce data available, Angelini et. al. (2015) find that every percentage point increase in the capital ratio causes a median 0.09% decline in the level of steady state (long-term) production output. This implies a significant long-term impact of the Basel Accords. However, a lot of research still has to be done and data still has to become available in order to draw strong conclusions.

The next section discusses the theoretical and empirical literature regarding the effect of capital requirements on the level of capital banks hold and risk a bank takes. What determines the level of risk a bank holds? Do increased capital requirements have an effect on the risk a bank will take in the future? These are questions discussed in the upcoming paragraph and further chapters.

2.2 Level of capital

Regarding the level of capital, the earliest literature is of empirical nature rather than theoretical. The large majority of the literature concludes that banks respond to increased capital requirements by increasing their level of capital and not by selling assets or retiring debt. Sheldon (1996) finds that the level of the capital to asset ratio goes up with increased capital requirements. In line with Sheldon (1996), Rime (2001) finds an increased level of capital with increased regulations for Swiss banks. This effect is stronger for banks relatively close to the regulatory minimum level of

capital, which seems logical, since they are closing in on receiving penalties. These penalties are comprised of the regulatory costs which are triggered if a breach of the capital requirements is reached by a bank. These costs are either related to market discipline, or related to supervisory intervention. Moreover, banks hold capital to insure themselves against the costs of getting too close to the regulatory minimum. On a more general level, undercapitalized banks tend to raise new equity after new regulatory requirements are installed (Jackson et. al., 1999). Regarding the UK banking sector, banks tend to reach the necessary adjustments of their capital ratio by boosting their capital rather than a shift away from high risk-weighted assets (Ediz et. al., 1998). However, these researches do not necessarily conclude if these effects are the one-on-one result of capital requirements or if market pressure plays a role as well.

As Basel III aims to address the pro-cyclicality of capital, it is of great interest to examine this pro-cyclicality of capital within banks. In earlier literature, cyclical effects on capital are found. For Spanish banks, a clear negative relationship between the level of capital and the phase of the economic cycle is found (Ayuso et. al., 2004), implying pro-cyclicality of capital regulations. However, limited evidence is found for pro-cyclicality in a cross-country analysis by Bikker & Metzemakers (2004). Assuming that capital regulations are tightened as a result of bad economic times, these results imply that the level of capital is raised in times where capital regulations might increase. It is however hard to align this evidence of pro-cyclicality with increased level of capital, because of increased regulation. Other factors may play a role as well. Thus, more research is needed to investigate this, whereas this thesis will focus on the determinants of risk.

2.3 Level of risk

As mentioned before, early research on the effect of capital regulation on the risk taking of banks is rather divided. The first group of researchers chose a model where bankers choose the composition of their portfolios, in order to maximize the expected profit for a given level of risk (Koehn & Santomero, 1980). Under the assumption that bankers are risk-averse and maximize a utility function of the bank's financial net wealth, it is concluded that an introduction of flat capital requirements may lead to an increase in the bank's probability of failure (Kim & Santomero, 1988), and thus induce the level of risk they are taking. The rationale behind this conclusion is that banks incur losses in their utility because of the reduction in leverage imposed by the capital requirement.

They wish to compensate this tightening by holding a riskier portfolio, in order to reach the same returns as before.

In their reexamination of the analyses mentioned above, Keeley & Furlong (1990) came to a rather different conclusion. They challenge the assumptions made by Koehn & Santomero (1980) and find several omissions in this theoretical model. Therefore, they conclude that this specific model is not suitable for analyzing the effects of capital regulation on asset risk. Furlong & Keeley (1989) examine a model in which banks are assumed to be value-maximizing, as opposed to utility-maximizing before. This means that managers will always act to maximize the value for shareholders. They find that more stringent capital regulation, and thus a higher capital ratio, does not lead banks to take on more asset risk. The case is even made for banks lowering their asset risk following more stringent capital requirements, which is in line with the goals of regulators imposing capital requirements; the same (or a lower) level of risk taking of banks combined with a stronger position in capital.

Adding to the above, a third stream in literature can be found. This stream follows the belief that capital regulation in itself is not enough to control the risk that banks are taking (Rochet, 1992). According to Rochet, additional regulation is needed in the form of at least the inclusion of correct risk weights on assets as opposed to the flat rated equity requirements of before. In examining the effects of different regulatory measures, Crouhy & Galai (1991) find that reserve requirements[3] alone should not affect the activities of banks in an efficient market. Earlier, Karaken & Wallace (1978) find that capital regulations in itself do nothing to prevent bankruptcies.

Findings from the aforementioned literature imply an ambiguous relationship between higher capital and bank risk-taking. On the one hand, theoretical analysis shows that banks increase their risk-taking and even their probability of failure with increased capital requirements. On the other hand, value-maximizing banks are found to decrease their risk-taking if faced with higher capital requirements. The research that combines these views and the research that forms the fundament of this thesis, is that of Calem & Rob (1998). They find a U-shaped relationship between capital and risk-taking. As a bank's level of capital increases, it first takes on less risk. With holding more capital a bank starts to increase its risk taking again. One conclusion in the light of newly required

[3] Either liquidity or capital reserves

capital requirements is that under-capitalized banks will take less risk if faced with higher capital requirements and well-capitalized banks will take more risk if faced with higher capital requirements.

Since economic theory seems rather unclear and inconclusive on whether increasing capital requirements lead to banks increasing or decreasing their asset risk, more empirical research is needed in order to reach conclusions. Most of the empirical research so far finds that the impact of capital regulation on bank risk taking is either inconclusive (Jackson et. al., 1999) or tends to a negative effect on risk taking (Berger et. al., 1995). In their study of the timing of bank failures, Cole & Gunther (1995) find that banks with higher levels of capital have a higher chance of survival. Next to the positive effect of capital buffers on the chance of survival, this also might imply that an increase in the capital requirements can be associated with lower levels of risk taking. Plenty of research has also been done concerning the impact of capital requirements during special economic conditions, as during credit crunches. Furfine (2001) finds that increased capital requirements during a credit crunch lead to a reduction in loan growth and an increase in securities invested in as opposed to riskier investments. On a country-specific level there are some notable empirical results as well. In the UK, banks do not substitute their assets from high risk-weighted assets to lower risk-weighted assets as they approach the regulatory minimum (Ediz et al., 1998). This implies that banks do not decrease their asset risk as they approach the minimum. Moreover, banks do not decrease their risk taking as a result of regulatory pressure according to the research that Rime (2001) performed in Switzerland. Hancock & Wilcox (1994) even find that banks falling short of capital requirements shift away from low-risk assets to high-risk assets.

As the research of Calem & Rob (1998) is an analysis based on theoretical models, the effects of increased capital regulations on the level of capital on an the level of risk taking of banks will be empirically investigated. Moreover, since most of earlier research, especially the theoretical analyses, is focused on banks in the United States, this research focuses on banks in Europe. Additional to this, the focus on banks in Europe results from the interest in the effectiveness of central regulations. Do the Basel Accords work the way they are intended to? Will banks take less risk and will banking crises be avoided or lessened in magnitude in the future? This research aims to find an answer to these questions.

2.4 Hypothesis development

H_1 *The higher the capital-to-asset ratio, the smaller the portfolio of risky assets invested in by European banks.*

This hypothesis is derived from the clear inconclusiveness on the effect of a higher level of capital on the level of risk a bank takes. The theoretical analysis of Kim & Santomero (1988) finds that an introduction of capital requirements increases the level of risk a bank, which is strengthened by the empirical research of Hancock & Wilcox (1994). Keeley & Furlong (1990) however find that banks might lower their risk facing more strict capital requirements. This is enforced by most empirical literature (Berger et. al., 1995, Cole & Gunther, 1995). In this research, this more common sense approach is followed. Thus, my hypothesis is that capital regulations do have a desired effect.

H_2 *If faced with higher capital requirements, undercapitalized European banks will decrease their portfolio of risky assets whereas well capitalized European banks will increase their portfolio of risky assets.*

This hypothesis is derived from the research of Calem & Rob (1998), who argued that the relationship between capital requirements and risk-taking is U-shaped. Their research focused on banks from the United States and this research hypothesizes that this conclusion also holds for European banks.

H_3 *Large banks react differently on increased capital requirements than smaller banks.*

Most theoretical research does not diversify on size. Hakenes & Schnabel (2011) find that, if faced with a choice, large banks have a competitive advantage pushing small banks to take on more risk. This implies that switching costs are higher for small banks and therefore induce these banks to take on more risks if faced with a choice to switch between risk weighing systems[4]. Moreover, small banks have a lower level of diversification than large banks (Demsetz & Strahan, 1997). This implies that small banks react more extreme than large banks to higher capital requirements and that small banks may take on more risk if faced with higher requirements.

[4] Basel II implied that banks had a choice between internal ratings and fixed ratings to determine the level of capital a bank is required to hold

Chapter 3: Research Methods

This chapter discusses the constructed data set and the methods used in order to test the hypotheses stated before and to discover the drivers risk of banks.

3.1 Data selection

In order to evaluate the effect of increased capital regulation on the level of capital a bank holds and the level of risk a bank takes, a dataset comprised of information on financial statements of banks is retrieved from Bankscope, the database concerning banks of Bureau van Dijk. Only banks from within the European Union are included in the dataset. To start, data from the period 2000 – 2015 was included. However, this dataset consisted of a large number of missing values in the first four years. Therefore, data from the first four years (2000 – 2003) are left out of the dataset in order to make it stronger. Continuing with a set of banks in the period between 2004 – 2015, different filters were used in order to clean the dataset. Only banks with an ISIN number were included, which means that unlisted and inactive banks were left out of the research. This, in order to increase the availability and reliability of the data. Conclusively and after applying these filters, the research is continued with a panel dataset comprised of 250 European banks over a period of 12 years, between 2004 – 2015.

3.2 Methodology

The first paragraph of this section discusses the different analyses done in order to capture the effects of different variables on the level of risk a bank takes. In paragraph 3.2.2. the actual regression equations and different models used are discussed.

3.2.1. Independent variables

This research focuses on two different sorts of risk, asset risk and credit risk. The majority of early literature takes asset risk as the variable in its research. Moreover, the Basel Committee weighs different asset classes by their level of risk. The level of asset risk of a bank can be measured by the volatility of bank portfolios (Sheldon, 1996). Therefore, the first regression analysis uses this volatility as a dependent variable. One can also use credit risk in order to measure the level of risk a bank is taking. For example, the ratio of non-performing loans to total loans (Ayuso et. al., 2004) is used in early literature as a measure of credit risk. A loan is non-performing if the terms are not reached in time by the respective creditor. A higher ratio means higher credit risk for a bank. Also the loan-loss provisions over total assets is used in earlier literature in order to measure the level of credit risk a bank is taking, for example by Stoltz & Medow (2005). Because the non-availability

of a full dataset regarding these variables, this thesis employs the level of net loans over total assets as risk measure as used by Jokipii & Milne (2006). A third way to measure risk is the probability of failure of a bank. Rochet (1992) finds that increased capital leads to an increased probability of failure of banks. On the other hand, Admati et. al. (2010) find that higher capital requirements lower the risk of bank bankruptcies. However, since this variable is not straightforward to measure, the research will be restricted to the level of asset and credit risk of a bank.

As seen in the analysis on the capital ratio and the level of capital, the independent variables can be classified in internal bank related measures, macroeconomic measures and controls. In the asset risk analysis, risk-weighted assets are included as independent variable. The risk-weighted assets are used as a measure of risky assets, which are negatively related to bank survival (Cole & Gunther, 2005). This negative relationship implies that the level of risk-weighted assets positively influences the level of risk-taking of a bank. Next to this, the level of loans will be added to the analysis as an independent variable. Cole & Gunther (2005) find that the level of loans is also negatively related to bank survival, thus implying a positive relationship with the level of risk-taking of a bank. Next to these risk-related variables, the level of total assets is added to the analysis as a measure of bank size. In the research of Cole & Gunther (2005), it is found that asset size is positively related to bank survival. This implies a negative relationship with the level of risk a bank takes since risk is adversely related with bank survival. As for the level of capital, which is also included in this research, the distance from the regulatory minimum is used. Since undercapitalized banks might lower their risk-taking whereas well-capitalized banks might increase their risk-taking (Calem & Rob, 1999) this variable is expected to be positively related. To be able to include bank performance in the analysis, return on average assets (ROAA) and net income are included. The ROAA is used in the research of Rime (2001) as a measure of current profits and net income by Cole & Gunther (2005), which is found to be positively related to bank survival, implying a lowering effect on risk-taking.

The independent variables were included separately into the regressions, as can be seen in chapter 4. Moreover, different regressions were run on the same dependent variable. This is done to verify that the sign and level of significance do not alter as a result of possible multicollinearity. As chapter 4 shows, not all variables were included, this because of collinearity problems.

Additionally, all variables measured in currency were included as their natural logarithms. This was done in order to smoothen the results, meaning not to have extreme coefficient values.

3.2.2. Models

This paragraph serves as a clear overview of the different analyses executed on the panel dataset. Two dependent variables (asset and credit risk) are subjected to regression analyses using different independent variables chosen based on earlier research.

Generally, the regression analyses on the panel dataset of banks take the following form:

$$y_{it} = X'_{it}\beta + \propto_i + u_{it} \; for \; i = 1, .., N \; and \; t = 1, \dots, T \qquad (Eq. 2)$$

Where *y* represents the dependent variable and *X'* is the vector term for all the regressors, or independent variables. Alpha represents the time-invariant individual effect and *u* represents the error term. There are two different subscripts present in the formula above, *i* stands for the individual bank observed at time *t*. The alpha is unobservable in this model and therefore clouds the results of the regression analysis, nor can it be controlled for. But since this is a panel data set, different models are used.

Firstly, an estimator was chosen with fixed effects since the sample is constructed with 250 different banks. Therefore it is needed to account for possible fixed effects among banks. A pooled OLS regression was considered as well, however a F-test was, in all regressions, in clear favor of the fixed effects OLS regression since the P-value is 0.000. Year dummies were added to capture time trends or to account for specific events like the financial crisis. The results from these regressions are presented in chapter 4, Table 1 and 3.

Secondly, a robustness check was executed, performing the same analysis using a LSDV estimator. This estimator can be used, since the data set in this research is relatively short, meaning that it contains more banks than time periods. This estimator adds company dummies to the regressions and returns results for time invariant variables, which is not done by the previous fixed effects estimator. Moreover, the model controls for all firm fixed effects and therefore accounts for all country fixed effects as well. As in the fixed effects estimator, year dummies were added. If results are similar, it means that conclusions drawn from it are more robust. It can be found as well if company fixed effects are significant determinants of the dependent variables.

The regression model including this LSDV estimator can be denoted as follows:

$$Y_{it} = \beta_0 + \beta X'_{it} + \sum_{i=2}^{n} \propto_i D_i + \delta_t + \mu_{it} \; for \; i = 1, .., N \; and \; t = 1, \dots, T \qquad (Eq. 3)$$

As in equation 2, *Y* represents the dependent variable, the vector *X'* represents the vector of the different independent variables and μ the error term for bank *i* at time *t*. The LSDV model includes dummy variables D_i for every individual bank, with their respective coefficients α. Manually, the year dummy variables δ were included. In order to control for heteroscedasticity in the model, standard errors were clustered within the clusters (banks). All these measures were taken in order to clean the data set and strengthen the results, which will be discussed in the next chapter.

3.3 Summary Statistics

Here the first results of the descriptive analyses are discussed in order to get a feel for the data and the direction of the answers to the hypotheses stated before. The complete statistics can be found in Appendix C, as this paragraph summarizes the most interesting results.

First, the level of net loans-to-asset ratio is of interest. The average of this ratio is 55.3%, with a maximum of 95.3% at the German Bausparkasse Mainz AG in 2015. On bank performance, the level of net income is on average EUR 302,066.10, with a maximum of EUR 13.9m of the British HSBC in 2012. The average of the total capital-to-asset ratio is 15.8%, well above the regulatory minimum. This shows that on average banks hold significantly more capital than is necessary. So, since banks hold excess capital it can be assumed that not only regulations drive the level of capital of banks. The tier 1 capital ratio is on average lower than the total capital-to-asset ratio, but still significantly higher than the regulatory minimum. This makes sense, since tier 1 capital is by definition less than total capital. Both these averages can be regarded as quite healthy. Moreover, the proximity to the regulatory minimum is on average positive at a level of EUR 8.2m.

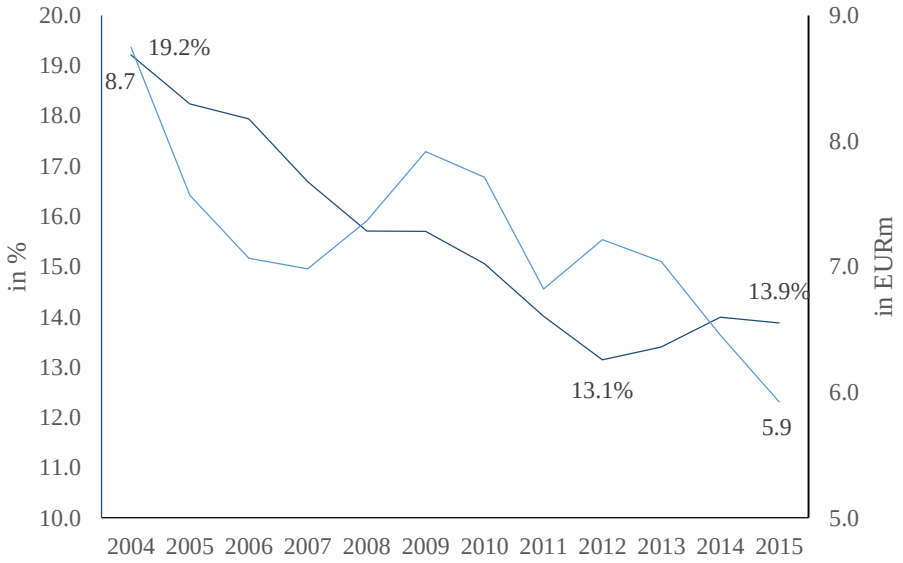

Figure 1 Development of the total capital-to-asset ratio of banks within the sample in the period 2004 – 2015 and, on the secondary y-axis the development of the level of total capital in millions of euros

As stated in chapter 2, the total capital-to-asset ratio increased after the first Basel accord was set in motion. It is interesting to see how the capital-to-asset ratio develops over time in the sample used in this research. As can be seen in Figure 1, the mean capital-to-asset ratio plunges in the period 2004 to 2015 from 19.2% in 2004 to 13.9% in 2015. Also, the average absolute level of capital within the sample decreases drastically in the sample period. This decrease in both measures can be attributed to the crisis, during which buffers declined due to general malaise and diminishing spreads as a result of decreasing interest rates. Before naming this an unhealthy phenomenon, it has to be noted that these levels are still significantly higher than the minimum levels required.

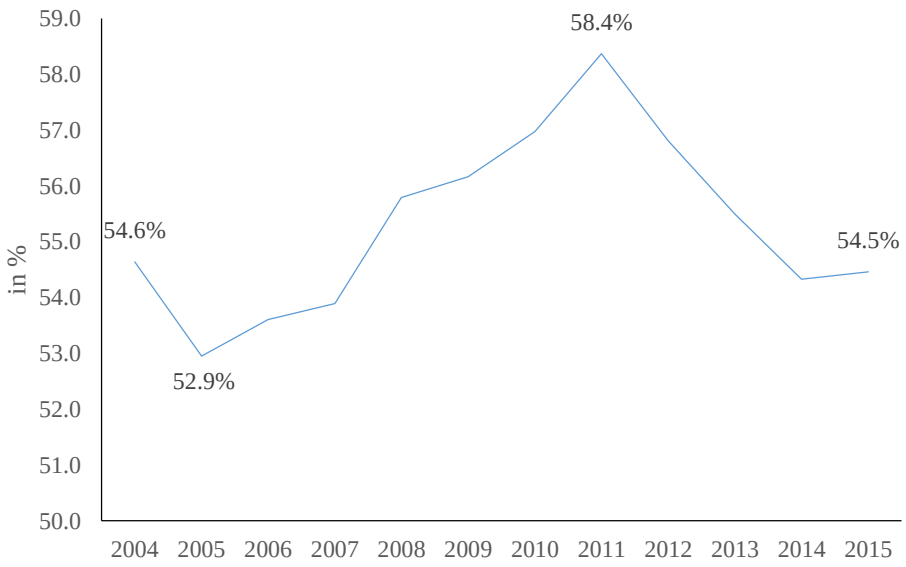

Figure 2 Development of the net loans-to-asset ratio of banks within the sample in the sample period

A different interesting statistic to include in this paragraph is the development of the net loans-to-asset ratio as a proxy of the level of credit risk banks take. As we can see in Figure 2, the level of this ratio develops in quite an interesting way. As in Figure 1, the crisis can explain this development. Pre-crisis levels are at a minimum of the sample period, at 52.9% in 2005. Then, as the financial crisis occurs and the credit crisis in Europe develops, these levels rise up to a maximum of 58.4% in 2011. Interestingly enough, the ratio shows a decline to levels at the beginning of the sample period. This can probably be explained by a recovering economy and banks reducing their loan portfolio as a result of the credit crisis.

Also, a comparison is made in the differences between levels of capital and risk between countries. In order to make a strong comparison, only countries are included with 10 or more banks in the sample. This comparison is not relevant for this research and can be found in Appendix D.

Chapter 4: Results

This chapter discusses the results from the different regression analyses. What coefficients and levels of significance belong to the different independent variables influencing levels of risk?

4.1 Variance in total assets

The variance in total assets is used as a proxy of the asset risk a bank takes. The statistical results for the fixed effects OLS regression can be found in Table 1. Strong significant effects are found for the level of total capital, total assets and net income on the variance in total assets. ROAA is only significant in the first regression.

Firstly, the level of total capital has a negative effect on the variance in total assets. Thus, every added unit of capital has a negative effect on the variance in total assets of a bank. This effect is found to be significant on a 5% confidence level. This effect coincides with the expected sign.

Then, total assets are found to be positively related to the asset risk a bank takes. Thus, larger banks take on higher levels of risk. This effect is found to be strongly significant on a 1% confidence level. The sign, however, is not as expected from earlier literature. It can be explained by the too-big-to-fail hypothesis (Lindquist, 2004). If large banks fail, this might have a systemic impact on the economy. Therefore, larger bank have the 'safety net' of a government bailing them out in case of possible bankruptcy. Jokipii & Milne (2006), moreover, find diversification effects. This means that larger banks are more diversified and can therefore hold higher levels of risk without closing in on possible failure.

Finally, as for bank performance, the level of net income is positively affecting the level of risk asset risk a bank takes. The effect is significant on a 10% confidence level and does not equal the expected sign from earlier literature. ROAA is only found to be positively significant in the first regression, therefore only careful conclusions can be drawn from this. The results on ROAA support the results on the level of net income; more profitable banks hold higher levels of risk.

Table 1: Regression of Determinants of Risk

Variance in total assets	(1)	(2)	(3)
Logarithm of the level of total capital	-0.3953**	-0.5672**	-0.5515**
	(0.046)	(0.011)	(0.015)
ROAA	0.0007**	0.0000	0.0000
	(0.027)	(0.980)	(0.957)
Logarithm of total assets	1.2237***	1.0262***	1.1480***
	(0.000)	(0.000)	(0.001)
Logarithm of the level of net income		0.1329*	0.1342*
		(0.092)	(0.091)
Logarithm of the level of net loans			-0.1363
			(0.534)
Constant	-16.0718***	-12.0589***	-11.5238***
	(0.000)	(0.001)	(0.003)
Observations	1,604	1,406	1,405
R-squared	0.6325	0.6641	0.6642

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Controlled for firm and year specific effects by using a fixed effects OLS with year dummies

Table 2 shows the results on the LSDV estimator, which serves as a robustness check on the results from Table 1. In this model, the results on the level of total capital hold, as well as the results of total assets on the asset risk a bank takes.

However, the results of bank performance, as measured by the level of net income and ROAA, on asset risk, do not hold under this more robust model anymore. So, we have to be more careful on drawing conclusions regarding these results. Conclusions drawn from the effects of the level of total capital and the level of total assets on asset risk are quite safe.

Table 2: Regression of Determinants of Risk

Variance in total assets	(1)	(2)	(3)
Logarithm of the level of total capital	-0.3953	-0.5672**	-0.5515**
	(0.224)	(0.045)	(0.036)
ROAA	0.0007	0.0000	0.0000
	(0.160)	(0.976)	(0.950)
Logarithm of total assets	1.2237***	1.0262***	1.1480**
	(0.001)	(0.003)	(0.044)
Logarithm of the level of net income		0.1329	0.1342
		(0.144)	(0.141)
Logarithm of the level of net loans			-0.1363
			(0.767)
Constant	-15.4160***	-11.7233***	-11.1300**
	(0.001)	(0.003)	(0.012)
Observations	1,604	1,406	1,405
R-squared	0.8189	0.8287	0.8285

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Controlled for firm and year specific effects by using the LSDV model with year dummies

4.2. Net loans-to-asset ratio

A second analysis on risk is an analysis with the net loans-to-asset ratio as dependent variable and proxy of credit risk. The statistical results for the fixed effects OLS regression can be found in Table 3. Significant effects are found for the level of total capital and total assets. ROAA is only found to be significant in the first regression.

Firstly, on the effect of the level of capital, it is interesting to see that this variable has a positive, significant effect on the level of credit risk a bank takes. This does not coincide with the expected sign from earlier literature as well as the results from previous regressions. For explaining this effect we refer to earlier literature, as Kim & Santomero (1988) find that increased capital regulations increases the probability of failure. The rationale behind this conclusion is that banks take on more capital on the expense of the level of leverage. To compensate for this tightening, banks hold a riskier portfolio in order to reach similar returns.

Secondly, as for the level of total assets, the same results are found as in paragraph 4.1.1. Larger banks hold higher levels of risk. The result is significant on a 1% and 5% level in respectively the first and second regression.

Finally, ROAA, as a measure of bank performance, shows a positive effect significant on a 5% confidence level. This coincides with the effects found in the previous paragraph. More profitable banks hold higher levels of risk.

Table 3: Regression of Determinants of Risk

Net loans-to-asset ratio	(1)	(2)
Logarithm of the level of total capital	1.1185*	1.6913**
	(0.087)	(0.019)
ROAA	0.0028**	-0.0035
	(0.028)	(0.320)
Logarithm of total assets	4.3474***	1.9729**
	(0.000)	(0.030)
Logarithm of the level of net income		0.3686
		(0.285)
Constant	-29.3989***	-3.2313
	(0.005)	(0.801)
Observations	2,087	1,709
R-squared	0.0671	0.0511

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Controlled for firm and year specific effects by using a fixed effects OLS with year dummies

As Table 4 on the next page shows, unfortunately no results hold on a confidence level after the robustness check performed by using a LSDV estimator. This means that drawing conclusions from the results in Table 3 should be done carefully. It shows as well that the model performed in paragraph 4.1.1. on asset risk is a stronger model to draw conclusions from.

Table 4: Regression of Determinants of Risk

Net loans-to-asset ratio	(1)	(2)
Logarithm of the level of total capital	1.1185	1.6913
	(0.529)	(0.453)
ROAA	0.0028	-0.0035
	(0.309)	(0.520)
Logarithm of total assets	4.3474	1.9729
	(0.217)	(0.725)
Logarithm of the level of net income		0.3686
		(0.638)
Constant	1.4129	24.4160
	(0.973)	(0.697)
Observations	2,087	1,709
R-squared	0.8263	0.8410

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Controlled for firm and year specific effects by using the LSDV model with year dummies

Chapter 5: Conclusions

This chapter tries to find answers to the research questions and hypotheses defined in this thesis and elaborates on the results of the different analyses.

5.1 Tested hypotheses

H_1 *The higher the level of capital of a bank, the lower the level of risk a bank takes.*

This is the central hypothesis driving this research and the main research question. Early research is divided, neither theoretical or empirical research provides a clear answer. The hypothesis is tested as part of the regression analyses on the level of risk a bank takes. In order to strengthen the conclusions drawn from the analyses, several variables are tested on two different dependent variables, being the variance in total assets as well as the net loans-to-asset ratio. By using the LSDV model, time invariant firm, country and year-fixed effects are cleared from the analysis to increase the reliability of the outcomes. From these analyses, it can be concluded that the level of capital of a bank has a strong and clear negative effect on asset risk. Following these results, this research can conclude that, if controlled for bank size, a higher capital-to-asset ratio leads to lower levels of risk a bank takes and subsequently confirms hypothesis H_1. However, it should be noted that if we focus on the results on the level of capital of paragraph 4.2, it is found that capital has positive effects on the level of credit risk a bank takes. Kim & Santomero (1988) find that increased capital regulations increases the probability of failure. The rationale behind this conclusion is that banks take on more capital on the expense of the level of leverage. To compensate for this tightening, banks hold a riskier portfolio in order to reach similar returns. To conclude on this hypothesis, the strongest results are found to be confirming H_1. However, contrary results have been found as well. Therefore we are inconclusive on whether to confirm this hypothesis or not.

H_2 *If faced with higher capital requirements, undercapitalized European banks will decrease their portfolio of risky assets whereas well capitalized European banks will increase their portfolio of risky assets.*

This hypothesis is derived from earlier research done by Calem & Rob (1998), which concludes that this hypothesis holds for American banks. Does this hypothesis hold for European banks too? The variable proximity to the regulatory minimum measures the distance between the level of capital of a bank and the regulatory minimum. The results of this variable regressed on the level

of risk serve as a proxy to answer this hypothesis. Unfortunately, however, because of collinearity the variable has not been taken into account in these regressions.

But proximity to the regulatory minimum corresponds with the level of capital of a bank. Therefore, it may be noted that this variable has the same effect to the level of risk a bank takes as the level of capital. If this is the case, then the closer a bank gets to the minimum, the more risk it will take. This would reject this hypothesis and correspond with the findings of Hancock & Wilcox (1994). However these are dangerous assumptions to make, since the variable has not been included in the statistical analyses and therefore one has to be very cautious to make any conclusions. And again, conclusions on hypothesis H_1 remain inconclusive. Thus, further, more extensive research is needed to be conclusive on this subject. Different proxies for the proximity to the regulatory minimum of banks should be incorporated in this follow up research. One might consider incorporating the probability of penalties and its effects on bank performance as an indicator of the proximity to the regulatory minimum.

H_3 *Large banks react differently on increased capital requirements than smaller banks.*

Results show that bank size, as measured by total assets, is significantly affecting the level of risk in a positive way. Thus, larger banks hold higher levels of asset and credit risk. This can be explained the mentioned too-big-to-fail hypothesis of Lindquist (2004) and the diversification effects in larger banks (Jokipii & Milne, 2006). However, it cannot be concluded that large banks respond differently to increased capital requirements than smaller banks. For this, future research is needed. This future research should focus on creating different datasets of banks according to size. Then, the effects of capital requirements can be analyzed on these data sets differentiating banks by size and derive conclusions from the results.

5.2 Concluding remarks

As mentioned above, it is hard to draw clear and definite conclusions. This research also tried to find the drivers of capital, but since problems with endogeneity arose, the results from these analyses were not incorporated in the thesis. Adding to the already mentioned possibilities of future research, the drivers of capital should be investigated by using lagged independent variables.

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Appendix A: Overview of variables and expected signs

Risk	
Variance in total assets	*Net loans-to-asset ratio*
Level of total capital (-)	Level of total capital (-)
ROAA (-)	ROAA (-)
Level of total assets (-)	Level of total assets (-)
Level of net income (-)	Level of net income (-)
Level of net loans (+)	

Appendix B: Country overview

Countries included in the analysis

Country	**Number of banks**
Austria	13
Belgium	3
Bulgaria	4
Croatia	13
Cyprus	5
Czech Republic	3
Denmark	26
Estonia	2
Faeroer	2
Finland	4
France	13
Germany	24
Greece	7
Hungary	2
Ireland	6
Italy	32
Latvia	1
Lithuania	3
Luxembourg	4
Malta	3
Netherlands	10
Poland	12
Portugal	7
Romania	4
Slovakia	5
Slovenia	5
Spain	10
Sweden	7
United Kingdom	20

Appendix C: Summary Statistics

Summary statistics of the variables in the risk analysis

Statistics	Variance in total assets	Net loans-to-asset ratio	Risk-weighted assets	Level of net loans	Level of total capital	ROAA	Net income
Mean	1.8mln	55.29%	605,414	5.64bn	7.3mln	0.55	302,066.10
Standard deviation	17.6mln	20.97%	1.3mln	12.8bln	17.0mln	2.59	1.9mln
Maximum	173.0mln	95.35%	10.1mln	113bln	174.0mln	28.79	13.9mln
Minimum	-194.0mln	0.00%	-550,256.40	0	-3.9mln	-30.21	-36.2mln
N	3,000	2,648	1,862	2,648	2,095	2,667	2,667

Appendix D: Comparison of countries

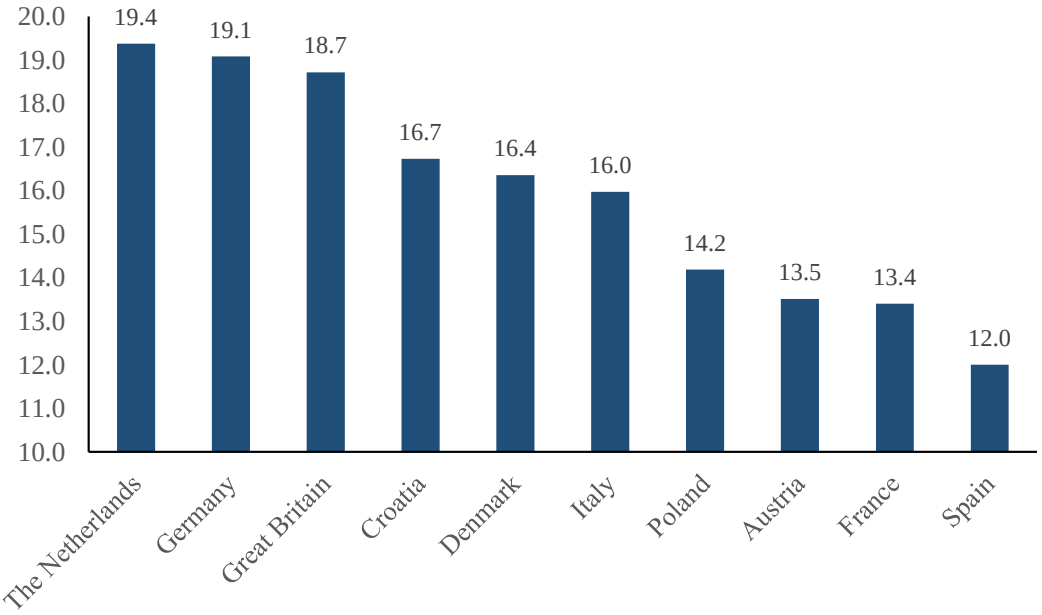

Figure 3 A comparison of the total capital-to-asset ratio (in %) between European countries represented by 10 or more banks in the sample

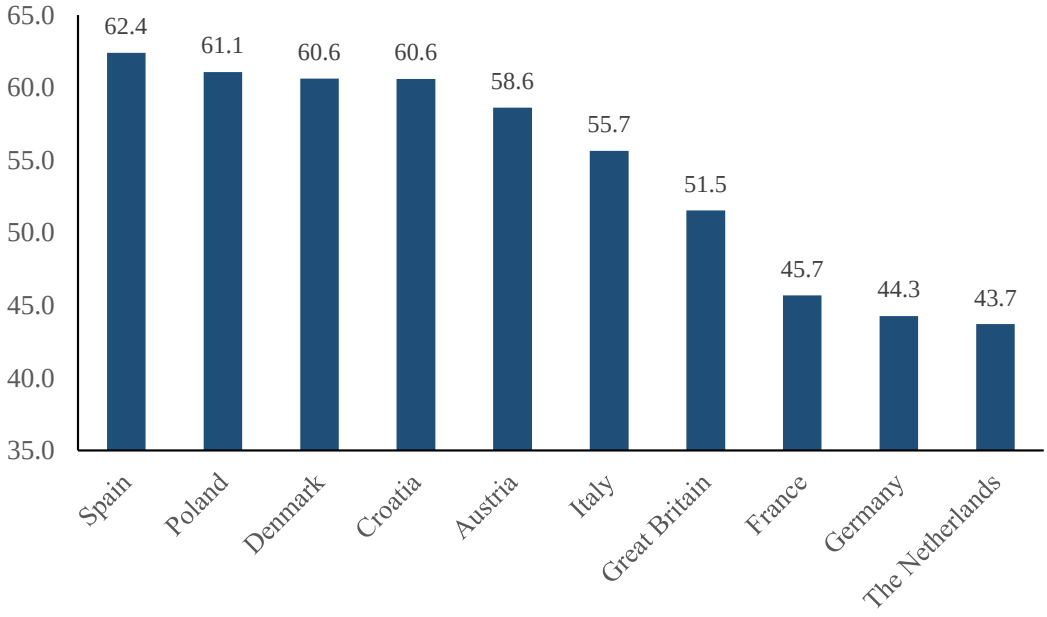

Figure 4 A comparison of the net loans-to-asset ratio (in %) between European countries represented by 10 or more banks in the sample