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THE IMPACT OF THE BASEL III ACCORD ON COMMERCIAL BANKS' CAPITAL AND RISK: EMPIRICAL ANALYSIS FOR THE EUROPEAN UNION AND THE UNITED STATES

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1. Introduction

On Friday 29 July 2016, the European Banking Authority (EBA) published the 2016 EU-wide stress test results. The objective of those tests is to evaluate the resilience of commercial banks towards adverse economic events. More precisely, the EBA checks if banks' own equity is large enough to absorb future potential losses (Berns, 2016a; 2016b). The stress tests were performed on 51 financial institutions across 15 EU and EEA countries (European Banking Authority, 2016). The results are hopeful as banks are now considered to be stronger than before: they have sensibly increased their capital since European banking legislation has been hardened.

In the academic literature, different opinions are shared on the necessity of regulating bank capital. Market failures usually generate reasons to create regulation. Some examples are externalities, market power or asymmetry of information between buyers and sellers. The banking industry is quite different from other industries in terms of regulation as there is still no consensus on whether banks have to be regulated and, if so, how. The main reason behind this is that one cannot agree on the nature of the market failure that prevents free banking from being optimal. Nevertheless, two main reasons are often put forward to justify banking regulation: the risk of a systemic crisis, and the inability of depositors to monitor banks (Santos, 2000).

First, the risk of a systemic crisis can be simply explained: it is the possibility that the failure of one financial institution could lead to the failure of others (Biggar and Heimler, 2005). Feldstein (1991, p.15) clarifies why banking regulation is needed to counter the systemic danger of a bank failure: "*The banking system as a whole is a "public good" that benefits the nation over and above the profits that it earns for the banks' shareholders. Systemic risks to the banking system are risks for the nation as a whole. Although the management and shareholders of individual institutions are, of course, eager to protect the solvency of their own institutions, they do not adequately take into account the adverse effects to the nation of systemic failure. Banks left to themselves will accept more risk than is optimal from a systemic point of view. That is the basic case for government regulation of banking activity and the establishment of capital requirements*".

The second argument for the introduction of bank supervision is the incapacity of depositors to monitor banks. Investors are willing to monitor banks because they are exposed to moral hazard and adverse selection issues. Yet, monitoring is costly and requires, among other things, access to information. Besides, this monitoring activity is wasteful when duplicated by other several parties. Add to this the fact that deposits are held to some extent by unsophisticated depositors, who do not have the incentive to monitor banks because they hold insignificant small deposits. This situation creates a need for a monitoring representative of depositors, which can be met by an effective banking regulation (Santos, 2000).

Nonetheless, to get out of the financial crisis of 2008-2009, the Basel Committee has decided to release in December 2010 the Basel III Accord as a comprehensive regulatory reform. There are obviously many national regulations in place for the banking sector, but Basel III is a unified framework and serves as a milestone. Whether it is mandatory or not depends on the country in question. Basel III needs to respond to the main failures of the previous Accord, which materialized during the financial crisis: the insufficient loss absorbency capacity of capital, excessive banks' leverage, inadequate liquidity risk management, systemic risk due to a high interconnectedness of the financial institutions (Baeten, 2015). Even before the financial crisis, the Committee noticed that a reform of Basel II was urgent. Indeed, banks had too much leverage, inadequate liquidity buffers, poor governance and risk management. The crisis only showcased all these deficiencies (BIS, 2015b). The Basel III Accord is composed of six main measures, which are further developed in Appendix A (as well as the prior Accords).

Due to this new guideline, banks have been forced to modify the shape of their balance sheet: equity had to be raised while risk-weighted assets had to be decreased. Those modifications can be noticed by a quick look at banks' financial statements over the years. However, whether those changes are due to the introduction of risk-based capital requirements or not, cannot be proved. That is why, to achieve our ends, a modified and extended version of the simultaneous equations model of Shrieves and Dahl (1992) is used in this thesis. Thanks to it, regulation pressure on banks can be identified and analyzed to determine its potential impact on banks' behavior.

Concretely, this thesis contributes to the literature by analyzing the effect of the Basel III Accord on commercial banks' capital and portfolio risk over the period 2006-2014. European banks are also to be compared with their American counterparts to study potential differences in behavior. The main question that will be asked throughout this thesis is: when commercial banks are under regulatory pressure, do they increase their capital and/or decrease their risk-weighted assets? In the meantime, we will take this opportunity to investigate some theories covered in Section 2.1., in particular those inducing that financial institutions raising capital are also willing to increase the riskiness of their portfolio. Besides, by means of a regression analysis in three steps, a distinction will be made between well-capitalized and undercapitalized organizations to analyze their respective capital and risk behavior to be in line with the risk-based capital requirements. Finally, by the inclusion of a year dummy variable in the model, the impact of the announcement of the implementation of a capital regulation on the capital and risk choices of financial institutions will be analyzed.

We address the issue through a literature review part and an empirical part. The literature overview is divided into two subsections. The first subsection reviews the theories developed by authors over the years, dealing with the impact of capital regulations on the behavior of banks. The second subsection summarizes the different empirical studies made on the subject, each one using a modified version of the model of Shrieves and Dahl (1992).

The empirical part is organized as follows. In Section 3, the model used for the thesis is developed, as well as each variable included in the model. The penultimate section presents the data on European and American banks, the methodology followed to get the results and some descriptive statistics. Finally, Section 5 focuses on the results of the regression analyses.

2. Literature review

The literature review covers theory and empirics about the effect of capital requirements on the capital and risk behavior of financial institutions.

2.1. Review of the theoretical literature

Our focus, during this thesis, is particularly on the regulation of bank capital. Santos (2000) explains that the main reason for regulating bank capital is the risk-shifting incentive as well as probable externalities arising from bank failures. According to him, when deposit insurance is improperly priced, banks have an incentive to increase risk through, for instance, a rise in risky assets. A great part of the literature has dealt with this relationship between capital and risk.

Two strands in the literature on the regulation of bank capital stand out. On the one hand, Kahane (1977), Koehn and Santomero (1980) and Kim and Santomero (1988) question the effectiveness of capital regulation through the use of the portfolio approach developed by Pyle (1971). The purpose is to show that risk-taking banks will react to a required increase of the capital ratio by shifting their portfolio towards riskier assets. Consequently, the increase in the capital ratio will be more than offset by this shift towards riskier assets, leading to a greater probability of banks' bankruptcy. Researchers eventually conclude that, due to binding capital requirements, safe banks will become safer while risky banks become riskier.

On the other hand, Furlong and Keeley (1989) argue that value-maximizing banks do not increase asset risk when regulators set more stringent capital requirements. The required higher capital ratios will reduce the benefits that banks gain when increasing the risk of their assets. As a result, banks will not see the point to increase their risk-weighted assets. Moreover, another finding of this strand of literature is that value-maximizing banks are more willing to raise capital to face higher requirements, rather than sell their assets or retire deposits. In further research, Keeley and Furlong (1990) even demonstrate that the framework used by Kahane (1977), Koehn and Santomero (1980) and Kim and Santomero (1988) is inappropriate, hence their point of view on binding capital requirements is biased.

Based on those and other analyses, Shrieves and Dahl (1992) developed other hypotheses, such as bankruptcy cost avoidance or managerial risk aversion, to explain the positive association between capital and risk. One interesting example of this positive relationship is provided: regulators allow banks that increased their capital to pursue riskier investments, but this leads to a higher risk level and consequently, forces banks through regulatory pressure to increase their capital level again. Gennotte and Pyle (1991) show that there are plausible cases where a more stringent capital regulation leads to a decrease in the level of investment, but an increase in the asset risk. Furthermore, Rochet (1992) proves that when the objective of commercial banks is to maximize the market value of their future profits, capital requirements cannot prohibit banks from choosing very specialized and very risky portfolios. Blum (1999) also finds that, in a dynamic framework, capital regulations may actually increase a bank's riskiness. Using a two-period model, he finds that when a bank faces binding capital requirements, it has to raise its capital to meet those requirements tomorrow. But if getting new equity is too costly, the only solution to increase equity tomorrow is to increase risk today.

Recently, Jeitschko and Jeung (2005) brought out a new theoretical framework to analyze the relationship between bank's capital and risk-taking behavior. They built a model that took account of the incentives of three agents: the deposit insurer, the shareholder and the manager. They demonstrate that the risk behavior of a bank may increase or decrease with capitalization. This relationship depends mostly on the relative forces of the three agents.

In conclusion, the literature does not reach a straightforward conclusion on whether the association between adjustments to capital and risk is negative or positive. Several papers have attempted to verify previously formed theories to discover an empirical relationship between adjustments to risk and capital. These papers and their results will be briefly introduced in the section on the empirical literature.

2.2. Review of the empirical literature

This section provides an overview of the empirical methods used by the most cited papers in the literature to study the capital and risk behavior of commercial banks in response to capital regulations. Across the analyzed papers, authors apply the simultaneous equations model introduced by Shrieves and Dahl (1992) but not using the same variables; moreover, the reference period and the capital regulation under study also vary.

The model built by Shrieves and Dahl had as its primary goal the analysis of the relationship between risk and capital within commercial banks. This model has then been used by a lot of researchers from another angle: the study of banks' behavior towards new regulation. This model enables investigators to focus on the capital and risk adjustments of banks' balance sheet to meet the new requirements. This other perspective of the model was also introduced by Shrieves and Dahl, but had a secondary purpose in their research. The regulation investigated by the two authors was an introduction of risk-based capital requirements by the Federal Reserve Board at the end of 1992. 1,800 FDIC-insured commercial banks[1] were analyzed on a period going from December 1984 to December 1987. Regarding the model, banks' capital (CAP) is defined as the ratio of capital to total assets. Risk is reflected by two factors: a composite measure of asset risk (RISK) and a measure for the quality of the loan portfolio (NON). On the one hand, regarding the RISK measure, weights are given to the different components of the asset portfolio. For example, the weight of interest-bearing balances is 0.25 whereas commercial letters of credit are weighted by 0.50. This composite risk measure is then divided by the total assets. On the other hand, the loan portfolio quality variable (NON) is measured by the ratio of non-performing loans to total loans. The simultaneous equations model of Shrieves and Dahl is specified as follows:

[1] FDIC-insured commercial banks are American financial institutions in which depositors are protected by a deposit insurance provided by the Federal Deposit Insurance Corporation. This corporation was created after the Great Depression to restore confidence in the American banking industry (Federal Deposit Insurance Corporation, 2014).

$$\Delta CAP_{j,t} = a_0 + a_1 LNSIZE_{j,t} + a_2 BHC_{j,t} + a_3 REG_{j,t} + a_4 \Delta NON_{j,t} + a_5 \Delta RISK_{j,t} - \left(\alpha_0 + \alpha_1 REG_{j,t}\right) CAP_{j,t-1} + E_{j,t}$$

(1)

$$\Delta NON_{j,t} = b_0 + b_1 LNSIZE_{j,t} + b_2 BHC_{j,t} + b_3 REG_{j,t} + b_4 \Delta CAP_{j,t} + b_5 \Delta RISK_{j,t} - \beta_1 NON_{j,t-1} + U_{1,j,t}$$

$$\Delta RISK_{j,t} = c_0 + c_1 LNSIZE_{j,t} + c_2 BHC_{j,t} + c_3 REG_{j,t} + c_4 \Delta CAP_{j,t} + c_5 \Delta NON_{j,t} - -\beta_2 RISK_{j,t-1} + U_{2,j,t}$$

where:

- LNSIZE represents the bank size and is computed as the natural logarithm of total assets;
- BHC represents the holding company affiliation status and is a dummy variable, equal to 1 if the bank is member of a multibank holding company and 0 otherwise;
- REG represents the regulatory pressure and is a binary variable, equal to 1 if the total capital ratio is inferior to 7% and 0 otherwise;
- $REG_{j,t} * CAP_{j,t-1}$ represents the speed of adjustment of capital levels and is computed as the product between the regulatory pressure variable and the lagged capital level.

Year dummy variables are also added to the model to take account of shocks that could occur in the regulatory or macro-economic environment. The methodology used to make the regressions was the two-stage least-squares. Regression results imply that risk and capital are simultaneously and positively related. The majority of banks increased their risk after having increased their capital and so annihilated the effect of an increase in their capital. Concerning the regulatory pressure, the authors find out that undercapitalized banks had higher target capital levels and higher rates of adjustment to those capital levels than other banks. They conclude that the regulation was effective but partially since there is a positive relationship between risk and capital.

Based on the work done by Shrieves and Dahl (1992), Jacques and Nigro (1997) examine the impact of the Basel Accord on bank capital and portfolio risk during the first year that this requirement was introduced. The sample contained 2,570 FDIC-insured commercial banks over the period 1990-1991. The capital variable (CAP) is measured as the ratio of total capital to risk-weighted assets, while the RISK variable is measured as the ratio of risk-weighted assets to total assets. The authors argue that the two features used by Shrieves and Dahl (1992) to measure risk - NON and RISK - are captured by the risk-weighted assets to total assets ratio. Their model is specified as follows:

$$\Delta CAP_{j,t} = \Gamma_0 + \Gamma_1 SIZE_{j,t} + \Gamma_2 BHC_{j,t} + \Gamma_3 LEVD_{j,t} + \Gamma_4 \Delta RISK_{j,t} + \Gamma_5 INC_{j,t} - \Gamma_6 CAP_{j,t-1} + \Gamma_7 RPG_{j,t} + \Gamma_8 RPL_{j,t} + \mu_{j,t}$$

(2)

$$\Delta RISK_{j,t} = \vartheta_0 + \vartheta_1 SIZE_{j,t} + \vartheta_2 BHC_{j,t} + \vartheta_3 LEVD_{j,t} + \vartheta_4 \Delta CAP_{j,t} - \vartheta_5 RISK_{j,t-1} + \vartheta_6 RPG_{j,t} + \vartheta_7 RPL_{j,t} + \omega_{j,t}$$

where:

- SIZE represents the size of the bank and is computed as the natural logarithm of the total assets;
- BHC represents the holding company affiliation status and is a dummy variable, equal to 1 if the bank is member of a multibank holding company and 0 otherwise;
- LEVD represents the leverage ratio and is a dummy variable, equal to 1 if the bank has a leverage ratio lower than 5% and 0 otherwise;
- INC represents income and is computed as the ratio of income to total assets;
- RPG and RPL are the regulatory pressure variables. The regulatory pressure variable is disaggregated in two parts because banks with a capital ratio above or below the minimum requirement may react to regulations differently. The capital minimum requirement is 7.25%. These two variables are 'unusual' dummies: RPL is equal to ($1/RBC_j$ – 1/7.25) for the banks with a total risk-based capital ratio (RBC) below the minimum requirement and 0 for the banks with a capital ratio above the minimum; RPG equals (1/7.25 – $1/RBC_j$) for banks with a total risk-based capital ratio above or equal to the threshold 7.25%, and 0 otherwise.

The regression results are obtained through the three-stage least-squares method. The authors show that well-capitalized banks increased their capital and decreased their portfolio risk after the introduction of the risk-based capital standards. The same behavior is noticed for capital-constrained banks. However, only 3% of their sample contained undercapitalized institutions (67 of the 2,570 FDIC-insured commercial banks). According to Van Roy (2005), this reduces the reliability of some of their estimates.

Aggarwal and Jacques (1998) used almost the same model as Jacques and Nigro (1997) with only some minor adjustments[2], and their focus is placed on the Federal Deposit Insurance Corporation Improvement Act (FDICIA)[3]. 2,552 FDIC-insured commercial banks were examined over a period from 1990 to 1993. The model uses a two-stage least-squares procedure. The authors find that both adequately capitalized and undercapitalized institutions increased their capital ratios in 1992 and 1993. Moreover, those institutions raised the adjustment rate of their capital levels to meet the PCA regulation. Concerning banks' risk, the authors conclude that banks significantly reduced their risk, especially in 1993 (one year after PCA was introduced). The applied model was slightly modified[4] by Aggarwal and Jacques (2001). Their main conclusion was that both adequately capitalized and undercapitalized institutions dropped their risk-taking for the 1993-1996 period in response to the PCA standard.

Ediz et al. (1998) were the first to use non-US banks to analyze the impact of capital requirements on banks' capital and risk behavior, as they analyze data on British banks from 1989 to 1995. Furthermore, the framework is different from the one of Shrieves and Dahl (1992): Ediz et al. (1998) created a dynamic, multivariate panel regression model. They are also the first to introduce the probabilistic approach to proxy regulatory pressure. This approach consists in attributing the value 1 to the variable if bank's capital ratio is below the minimum capital requirement plus one bank-specific standard deviation of its capital ratio, and 0 otherwise. The

[2] Only the variable LEVD used by Jacques and Nigro (1997) is omitted and Jacques and Aggarwal (1998) add interaction terms to deal with bank's speed of adjustment to the capital levels required.

[3] This Act was aimed at addressing the problem of a large number of bank failures in the 1980s. It comprised two provisions. The first one allows bank regulators to close down failed financial institutions at a positive capital level. The second provision, the so-called prompt corrective action (PCA), enables regulators to intervene in capital-constrained banks to save them from insolvency. This PCA provision defines five categories of financial institutions in function of capital thresholds: well-capitalized, adequately capitalized, undercapitalized, significantly undercapitalized and critically undercapitalized. Regulators determine supervisory actions in function of the bank classification in one of those categories.

[4] Some new variables are added to the model as holdings of government securities, liquidity, asset quality… The whole framework stays the same.

authors show that banks mainly adjust their capital ratios by raising capital rather than playing with risk-taking.

Rime (2001) was the first to implement the simultaneous equations framework of Shrieves and Dahl (1992) to non-US financial institutions. The objective of his paper is to study the behavior of Swiss banks to two types of capital regulations: the implementation of the Basel Accord in Switzerland (through the probabilistic approach) and the PCA-approach (cfr. Aggarwal and Jacques (1998)). The PCA-approach is quite inappropriate because PCA is a regulation that has never been adopted in a different country than the United States; hence, the author studied the capital and risk behavior of banks towards a regulation that is not applicable in Switzerland. Two definitions of bank capital are used: the ratio of capital to total assets and the ratio of capital to risk-weighted assets. Bank risk is defined as the ratio of risk-weighted assets to total assets. The sample comprises 4 big banks, 25 cantonal banks and 125 regional banks over the period 1989-1995. The model of Rime (2001) is written as follows:

$$\Delta CAP_{j,t} = a_0 + a_1\, REG_{j,t-1} + a_2\, ROA_{j,t} + a_3\, SIZE_{j,t} + a_4\, \Delta RISK_{j,t} - a_5 CAP_{j,t-1} + \varepsilon_{j,t}$$

(3)

$$\Delta RISK_{j,t} = a_0 + a_1\, REG_{j,t-1} + a_2\, LLOSS_{j,t} + a_3\, SIZE_{j,t} + a_4\, \Delta CAP_{j,t} - a_5 RISK_{j,t-1} + \nu_{j,t}$$

where:

- REG represents the regulatory pressure variable and is defined in two different ways as explained in the paragraph above;
- ROA represents the current profits and is measured by the return on assets;
- SIZE represents the size of the bank and is computed as the natural logarithm of the total assets;
- LLOSS represents the current loan losses and is proxied by the ratio of new provisions to total assets.

This model is analyzed using a three-stage least-squares procedure. The regression results show that banks, just below the minimum capital requirement, are willing to increase their ratio of capital to risk-weighted assets, as well as the ratio of capital to total assets. However, the impact of regulatory pressure on banks' risk is not significant. Finally, the author observes a positive and significant relationship between changes in risk and changes in the ratio of capital to total assets but this is not the case if he uses the ratio of capital to risk-weighted assets.

The research setup in Heid et al. (2003) is very similar to the one of Rime (2001), as the variables that were used are identical. Nonetheless, only one definition of capital is applied: the ratio of capital to total assets and the probabilistic approach is used alone to define the regulatory pressure variable. The purpose of the analysis was to assess the capital and risk behavior of 550 German savings banks facing capital regulations over the period 1994 to 2002. The main finding is that the relationship between capital and risk adjustments depends on the capital buffer of each bank. Banks with low capital buffers are willing to raise this buffer by increasing their capital and reducing their risk. However, banks with high capital buffers try to maintain them by raising capital and risk simultaneously.

Van Roy (2005) compares the capital and risk behavior of financial institutions across six G10 countries - Canada, France, Italy, Japan, United Kingdom and the United States – to study whether banks comply with the 1988 Basel Accord. As there are different countries, the author introduces country dummy variables in his model to take account of national preferences in capital or risk decisions. Besides, year dummies are also useful to capture the national variants of the Basel Accord. Bank capital is defined as the ratio of capital to total assets and risk as the ratio of risk-weighted assets to total assets. The model is also based on the partial adjustment framework of Shrieves and Dahl (1992) and is specified as follows:

$$\Delta CAP_{i,t} = a_0 SIZE_{i,t} + a_1\, LOANS_{i,t} + a_2\, LLOSS_{i,t} + a_3\, ROA_{i,t} + a_4\, GROWTH_{j,t} + a_5 CAP_{i,t-1} + a_6 \Delta RISK_{i,t} + \sum_j a_{7j} c_j + \sum_j a_{8j} c_j REG_{i,t-1} + \sum_t a_{9t} YEAR_t + E_{i,t}$$

$$\Delta RISK_{i,t} = b_0 SIZE_{i,t} + b_1\, LOANS_{i,t} + b_2\, LLOSS_{i,t} + b_3\, GROWTH_{j,t} + b_4 RISK_{i,t-1} + b_5 \Delta CAP_{i,t} + \sum_j b_{6j} c_j + \sum_j b_{7j} c_j REG_{i,t-1} + \sum_t b_{8t} YEAR_t + S_{i,t}$$

(4)

where:

- SIZE represents the size of the bank, is computed as the natural logarithm of the total assets and is considered as a control variable;
- LOANS represents the riskiness of banks and is defined as the ratio of loans to total assets;
- LLOSS represents the current loan losses and is proxied by the ratio of new provisions to total assets;
- ROA represents the current profits and is measured by the return on assets;
- GROWTH takes country-specific macroeconomic shocks into consideration and is defined as the rate of GDP growth;
- REG represents the regulatory pressure variable, is measured via the probabilistic approach and is interacted with a second set of country dummies;
- c represents the country dummy variables;
- YEAR represents the year dummy variables.

The sample consists of 576 commercial banks over the 1988-95 period. The procedure used is three-stage least-squares. The results show that undercapitalized banks in Canada, Japan, the UK and the US increased their capital to assets ratio, but this was not the case in France and Italy. No evidence has been found whether G10 banks increased or decreased their credit risk over the period. Overall, the author finds that the regulatory pressure was effective since undercapitalized G10 banks globally increased their capital and not their risk.

Matejasak et al. (2009) study the responses of US and EU-15 commercial banks towards regulatory pressure (Basel II capital requirements) over the period 2000-2005. The model used is very similar to the works of Rime (2001) and Heid et al. (2003). The results of the regressions state that European and American undercapitalized banks increased their capital level, but only US banks also reduced their risk-taking. Besides, well-capitalized European banks preferred to have a buffer and tried to maintain it. Very recently, Akinsoyinu (2015) studied the impact of the Basel III regulation on the capital and risk decisions of European global systemically important banks over the period 2009-2014. He found that those banks increased their capital position when under regulatory pressure, while the effect on risk-taking is quite unclear.

Jakovljevic et al. (2015) have summarized the results of different empirical works. They come to the conclusion that the impact of capital regulation mainly depends on the capital buffer held by financial institutions. Jakovljevic et al. (2015, p.425) further develop different reasons why a bank may hold capital buffers: "*to avoid costs associated with falling below the regulatory requirement (Lindquist, 2004), to insure themselves against insolvency risk (Nier and Baumann, 2006) or economic recessions (Bikker and Metzemakers, 2005), to satisfy the criteria of rating agencies (Memmel and Raupach, 2010), to optimize their market value (Barrios and Blanco, 2003), or to exploit possible investment opportunities (Jokipii and Milne, 2008)*". Hence, based on empirical evidence, the authors state that only financial institutions with a capital level around the regulatory minimum may feel the regulatory requirement as binding.

Table 1 recapitulates the different prior publications on the research subject. The second column of this table describes the sample and the reference period of each study. The last three columns summarize the regression results obtained by each author for the regulatory pressure variable in the capital and risk equations, and for the relationship between capital and risk.

3. The model

3.1. Simultaneous equations model

Our empirical analysis of EU and US commercial banks is based on the simultaneous equations model of Shrieves and Dahl (1992), which was also used by other researchers as Jacques and Nigro (1998), Aggarwal and Jacques (1998), Rime (2001), Van Roy (2005) and Matejasak et al. (2009). This model is composed of two equations: one focuses on the observed changes in bank capital levels and the other one on observed changes in bank risk levels. These changes are decomposed into two parts: a discretionary adjustment and a change caused by factors exogenous to the bank:

$$\Delta CAP_{j,t} = \Delta^d CAP_{j,t} + E_{j,t};$$
$$\Delta RISK_{j,t} = \Delta^d RISK_{j,t} + U_{j,t}; \quad (5)$$

$\Delta CAP_{j,t}$ and $\Delta RISK_{j,t}$ are the observed changes in the capital and risk levels for bank *j* at time *t*. $E_{j,t}$ and $U_{j,t}$ are the exogenous factors. Besides, $\Delta^d CAP_{j,t}$ and $\Delta^d RISK_{j,t}$ are considered as the discretionary changes in capital and risk.

According to Shrieves and Dahl (1992), those discretionary adjustments are modeled in a partial adjustment framework. This supposes that banks are not able to directly adjust their targeted capital ratio and risk levels. This framework can be represented by:

$$\Delta^d CAP_{j,t} = \alpha \left(CAP^*_{j,t} - CAP_{j,t-1}\right) + E_{j,t};$$
$$\Delta^d RISK_{j,t} = \beta \left(RISK^*_{j,t} - RISK_{j,t-1}\right) + U_{j,t}; \quad (6)$$

$CAP^*_{j,t}$ and $RISK^*_{j,t}$ are respectively the target capital ratio and target risk level, while $CAP_{j,t-1}$ and $RISK_{j,t-1}$ are the lagged capital ratio and risk level. As can be seen from Equation (6), the discretionary changes in capital and risk are function of the difference between the target levels and the observed levels one year ahead.

Now that the discretionary factors are defined, they can be substituted into the two first Equations (5), giving:

$$\Delta CAP_{j,t} = \alpha \left(CAP^*_{j,t} - CAP_{j,t-1}\right) + E_{j,t};$$
$$\Delta RISK_{j,t} = \beta \left(RISK^*_{j,t} - RISK_{j,t-1}\right) + U_{j,t}; \quad (7)$$

Thus, on the one hand, observed changes in capital at time *t* for bank *j* are function of the target capital level in period *t* ($CAP^*_{j,t}$), the capital ratio in period *t-1* ($CAP_{j,t-1}$) and any exogenous shocks ($E_{j,t}$). On the other hand, observed changes in risk at time *t* for bank *j* are function of the target risk level in period *t* ($RISK^*_{j,t}$), the risk level in period *t-1* ($RISK_{j,t-1}$) and any exogenous shocks ($U_{j,t}$).

3.2. Definitions of capital and risk

A crucial part of the analysis is to define how bank capital (CAP) and bank risk (RISK) will be measured. In the literature, only two ways have been used to express capital: the ratio of capital to total assets or the ratio of capital to risk-weighted assets. Shrieves and Dahl (1992), Aggarwal and Jacques (1998), Heid et al. (2003) and Van Roy (2005) used the first measure, while Jacques and Nigro (1997) and Matejasak et al. (2009) used the second measure; Rime (2001) used both.

The use of the second definition for bank capital can be explained by the fact that risk-weighted capital requirements became more popular after they were introduced. When Shrieves and Dahl wrote their paper, the notion of risk-weighted assets was not mature enough. As in the majority of previous analyses, bank capital (CAP) will be represented by the ratio of total capital to total assets (K/A). By total capital, the total regulatory capital is understood, i.e. tier 1 and tier 2 capital.

Bank risk (RISK) will be explained by the ratio of risk-weighted assets to total assets (RWA/A). This was introduced by Shrieves and Dahl (1992) and then subsequently used by Jacques and Nigro (1997), Aggarwal and Jacques (1998), Rime (2001), Van Roy (2005) and Matejasak et al. (2009). The ratio of risk-weighted assets to total assets was chosen to represent bank risk because Avery and Berger (1991) proved that this ratio correlates with the risky behavior of banks.

Banks have three alternatives to increase their capital adequacy ratio to respect the binding legal requirements: they can raise the capital level, decrease their risk-weighted assets or sell off their assets (Van Roy, 2005). Equation (8) shows this by decomposing the growth rate of the total capital ratio of bank *j* into three parts: the growth rate of capital, the growth rate of the credit risk ratio and the growth rate of total assets.

$$\frac{\Delta CAR_{j,t}}{CAR_{j,t}} = \frac{\Delta K_{j,t}}{K_{j,t}} * \frac{\Delta RISK_{j,t}}{RISK_{j,t}} * \frac{\Delta A_{j,t}}{A_{j,t}} \qquad (8)$$

where:

- CAR (= K/RWA) represents the capital adequacy ratio;
- K and A represent respectively total capital and total assets;
- RISK (= RWA/A) represents the credit risk ratio.

As a reminder, one of the main objectives of the Basel III Accord is to increase the CAR of commercial banks. Therefore, by defining CAP as the ratio of total capital to total assets (K/A) and RISK as the ratio of risk-weighted assets to total assets (RWA/A), two of the three alternatives, available for banks to increase their CAR, are represented within the model.

3.3. Variables of the model

The partial adjustment framework, described by Equation (7), shows that observed changes in capital and risk in period *t* are function of the target capital and risk levels, the lagged capital and risk levels and any exogenous shocks. Yet, the target capital and risk levels are not directly observable and need therefore to be approximated by some explanatory variables. Therefore, to proxy the target capital level ($CAP^{*}_{j,t}$ in Equation 7), the size of the bank (SIZE), a profitability indicator (ROA), changes in the risk level (ΔRISK), the regulatory pressure (REG), the speed of adjustment of capital levels (SPEED), a year dummy and country dummies are used. Not all those variables will be needed to approximate the target risk level ($RISK^{*}_{j,t}$). The variables used, in that case, are the size of the bank (SIZE), the regulatory pressure (REG), current loan losses (LLOSS), changes in the capital level (ΔCAP), a year dummy and country dummies. All those variables were already handled by Shrieves and Dahl (1992), except the profitability indicator, proposed for the first time by Aggarwal and Jacques (1998), and the country dummies, introduced by Van Roy (2005). Let us now explain the choice for and the content of each variable.

3.3.1. Size of the bank (SIZE)

Shrieves and Dahl (1992) affirm that size may affect the target capital and risk levels because size is related to access to equity capital and risk diversification. As noted by Van Roy (2005), large banks have an easier access to equity capital markets and should therefore have a lower capital to assets ratio than smaller banks. Besides, larger banks are supposed to be able to diversify their portfolio in a better way than smaller banks and so reduce their credit risk. Consequently, the SIZE variable is incorporated in the capital and risk equations of the model to capture size effects. This variable is computed as the natural logarithm of bank's total assets to stay in line with the previous studies.

3.3.2. Profitability indicator (ROA)

The profitability indicator is represented by the return on assets (ROA), obtained by dividing bank's net income by its total assets. Following previous studies, this variable is only included in the capital equation because it is supposed that ROA will have a positive impact on capital. Profitable banks are more willing to increase their capital through retained earnings rather than through equity issues, as equity issues could create negative information about the bank in the market, in presence of asymmetric information.

3.3.3. Current loan losses (LLOSS)

The LLOSS variable is the ratio of loan loss provisions to total assets. Banks set money (loan loss provisions) aside to cover potential losses on bad loans (Financial Times, 2011). Higher loan loss provisions will be recorded by financial institutions when their loans seem to be riskier or when the volatility is high within the economy. Following Van Roy (2005) and Matejasak et al. (2009), this means that the LLOSS variable can be considered as a substitute for asset quality. Indeed, banks with a lower asset quality (higher LLOSS) are supposed to have a higher risk. That is why this variable is only included in the risk equation.

3.3.4. Changes in the capital (ΔCAP) and in the risk level (ΔRISK)

The theoretical models explained in Section 2.1. show that banks' capital and risk decisions are interdependent. This leads to the incorporation of ΔRISK in the first part of Equation (10) and of ΔCAP in the second part of Equation (10) to find the relationship that exists between the two. If we focus on the risk part of Equation (10), a significant and positive coefficient for ΔCAP would mean that banks increase their capital to total assets ratio in chorus with the risk ratio, while a significant and negative coefficient for ΔCAP would indicate that higher capital to assets ratios lead banks to reduce their credit risk ratio.

3.3.5. Year dummy variable (dy2011)

As done by Shrieves and Dahl (1992), Rime (2001), Van Roy (2005) and Matejasak et al. (2009), year dummy variables are added in the two equations (risk and capital) of the simultaneous equations model. Nevertheless, in our model, there is only one year dummy and it is built differently. It is equal to 1 in 2011 and the years after, and 0 otherwise. This year variable is included in the model to take account of changes in the regulatory or macro-economic environment. In December 2010, the Basel Committee announced the implementation of Basel III as bank regulation in a near future with more stringent capital requirements. Banks knew at that time that they would have to increase their capital level in the future, so the first reaction of financial institutions can only be noticed from the year 2011.

3.3.6. Country dummy variables

As Van Roy (2005) proposed in his research, country dummy variables are included in the two parts of the simultaneous equations model. Those variables are encompassed in the framework to capture national variances in capital preferences, national laws and risk-aversion (Van Roy, 2005). Actually, those dummies are also necessary to reflect the regional variants of the Basel III Accord between the European Union and the United States. Yet, the country dummies will not reflect national differences of Basel III within the European Union as this Accord is a regulation (Regulation No 575/2013) and is thus the same for every Member Country of the EU.

3.3.7. Regulatory pressure (REG)

The regulatory pressure variable (REG) is, in our view, of main interest. It tells us how banks behave when they are under pressure, i.e. under the minimum required risk-based capital. As a reminder, the Basel III Accord asks financial institutions to have a total capital ratio higher than 8% in the reference period of the model. Following the moral hazard problem model of Calem and Rob (1996), financial institutions that almost meet the minimum capital requirement are more willing to increase capital and reduce risk to escape regulatory costs, generated by a breach of the capital regulation. Though, strongly undercapitalized banks may be attracted by a very risky behavior in hope of creating higher returns, which will support them in building up their capital ("*gambling for resurrection*") (Calem and Rob, 1996).

We predict regulatory pressure to have a positive impact on observed changes in capital, since a breach of the regulation could lead to high penalties, whereas its effect on observed changes in risk is more undecided. The REG variable has been approached in essentially two different ways by academics over time:

(1) The prompt corrective action – approach (PCA-approach) introduced by Aggarwal and Jacques (1998) and then taken back by Rime (2001);
(2) The probabilistic approach introduced by Ediz et al. (1998) and then used in the majority of the more recent papers.

As the main part of the literature, we opt for the probabilistic approach. The regulatory pressure variable is a dummy variable, equal to 1 if the capital adequacy ratio (CAR) of the concerned bank is below a certain threshold and 0 otherwise. This threshold is equal to the minimum capital requirement of the Basel III agreement (8%) plus one bank-specific standard deviation of its capital adequacy ratio.

$$\begin{aligned} REG &= 1\ if\ CAR < (8\% + 1\ bank - specific\ standard\ deviation\ of\ CAR) \\ &= 0\ otherwise \end{aligned} \qquad \textbf{(9)}$$

The rationale behind this approach is that banks prefer to have a buffer above the minimum requirement for reputational reasons and to decrease the probability of falling under this legal requirement (Rime, 2001).

As in Shrieves and Dahl (1992), the speed of adjustment of capital levels (SPEED) is going to be studied. As a reminder, the SPEED variable is used to proxy the target capital level ($CAP^*_{j,t}$) with the previously seen other variables. The SPEED variable is therefore only included in the capital equation. Did financial institutions under regulatory pressure adjust their capital at a higher rate than adequately capitalized institutions? Or did EU institutions adjust their capital level quicker than American ones? The answers to these questions will be given by this variable, computed as the product between the regulatory pressure variable (REG) and the lagged capital level ($CAP_{j,t-1}$).

3.4. Model specification

Now that each variable of the model has been explained, Equation (7) can be rewritten as:

$$\Delta CAP_{j,t} = \alpha_0 + \alpha_1\, ROA_{j,t} + \alpha_2\, SIZE_{j,t} + \alpha_3\, \Delta RISK_{j,t} + \alpha_4\, REG_{j,t-1} + \alpha_5\, SPEED_{j,t} - \alpha_6 CAP_{j,t-1} + \alpha_7\, dy2011 + \sum_i \alpha_{8i} c_i + E_{j,t}$$

$$\Delta RISK_{j,t} = \beta_0 + \beta_1\, LLOSS_{j,t} + \beta_2\, SIZE_{j,t} + \beta_3\, \Delta CAP_{j,t} + \beta_4\, REG_{j,t-1} - \beta_5\, RISK_{j,t-1} + \beta_6\, dy2011 + \sum_i \beta_{7i} c_i + U_{j,t}$$

(10)

where:

- $SPEED_{j,t} = REG_{j,t} * CAP_{j,t-1}$ is the speed of adjustment of capital levels;
- c_i is a country dummy variable, equal to 1 if bank *j* belongs to country *i* and 0 otherwise.

4. Data and methodology

4.1. The main data source - Bankscope

Data come from Bankscope, a Bureau Van Dijk database containing information about 30,000 banks all over the world. Data are thus retrieved for the period 2006-2014 and only covering commercial banks since this type of institutions is the most impacted by the Basel Accords. All the variables of the model were retrieved from Bankscope, except RISK, which was computed in two steps: first, the total regulatory capital of each bank *j* at time *t* ($K_{j,t}$) is divided by its corresponding capital adequacy ratio ($CAR_{j,t}$) to obtain the so-called risk-weighted assets ($RWA_{j,t}$).

$$RWA_{j,t} = \frac{K_{j,t}}{CAR_{j,t}} \quad (11)$$

In a second step, the variable RISK ($RISK_{j,t}$) is found by dividing the risk-weighted assets of bank j at time t ($RWA_{j,t}$) by its total assets ($A_{j,t}$).

$$RISK_{j,t} = \frac{RWA_{j,t}}{A_{j,t}} \quad (12)$$

Since the purpose of this thesis is to compare EU commercial banks with US commercial banks, two datasets are created. The EU dataset contains banks from each Member State of the European Union, i.e. from Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom[5].

4.1.1. Adjustments to the dataset

Consistent with other studies, banks with a total capital ratio higher than 50% are omitted from the datasets. Banks with a risk ratio higher than 200% are also excluded because they are considered as outliers and are not representative of the majority of the financial institutions. Besides, banks that did not report their total capital ratio for at least two consecutive years are ignored to have consistent regression results (avoidance of too many missing observations). Another important characteristic of the datasets is the exclusion of banks with an amount of total assets inferior to $100 million during the reference period. In the banking industry, the number of small banks is largely superior to that of large banks. That is why, to avoid a domination of the large number of small banks on the regression results, the dataset is limited to larger banks (Shrieves and Dahl, 1992).

Moreover, all the financial institutions that were in liquidation or went bankrupt during the period 2006-2014 have been excluded from the datasets in order to avoid their impact on the

[5] These Member States were consistent members of the European Union during the period 2006-2014.

regression results. However, banks that "disappeared" from the Bankscope database during the period 2006-2014 due to mergers or acquisitions are not removed from our datasets. Indeed, their assets and liabilities are still part of Bankscope but they are integrated in the balance sheet of the acquirer. Furthermore, the figures are represented on a yearly basis. Finally, concerning the utilization of Bankscope, several choices needed to be made. Each of them, if wrong, could have a big impact on the regression results. Those choices are further explained in Appendix B.

4.1.2. General comment on the data

The data of Bankscope are accounting data. This means that they are retrieved from the annual accounts published by the banks. Yet, with respect to the applicable regulations, banks can choose which financial reporting framework they use to publish those accounts (for instance, US GAAP or IFRS). Some slight differences exist between those two frameworks and consequently, it will have an effect on the regression results. Those outcomes cannot be changed as the data are taken as they are presented by Bankscope. Besides, banks' management will also play a role in the regression results. Some managers are risk averse, whereas others are risk takers. Regression estimates will be impacted as observed changes in risk are analyzed with the simultaneous equations model.

4.2. Methodology

The main contribution of our study is to extend the empirical literature on the impact of the Basel III Accord on European and American commercial banks of any size (still, we only keep banks with assets greater than $100 million) over the period 2006-2014. Furthermore, we want to analyze the impact of the announcement of a capital regulation on the capital and risk behavior of financial institutions. Therefore, we use a modified version of the simultaneous equations framework of Dahl and Shrieves (1992) but in line with the papers we have discussed in Section 2.2.

The regression analysis of banks' behavior towards banking regulation will be done in three stages. Figure 1 schematizes those three layers of the regression analysis. We start from a more global view to end with a more specific view on the matter. The first regression will be performed on a database containing both American and European banks: the EU – US dataset. At this level of investigation, overall insights on the subject can be retrieved from the model estimates. The second stage of the process is a regression study on banks' behavior in the EU and the US separately. This will be completed by a particular emphasis on the well-capitalized (CAR>8%+standard deviation) and undercapitalized (CAR<8%+standard deviation) financial institutions of each area. The regulatory pressure variable may be indeed more powerful if each dataset (dataset with American banks and dataset with European banks) is cut in two: one subset with undercapitalized banks and another with well-capitalized banks. This alternative approach will give us more insights about the role of regulation on each subset of banks but also on the relationship between changes in capital and risk (Shrieves and Dahl, 1992).

Consistent with previous studies, the method used to estimate the simultaneous equations model is the three-stage least-squares regression (3SLS). The right-hand side of each equation of the simultaneous equations model contains at least one endogenous variable[6]. The 3SLS estimator takes account of this endogeneity and creates consistent parameter estimates. The 2SLS (two-stage least-squares) estimator does the same but it produces asymptotically less efficient estimates than the 3SLS. Concretely, the three-stage least-squares method is done in three steps. First, the reduced form equations are estimated by OLS (ordinary least squares). This is a regression of the endogenous variables upon all instruments. In the second step, the original structural equations are estimated by OLS but all endogenous variables on the right-hand side are replaced with their predicted values from the first stage (Verbeek, 2004). The third step enables non-zero covariance between the error terms.

4.3. Descriptive statistics

4.3.1. Representativeness of the sample

The selected banks in the sample should be representative of their national banking sector and should therefore explain at least half of the total national assets in 2014.

Table 2 displays in its second column how many commercial banks per country are represented within the sample. The last column shows how many of those banks are part of the national top ten with regard to their total assets. And the third column of Table 2 suggests whether those banks are representative of their country. All the countries listed in Table 2 are well represented

[6] An endogeneity problem arises when an explanatory variable is correlated with the error term.

within the sample. Indeed, the sum of the sample assets always outpaces 50% of the total national assets in the banking industry. Estonia and Hungary are not part of the table as their ratio of sample assets to total national assets is lower than 50%. Bankscope does contain data about banks having their headquarters in Estonia and Hungary, but these data, and particularly the capital adequacy ratios, are not reported in the database. That is why several Estonian and Hungarian commercial banks were omitted in the datasets. Consequently, the remaining Estonian and Hungarian commercial banks are deleted from the database.

A huge gap can be detected between the number of commercial banks in the EU dataset and the US dataset. The first one contains 421 financial institutions, whereas the second one 2,337 institutions. This difference is explained by a higher number of available data for US banks in Bankscope. Besides, the original quantity of banks in each area can be a justification. According to the Federal Reserve (Federal Reserve Bank of St. Louis, 2016), there existed 5,573 commercial banks in the United States at the end of 2014, while, according to Bankscope, around 1,733 commercial banks in the European Union.

4.3.2. Sample characteristics

Table 3 presents the characteristics of each dataset that will be used for the regression analysis. In total, the EU dataset includes 3,061 observations and the US dataset 20,917 observations. The "total" line of Table 3 corresponds to the sample characteristics for the EU-US dataset, the dataset where American and European financial institutions are combined (first stage of the regression analysis).

Table 3 also suggests the sample characteristics of the datasets, which are only composed of undercapitalized or well-capitalized institutions of each area. We can observe that the number of poorly capitalized banks is far below that of adequately capitalized institutions in the United States, whereas, in the European Union, those numbers are closer to each other.

4.3.3. Summary statistics

For each dataset, three types of tables are distinguished in the List of Tables. Each group of tables is separated from each other according to which layer of regression analysis they belong. The first type of table (corresponding to Tables 5, 8, 11, 14, 17, 20 and 23) shows the summary statistics of each dataset, i.e. the number of observations, the mean, the standard deviation and the minimum and maximum values over the total reference period of the data. The second type of table (corresponding to Tables 6, 9, 12, 15, 18, 21 and 24) separates the data into two parts: before and after the year 2010, i.e. the year where the Basel Committee announced a new Basel regulation with more stringent capital rules. Furthermore, in the last column, a t-statistic is included for each variable of the model. It compares the means of a same variable between two groups (before and after the announcement of implementation of Basel III) (Stata, 2016b). The last type of table (corresponding to Tables 7, 10, 13, 16, 19, 22 and 25) displays the results of the regression analyses on each dataset. These tables will be covered in Section 5.

In this section, only the first two types of tables are of interest. With respect to our analysis, the most interesting variables in those tables are $\Delta CAP_{j,t}$ and $\Delta RISK_{j,t}$ because they check the evolution of bank capital and bank risk levels over the years. Globally, banks have increased their capital and decreased their risk over the period 2006-2014. And the introduction of Basel III has had a positive impact on banks' behavior: before 2010, banks decreased their capital but afterwards, they increased it to be in line with the more severe regulation. No significant impact of the regulation can be noticed regarding banks' risky assets. The same conclusions can be drawn for the US datasets separately except that adequately capitalized American banks can afford them to increase their risk-weighted assets in the Basel III-period as they have enough capital buffers. No conclusions can be taken for the EU datasets as their t-values for $\Delta CAP_{j,t}$ and $\Delta RISK_{j,t}$ are not statistically significant.

4.3.4. Preliminary analysis

As a very first step, we can visually check if banks increased their capital adequacy ratio and decreased their credit risk ratio during the sample period. Figure 2 presents the evolution of the capital adequacy ratios for European financial institutions. It essentially shows an increasing trend in capital ratios, but with ups and downs. The black dashed line is the European Union line and is computed as the average of all the other lines. This EU line proves that European commercial banks have tried to boost their capital adequacy ratio over the period 2006-2014. Though, in lots of countries, a drop can be noticed in the years 2007-2008 due to the financial crisis. The United Kingdom, Finland, Greece, Poland and France are good examples as we can see on Figure 3 (zoom-in of Figure 2 in the years 2007-2010).

During this crisis period, financial institutions had to make huge depreciation of assets, especially of assets linked to toxic securities. Therefore, banks had to build lots of provisions to compensate the incurred losses. This degradation of banks' balance sheets led to a fall in stock prices, and so to losses on financial assets owned by banks. That is why banks decided to sell parts of their highly liquid assets to stop this vicious circle (Plane and Pujals, 2009). Banks were also forced to increase provisions on doubtful loans in response to a huge rise of the default rates on household loans and corporate loans. All in all, these different crisis' consequences converted later on in huge losses (Plane and Pujals, 2009). As we know, incurred losses decrease banks' own funds and consequently, their capital ratios; hence the drop in ratios in the years 2007-2008 in Figure 3.

Another important insight from Figure 3 is the boost in capital ratios just after 2008. As a consequence of those important losses in 2008, banks were threatened to become insolvent. Different ways existed to raise again the solvency of banks; either the equity could be increased and/or risk-weighted assets could be decreased. But banks were not able anymore to raise equity alone. Public authorities had a great deal in the rescue of banks. We could think that banks have increased their capital ratios because they wanted so, but it is not. Capital increases are not the result of good management of the crisis by financial institutions, but they are only due to government support. Only a few banks succeeded to raise equity through capital markets in the financial crisis' period.

The way governments helped banks to raise equity differed from country to country. They have among others granted financing facilities to banks, implemented recapitalization plans or they have created bad bank assets (Plane and Pujals, 2009). Besides, banks decreased their risky assets, mostly through a reduction of household loans and loans to risky corporations. Thus, several countries saw banks' capital ratio reaching the bottom in 2008 and then going up again due to the effect of recapitalizations and the reduction of risk-weighted assets (Plane and Pujals, 2009).

One more pattern in the capital ratios' curve still needs to be clarified. As it can be seen on Figure 2, the ratio of Greece (yellow line) dropped from a safe 14% in 2010 to just above 8% in 2011. This was due to the Greek government-debt crisis. The four biggest Greek commercial banks were also recapitalized afterwards leading to a huge increase of their capital adequacy ratio in the following years (equal to 16% in 2013).

Figure 4 compares the evolution of banks' capital adequacy ratios in the United States and in the European Union. From this figure, it can be assessed that capital ratios in Europe and in the United States followed the same pace. After having bottomed out in 2007-2008, the ratios increased significantly in the following years. American banks' ratios underwent a period of stagnation over the period 2011-2014.

As Figure 2 presented an increasing trend in the total capital ratios, Figure 5 displays a downward trend in the credit risk ratios. The European Union is again represented with a black dashed line. Globally, European banks have thus decreased their risk over the reference period. Good examples of this pattern are Denmark and Spain. Danish organizations had in 2006 a risk ratio of 93.35%, which dropped to 65.13% in 2014, while Spain went from a risk ratio of 65.5% in 2006 to 44.37% in 2014. Figure 6 compares this decrease of the credit risk ratios in the EU and the US. It can be noticed that American banks have always had a higher risk than European banks over the reference period. Both areas dropped their risk, but the decrease in risk performed by European institutions is almost twice that of American institutions. Moreover, in the last three years of the sample period, American banks appear to increase their risk-weighted assets to total assets ratio.

In conclusion, those figures do not bring sufficient evidence whether banks reacted to regulatory requirements by increasing their capital adequacy ratio and decreasing their risk. Indeed, the capital ratios have mainly fluctuated due to macro-economic shocks in the European banking environment. And by looking at Figures 5 and 6, it cannot be proved whether banks have decreased their risk as a result of regulatory pressure. A more detailed econometric analysis is thus required.

4.3.5. How to increase capital ratios?

Before focusing on the econometric analysis, it would be interesting to look more in depth at how capital ratios varied over the sample years. As mentioned in Section 3.2., banks have three alternatives to increase their capital adequacy ratio to respect the capital minimum requirements: they can boost their capital (increasing the numerator of the ratio), decrease their risk-weighted assets (decreasing the denominator of the ratio) or sell off their assets. In this section, only the two first alternatives are of interest.

Table 4 summarizes the attitude followed by the banks of each country with respect to the two alternatives, mentioned here above. Capital (C) and risk-weighted assets (R) work on the capital ratio (CR) in opposite directions. A boost in capital (C) increases the capital ratio (CR). It has thus a positive (+) effect on CR and is therefore represented with a (+) sign in the table. The (–) sign for C means that C went down and consequently, reduced CR. An increase in risk-weighted assets (R) leads to a reduction of CR and is thus shown in the table with a (-) sign. The (+) sign for R means that R went down and increased CR (Jackson, 1999). Each column CR of Table 4 represents the change (in %) in the banks' capital adequacy ratios of each country between two consecutive years.

To illustrate our sayings, let us take the case of Belgian banks in 2007. That year, banks increased their capital (+) but also did the same for their risk-weighted assets (-). Thus, the effects of C and R worked in opposite directions on CR, and the R effect prevailed. The increase in risky assets was thus bigger than the boost in capital. The net effect of those actions was a decrease of 0.2% in Belgian banks' capital adequacy ratios in 2007, in comparison with 2006.

We can conclude that banks' capital/lending decisions varied a lot during the period covered. Table 4 may thus give an indication on the economic condition of each individual country. Consequently, we may already infer some results of the empirical analysis covered in Section 5. It is quite probable that the regulatory pressure has induced banks to increase their capital but its effect is rather uncertain on banks' treatment of risk-weighted assets.

5. Regression results

Based on the first results from previous section, we expect to find that banks increase their capital level due to the pressure set by regulatory authorities, while its impact on the risk level is rather uncertain. An empirical analysis will give us more insights on how banks adjusted their balance sheet to be in line with the Basel III Accord.

As explained in the section on methodology, the regression analysis will be composed of three layers. It begins with a three-stage least-squares regression on the EU – US dataset and will be then narrowed down to the more specific datasets. This analysis in three steps enables to see whether the results are different when the regression is performed on a more precise layer.

5.1. The overall sample

As a result of the regression analysis on the EU-US dataset, bank size is negatively significant, but only in the ΔCAP equation. Larger banks are supposed to have a better access to capital markets and consequently, they can be run with a lower amount of capital. Another possible explanation is that those banks do not want to increase their capital ratio too much because they fear for a "too-big-to-fail" effect, which is further explained in Appendix C. Globally, size has no effect on the credit risk ratio. As hypothesized, the return on assets' variable has a positive significant effect on bank capital in each layer of the regression analysis. This is consistent with the idea that profitable banks can more easily raise their capital through retained earnings. The negative significant impact of the LLOSS variable on ΔRISK is in line with the hypothesis formulated in Section 3.3.3, as banks with a lower asset quality (higher LLOSS) are normally supposed to have a higher risk. The country dummy variables in the ΔCAP equation are very positively significant for Bulgaria, Denmark, Greece, Ireland, Latvia, Lithuania and Slovenia. Institutions of those countries have thus experienced an increase in their capital level. Yet, countries as Greece and Ireland have also increased their risky assets over the period 2006-2014[7]. The 2011 year dummy is positively significant in the ΔCAP equation. It indicates that target equity levels were higher in 2011 and after than the years before. This means that the

[7] Both countries have endured an additional crisis after the financial crisis; in Greece, the so-called Greek government-debt crisis and in Ireland, the so-called post-2008 Irish banking crisis. In those critical periods, financial institutions of both countries had a high risk and were recapitalized to avoid insolvency and bankruptcy. That is why, regression results display a parallel increase in the capital to assets ratio and the credit risk ratio.

pressure set by the announcement of Basel III's introduction was effective. Commercial banks have consequently followed the regulation by increasing their capital to reach a higher total capital ratio. However, the effect on risk is rather uncertain.

Changes in capital levels and changes in risk are positively related. In Table 7, an increase of 1 percentage point in the capital to assets ratio increased the average credit risk ratio by 1.2 percentage points from 68.87% to 70.07%., whereas a similar increase in the credit risk ratio had only a small impact on the capital to assets ratio (+0.06%). Consequently, banks seem willing to raise capital and risk simultaneously. This finding is consistent with the theory of Kahane (1977), Koehn and Santomero (1980) and Kim and Santomero (1988). Those academics found out that an increase of the capital ratio implies a shift of banks' portfolio towards riskier assets.

As a reminder, the impact of Basel III on the observed changes in bank capital and risk is mainly studied through the variable $REG_{j,t-1}$. In Table 7, this variable is statistically significant in both equations of the model: positively in the capital equation and negatively in the risk equation. Financial institutions close to the minimum regulatory requirements increased their capital to assets ratio by 0.015 percentage points more than other banks. With regard to the risk equation, those institutions have decreased their risk ratio by 0.024 percentage points more than other banks. Banks have thus used the two alternatives that were at their disposition to increase their capital adequacy ratio.

Furthermore, the regulatory pressure imposed by the implementation of Basel III is normally expected to be effective. Therefore, poorly capitalized banks should have increased their capital to assets ratio and/or decreased their risk ratio more than well-capitalized banks. This can be proved in two ways: first, by the analysis of the lagged capital and lagged risk variables and second, by the analysis of a combination between the lagged capital variable and the SPEED variable. The coefficient estimates of lagged capital and lagged risk are negative and statistically significant. Moreover, their values lie in the interval [-1; 0] and therefore, it can be concluded that, overall, banks have adjusted capital and risk to the desired levels as soon as they could during the period 2006-2014. The introduction of the SPEED variable in the simultaneous equations model enables banks with low capital buffers to adjust capital at a higher rate than banks with high capital buffers. In Table 7, this variable has a negative significant impact on $\Delta CAP_{j,t}$. So, the regressions results infer that capital-constrained organizations have adjusted their capital faster than other banks.

At the end of each table about the regression estimates, the coefficient of determination, also called R-squared value, is displayed. It is a statistical measure that indicates the proportion of variance in the dependent variable, which can be explained by the explanatory variables (Stata, 2016a). For instance, in Table 7, the R-squared value tells us that the independent variables of the model (in this case, $REG_{j,t-1}$, $SIZE_{j,t}$, $ROA_{j,t}$, $\Delta RISK_{j,t}$, $CAP_{j,t-1}$, $SPEED_{j,t}$, $dy2011$ and *Country effects*) explain 29.25% of the variance in $\Delta CAP_{j,t}$. This is considered as a low coefficient of determination. Nevertheless, a coefficient of determination can be low provided that, in the model, we have statistically significant estimators.

In the two next sections, only the main differences with the regression results obtained in the first layer will be pointed out.

5.2. Sample split according to regions – EU vs. US

Interestingly, the variable SIZE is not significant for American banks in the capital equation. However, in the risk equation, this variable is positively significant in the US dataset while negatively significant in the EU dataset. This negative effect on ΔRISK is not in line with the empirical literature. Larger European banks, whether well-capitalized or poorly capitalized, seem to have lower target risk levels than smaller banks. Regarding the current loan losses, European banks do not respect the hypothesis (almost all coefficient estimates are positively significant), while American banks do (all parameter estimates are negatively significant). That is why, in the global dataset, a negative significant coefficient is obtained because this dataset contains many more observations about US banks than EU banks. The announcement of Basel III's implementation in 2010 has no effect on capital for European banks, but well on risk; banks' target risk levels were lower after 2010. On the contrary, American banks boosted their equity levels, but risk was not affected by the variable dy2011.

The focus on the EU and US datasets gives us more insights on the impact of the risk-based capital requirement. European banks approaching the minimum legal requirement have increased their capital ratio by 0.016 percentage points more than other banks and decreased their credit risk ratio by 0.046 percentage points. American banks that were under pressure experienced the same behavior: they increased the capital ratio by 0.015 percentage points more than other banks and dropped the risk ratio by the same amount. In the European Union, the estimated speed of adjustment for capital equals 0.3574 (= $SPEED_{j,t}$ + $CAP_{j,t-1}$= 0.2677 + 0.0897) for undercapitalized banks, whereas for the banks with high capital buffers, the speed of adjustment is 0.0897, which makes a big difference between the two. The same comparison can be made for American banking organizations. Poorly capitalized financial institutions have adjusted their capital at a speed of 0.365 (= $SPEED_{j,t}$ + $CAP_{j,t-1}$= 0.2382 + 0.1268), while those with high capital buffers at a speed of 0.1268 (Heid et al., 2003).

5.3. Sample split according to region and bank type – well- vs. undercapitalized banks in EU vs. US

The last layer of the regression analysis also brings new relevant information. The variable SIZE shows that larger undercapitalized banks in the United States increased their capital more than similar smaller undercapitalized institutions. And larger adequately capitalized American financial institutions pursued a greater diversification to reduce risk exposure (positive parameter estimate of 0.0011). Another important insight comes from the positively significant coefficient estimates of the country dummy variables in the ΔCAP equation. Poorly capitalized European financial institutions have globally increased their capital level over the reference period. Concerning the 2011 year variable, the pressure set by the announcement of Basel III's implementation has had the expected impact on capital and risk. Both American and European undercapitalized banks show higher target equity levels and lower target risk levels after 2010. Moreover, American well-capitalized institutions seem to have increased their risk under the pressure of Basel III's announcement. Nevertheless, dy2011 has no significant impact on both equations of the model for European organizations with adequate capital buffers. It suggests that target capital and risk levels were relatively constant over the years of the reference period.

As shown by Tables 16 and 19, European well-capitalized institutions appear to increase more their risk after having increased their capital than undercapitalized institutions do. Indeed, a 1 percentage point increase in the capital to assets ratio of capital-constrained banks increased the average credit risk ratio by 1.41 percentage points from 57.89% to 59.3%, while a 1 percentage point increase in the capital to assets ratio of well-capitalized banks increased the average credit risk ratio by 2.43 percentage points from 60.83% to 63.26%. And this growth in the average credit risk ratio of EU adequately capitalized organizations is about 1 percentage point higher than the rise for similar American institutions. This difference in risk-taking between well-capitalized and undercapitalized organizations is logical as banks with an adequate capital buffer may pay less attention to capital and can consequently invest more in risk-weighted assets than capital-constrained institutions.

In the European Union, capital-constrained banks have adapted their capital levels at a rate several times higher than adequately capitalized banks. This rate equals 0.23% per year for banks that were under regulatory pressure and 0.07% per year for the banks with a total capital above the required 8% (plus one standard deviation). This again proves that a capital regulation can be effective. The difference in the rate of adjustment between a healthy bank and a bank under pressure is even more evident in the United States. Well-capitalized banks adjusted their capital levels at a rate of 0.10% per year, whereas poorly capitalized institutions did not want to be in breach of the regulation, and thus, they adjusted at a rate of 0.31% per year. Similar data can be retrieved for the credit risk ratio. Adequately capitalized European banks adjusted the share of risk-weighted assets in their portfolio at a rate of 0.12% per year, while undercapitalized institutions did the same but at a rate of 0.22% per year. On the other side of the Atlantic, the risk-weighted assets to total assets ratio is adjusted at a rate of 0.06% per year for adequately capitalized banks, while 0.17% per year for poorly capitalized banks.

6. Conclusion

This thesis has examined the effect of the Basel III regulation on the behavior of European and American commercial banks with respect to capital and risk-taking over the period 2006-2014. This has been done through a regression analysis in three steps on a modified version of the simultaneous equations model developed by Shrieves and Dahl (1992). Previous studies found out that the regulatory pressure, imposed by the introduction of risk-based capital requirements, had a positive impact on the capital levels, but no effect could be inferred on the credit risk-taking of financial institutions.

In our study, we have obtained empirical evidence that, during the reference period, financial institutions tried by all means to boost their total capital ratio. Indeed, commercial banks under regulatory pressure, whether those were American or European, increased their capital to assets ratio, but those institutions also decreased their credit risk ratio.

Furthermore, we can say that the Basel III Accord is an effective regulation. Banks that were under the minimum capital requirement increased their capital and decreased their risk more than their healthy counterparts. Besides, the regression outcomes indicated a higher adjustment rate of capital and risk levels for undercapitalized organizations than for adequately capitalized organizations. And this difference in adaptation pace was even more obvious when banks were located in the United States of America. Another empirical evidence of Basel III's effectiveness is shown by the inclusion of the 2011 year dummy variable in the model. For American and European capital-constrained institutions, target equity (risk) levels were indeed higher (lower) in 2011 than the years before. Only for European institutions with adequate capital buffers, the target capital and risk levels were relatively constant over the years of the reference period.

Another important insight from this thesis came from the relationship between risk and capital. As some prior studies mentioned, risk-taking banks will react to a required increase of the capital ratio by shifting their portfolio towards riskier assets. This behavior is especially noticed in the presence of well-capitalized banks, and even more if they are part of the European Union. Actually, we do not know why banks react in such a way. There are two possible explanations for it. Firstly, it may be just a voluntary choice of commercial banks. Or thanks to the additional capital raised, banks may be more able to earmark their risk portfolio and may be thus not forced to sell a share of it on the market. As a result, banks may have decided to keep the value of their risk portfolio at the same level because the overall risk in the credit markets has increased. Those statements cannot be verified with the simultaneous equations model and are consequently subject to further research.

In short, this thesis showed that capital regulation, in particular the Basel III Accord, seems to be effective since American and European banks’ capital adequacy ratios have been increased over the period studied.

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List of Tables

Table 1: Previous papers on the effect of capital regulation on bank capital and risk-taking

Author(s) (Year of publication)	**Sample and period**	**Effect of regulatory pressure on ΔCAP**	**Effect of regulatory pressure on ΔRISK**	**Relationship between ΔCAP and ΔRISK**
Shrieves and Dahl (1992)	1,800 US commercial banks over the period 1983-1987	+ for *B*	**-** for *B*	+
Jacques and Nigro (1997)	2,570 US commercial banks over the period 1990-1991	+ for *A* -/**0** for *U*	**-** for *A* **0** for *U*	overall **0**
Aggarwal and Jacques (1998)	2,552 US commercial banks over the period 1990-1993	+ for *A* + for *U*	+ in 91/ **-** in 92-93 for *A* and *U*	+
Ediz et al. (1998)	94 UK banks from the 4th quarter 1989 to the 4th quarter 1995	+ for *U*	**0** for *U*	not studied
Rime (2001)	154 Swiss banks over the period 1989-1995	**0** for *A* + for *U*	**0** for *A* and *U*	**0**/+
Aggarwal and Jacques (2001)	1,685 US commercial banks over the period 1990-1997	+ for *A* and *U* in 91 **0** for *A* and *U* in 92 and 93-96	+ in 91 / **0** in 92 / **-** in 93-96 for *A* and *U*	+ and **-** in 91 and 92 + in 93-96
Heid et al. (2003)	550 German savings banks over the period 1993-2002	**-** for *B*	+ for *B*	**0**
Van Roy (2005)	576 G-10 commercial banks over the period 1988-1995	+ and **0** for all *B* except **0** for Japanese *B* and + for US *B*	**0** for all *B*	**0** for all except **-** for US
Matejasak et al. (2009)	580 European and 683 US commercial banks over the period 2000-2005	+ for all *B*	**0** for EU *B* **-** for US *B*	+
Akinsoyinu (2015)	17 European global systemically important banks over the period 2005-2014	+ for *B*	**0** for *B*	**-**

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

Table 2: Representativeness of the sample

Countries	Number of banks	Sample assets / total national assets	Number of banks in national top 10
Austria	10	78%	4
Belgium	9	94%	5
Bulgaria	13	95%	7
Cyprus	7	53%	5
Czech Republic	15	96%	9
Denmark	44	100%	5
Finland	8	96%	5
France	14	88%	4
Germany	12	83%	4
Greece	12	100%	6
Ireland	6	93%	5
Italy	93	97%	4
Latvia	10	86%	7
Lithuania	7	91%	6
Luxembourg	17	60%	7
Malta	3	90%	3
Poland	22	85%	7
Portugal	12	72%	3
Romania	10	72%	6
Slovakia	9	74%	5
Slovenia	14	92%	7
Spain	20	97%	9
Sweden	14	98%	4
The Netherlands	21	98%	6
United Kingdom	19	67%	4
Total	421		
United States	2337	95%	5

Note: Columns 3 and 4 are as of 2014. Colum 3 is computed on the basis of column 2.

Table 3: Characteristics of the datasets

			Undercapitalized banks		**Well-capitalized banks**	
	Number of banks	*Number of observations*	*Number of banks*	*Number of observations*	*Number of banks*	*Number of observations*
EU dataset	421	3,061	187	1,405	234	1,656
US dataset	2,337	20,917	302	2,688	2,035	18,229
Total (EU-US dataset)	**2,758**	**23,978**				

Table 4: Contribution of the change in capital and risk-weighted assets to the change in the capital adequacy ratio

	2007			2008			2009			2010			2011			2012			2013			2014		
	C	**R**	**CR**	**C**	**R**	**CR**	**C**	**R**	**CR**	**C**	**R**	**CR**	**C**	**R**	**CR**	**C**	**R**	**CR**	**C**	**R**	**CR**	**C**	**R**	**CR**
Austria	+	-	-0,4	-	-	-1,0	+	+	1,9	+	-	0,8	+	+	1,1	+	+	0,9	+	+	1,0	-	-	-0,7
Belgium	+	-	-0,2	+	+	1,7	+	+	2,8	-	+	0,6	-	+	-0,1	-	+	0,3	-	+	0,6	-	-	0,6
Bulgaria	+	-	-1,8	+	-	0,6	+	-	1,2	-	+	-0,4	+	-	0,4	-	-	-1,0	+	-	2,4	+	+	5,7
Cyprus	+	-	-1,6	+	-	-1,2	+	-	0,6	+	-	0,3	-	+	-0,4	-	+	-1,8	+	+	2,2	+	-	1,7
Czech Republic	+	-	-0,2	+	+	2,5	+	-	0,2	+	-	0,0	+	-	0,8	+	-	-1,2	+	+	-0,6	+	-	0,6
Denmark	-	-	-0,3	+	+	2,4	+	+	1,8	+	-	-0,4	+	-	0,2	+	+	0,1	+	-	-0,1	-	-	-0,7
Finland	+	-	-1,4	-	-	-1,2	-	+	1,2	+	-	0,2	-	-	-0,9	-	+	2,7	+	-	-0,5	+	-	0,5
France	-	-	-0,7	+	-	-0,3	+	+	1,2	+	-	-0,1	-	-	0,7	-	+	1,1	-	-	0,3	+	-	0,0
Germany	+	-	-0,2	-	+	-0,3	+	+	0,8	+	-	0,7	+	+	2,2	+	+	1,4	-	+	-1,0	+	-	-1,1
Greece	-	-	-0,6	+	-	-0,8	+	-	1,5	+	+	0,6	-	+	-6,3	+	+	4,1	+	-	2,1	+	+	0,4
Ireland	+	-	-0,2	-	+	-0,6	-	+	-0,2	-	+	0,1	+	+	4,9	-	+	1,4	-	+	-1,3	+	+	3,2
Italy	+	-	-0,7	+	+	1,4	+	+	1,4	+	+	0,4	+	+	0,5	-	+	1,4	-	+	0,9	+	+	-1,4
Latvia	+	-	0,7	+	+	0,3	+	+	1,6	-	+	0,0	+	+	1,2	-	+	0,3	-	+	2,4	+	-	1,0
Lithuania	+	-	-0,4	+	-	1,3	-	+	1,2	+	+	1,5	-	-	-1,9	+	-	1,8	+	+	0,7	+	+	1,1
Luxembourg	-	-	0,0	-	+	1,3	+	+	2,5	+	-	-0,7	-	+	-3,7	+	+	2,6	+	+	4,0	-	+	0,7
Malta	+	-	0,0	+	-	-1,3	+	-	0,1	+	+	1,4	+	-	-0,2	+	-	0,6	+	-	0,8	+	-	-0,7
Netherlands	+	-	1,5	+	-	0,6	+	+	-0,3	+	-	0,4	-	+	-0,2	+	+	0,3	-	+	1,5	+	+	0,6
Poland	+	-	-0,9	+	-	-1,3	+	+	1,8	+	-	0,2	-	+	-1,0	+	-	2,3	+	-	0,2	-	-	-0,2
Portugal	+	-	-0,9	+	-	-1,3	+	-	1,8	+	-	0,2	-	+	-1,0	+	+	2,3	+	+	0,2	-	+	-0,2
Romania	+	-	-2,5	+	-	-0,3	+	+	2,7	+	-	0,4	+	-	0,1	-	+	-0,9	+	+	0,3	-	+	-0,6
Slovakia	+	-	-1,9	+	-	-0,9	+	+	1,0	+	-	-0,8	+	-	0,5	+	+	1,1	+	-	0,1	+	-	0,1
Slovenia	+	-	-2,2	+	-	0,7	-	-	0,0	-	+	-0,4	-	+	0,2	-	+	-0,8	-	+	-0,5	+	+	2,3
Spain	+	-	-0,2	-	+	0,3	-	+	0,3	+	-	-0,2	-	+	-0,4	-	+	-0,7	+	+	1,4	+	-	0,6
Sweden	+	-	1,1	-	+	-0,1	+	+	0,8	+	-	-0,5	+	-	-0,2	+	-	0,5	+	+	1,9	+	+	2,9
United Kingdom	+	-	0,5	-	+	-0,3	+	+	2,2	+	-	0,3	+	-	0,4	+	+	-0,8	-	+	1,7	-	-	-0,6
European Union	+	-	-0,5	+	+	0,5	+	+	1,2	+	-	0,1	-	+	0,0	+	+	0,7	+	+	0,9	+	-	0,3
United States	+	-	-0,5	+	-	-0,3	+	-	0,4	+	-	0,9	+	-	0,7	+	-	0,2	+	-	0,1	+	-	0,0

First layer – overall

Table 5: Summary statistics of the EU – US dataset

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
$\Delta CAP_{j,t}$	20814	.0005238	.012522	-.1835676	.1775389
$ROA_{j,t}$	23978	.0074467	.0126631	-.6378987	.2271863
$SIZE_{j,t}$	23978	6.618545	1.630296	4.61512	14.93559
$REG_{j,t-1}$	21146	.0565119	.230913	0	1
$CAP_{j,t-1}$	20859	.10235	.027713	-.0375675	.526047
$SPEED_{j,t}$	20833	.0040671	.0195552	-.0375675	.4413365
$\Delta RISK_{j,t}$	20797	-.0058695	.0597442	-1.083026	.9095434
$LLOSS_{j,t}$	23891	.0044892	.0093845	-.050557	.5497186
$RISK_{j,t-1}$	20849	.6913469	.1438648	-.4083425	1.99569
$dy2011$	23978	.4451998	.4969982	0	1

Table 6: Means and standard deviations of model variables before and after announcement of Basel III for the EU-US dataset

	Before announcement of implementation of Basel III			After announcement of implementation of Basel III			t-statistic
Variables	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
$\Delta CAP_{j,t}$	7673	-.0009784	.013637	10520	.0013278	.0114764	-12.3551
$ROA_{j,t}$	10623	.0079284	.0114994	10675	.0074993	.0138476	2.4593
$SIZE_{j,t}$	10623	6.492577	1.643636	10675	6.738293	1.609591	-11.0224
$REG_{j,t-1}$	7864	.0820193	.2744116	10626	.0382082	.1917075	12.7756
$CAP_{j,t-1}$	7686	.1013479	.0294278	10546	.1036423	.026639	-5.4935
$SPEED_{j,t}$	7677	.0063728	.0248617	10531	.0025213	.0148715	13.0202
$\Delta RISK_{j,t}$	7666	-.0051635	.0630418	10512	-.0018219	.0565934	-3.7457
$LLOSS_{j,t}$	10584	.004398	.0085899	10634	.003782	.0098639	4.8502
$RISK_{j,t-1}$	7681	.7257315	.1428019	10543	.663593	.139241	29.4288
$dy2011$	10623	0	0	10675	1	0	.

Table 7: Three-stage least-squares regression on the simultaneous equations model with the EU – US dataset

	$\Delta CAP_{j,t}$		$\Delta RISK_{j,t}$	
Variables	Coefficient	z-Value	Coefficient	z-Value
$Intercept$	.0088 ***	4.36	.0415 ***	3.08
$REG_{j,t-1}$	.0150 ***	38.13	- .0243 ***	-13.52
$SIZE_{j,t}$	- .0002 ***	-3.64	- .0004	-1.21
$ROA_{j,t}$	.1374 ***	22.80		
$\Delta RISK_{j,t}$	.0601 ***	48.20		
$CAP_{j,t-1}$	- .1192 ***	-41.06		
$SPEED_{j,t}$	- .2410 ***	-54.62		
$LLOSS_{j,t}$			- .1516 ***	-3.51
$\Delta CAP_{j,t}$			1.200 ***	38.35
$RISK_{j,t-1}$			- .0865 ***	-28.57
$dy2011$	.0011 ***	7.31	0.0004	0.45
Country effects	Yes		Yes	
No. obs.	20797		20752	
R-squared	0.2925		0.1330	

***,** and * represent statistical significance at the 1%, 5% and 10% level respectively in a two-tailed t-test.

Second layer – EU vs. US.

Table 8: Summary statistics of the EU dataset

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
$\Delta CAP_{j,t}$	2249	.000437	.0191637	-.1478748	.1775389
$ROA_{j,t}$	3061	.0022551	.0223379	-.6378987	.1822034
$SIZE_{j,t}$	3061	8.788031	2.181632	4.622521	14.60507
$REG_{j,t-1}$	2572	.1807932	.3849215	0	1
$CAP_{j,t-1}$	2294	.0847149	.0394023	-.0375675	.3361702
$SPEED_{j,t}$	2268	.0105861	.02731	-.0375675	.1900826
$\Delta RISK_{j,t}$	2232	-.014569	.0995514	-1.048141	.9095434
$LLOSS_{j,t}$	2987	.0081523	.0173882	-.050557	.5497186
$RISK_{j,t-1}$	2284	.6005638	.2257941	-.4083425	1.506971
$dy2011$	3061	.4354786	.4959005	0	1

Table 9: Means and standard deviations of model variables before and after announcement of Basel III for the EU dataset

	Before announcement of implementation of Basel III			**After announcement of implementation of Basel III**			**t-statistic**
Variables	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
$\Delta CAP_{j,t}$	765	.0007626	.0181198	1187	.0005392	.0202141	0.2481
$ROA_{j,t}$	1382	.0061936	.0130448	1333	-.0017606	.0297907	9.0657
$SIZE_{j,t}$	1382	8.691498	2.210865	1333	8.879915	2.158875	-2.2457
$REG_{j,t-1}$	953	.2917104	.4547884	1289	.1062839	.3083203	11.4953
$CAP_{j,t-1}$	778	.0821951	.0391546	1213	.0858081	.0387474	-2.0217
$SPEED_{j,t}$	769	.0183754	.0335007	1198	.0060349	.0218649	9.8856
$\Delta RISK_{j,t}$	758	-.0199226	.1037654	1179	-.0125515	.1024012	-1.5381
$LLOSS_{j,t}$	1344	.0052518	.0096042	1303	.0107861	.0231437	-8.0784
$RISK_{j,t-1}$	773	.6481369	.2357424	1210	.5701228	.215373	7.5798
$dy2011$	1382	0	0	1333	1	0	.

Table 10: Three-stage least-squares regression on the simultaneous equations model with the EU dataset

	$\Delta CAP_{j,t}$		$\Delta RISK_{j,t}$	
Variables	Coefficient	z-Value	Coefficient	z-Value
$Intercept$	.0146 ***	3.89	.1321 ***	6.20
$REG_{j,t-1}$	.0161 ***	15.59	- .0460 ***	-8.90
$SIZE_{j,t}$	- .0009 ***	-4.28	- .0068 ***	-5.90
$ROA_{j,t}$	.1425 ***	10.04		
$\Delta RISK_{j,t}$	.0843 ***	24.74		
$CAP_{j,t-1}$	- .0897 ***	-8.34		
$SPEED_{j,t}$	- .2677 ***	-19.26		
$LLOSS_{j,t}$			.7474 ***	7.28
$\Delta CAP_{j,t}$			2.022 ***	20.87
$RISK_{j,t-1}$			- .1565 ***	-14.85
$dy2011$	.0007	0.96	- .0155 ***	-4.07
Country effects	Yes		Yes	
No. obs.	2232		2196	
R-squared	0.3704		0.2807	

***,** and * represent statistical significance at the 1%, 5% and 10% level respectively in a two-tailed t-test.

Table 11: Summary statistics of the US dataset

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
$\Delta CAP_{j,t}$	18565	.0005343	.0114596	-.1835676	.100327
$ROA_{j,t}$	20917	.0082065	.0103101	-.1592428	.2271863
$SIZE_{j,t}$	20917	6.256956	1.15185	4.61512	14.54545
$REG_{j,t-1}$	18574	.0393023	.1943183	0	1
$CAP_{j,t-1}$	18565	.1045291	.0250593	0	.526047
$SPEED_{j,t}$	18565	.0032707	.0182269	0	.4413365
$\Delta RISK_{j,t}$	18565	-.0048235	.0528896	-1.083026	.6166539
$LLOSS_{j,t}$	20904	.0039657	.0074344	-.027361	.1983914
$RISK_{j,t-1}$	18565	.7025156	.1258368	0	1.99569
$dy2011$	20917	.4466224	.4971545	0	1

Table 12: Means and standard deviations of model variables before and after announcement of Basel III for the US dataset

	Before announcement of implementation of Basel III			**After announcement of implementation of Basel III**			**t-statistic**
Variables	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
$\Delta CAP_{j,t}$	6908	-.0011712	.0130337	9333	.0014281	.0098205	-14.4940
$ROA_{j,t}$	9241	.0081878	.0112279	9342	.0088206	.0088649	-4.2665
$SIZE_{j,t}$	9241	6.112763	1.124729	9342	6.39507	1.163157	-16.8166
$REG_{j,t-1}$	6911	.0531037	.2242566	9337	.0288101	.1672815	7.9089
$CAP_{j,t-1}$	6908	.1035049	.0272965	9333	.1059602	.023668	-6.1206
$SPEED_{j,t}$	6908	.0050366	.0233303	9333	.0020703	.0136544	10.1560
$\Delta RISK_{j,t}$	6908	-.003544	.0566022	9333	-.0004665	.0476172	-3.7555
$LLOSS_{j,t}$	9240	.0042738	.0084255	9331	.0028039	.0053226	14.2274
$RISK_{j,t-1}$	6908	.7344142	.1253546	9333	.6757112	.1208836	30.1179
$dy2011$	9241	0	0	9342	1	0	.

Table 13: Three-stage least-squares regression on the simultaneous equations model with the US dataset

	$\Delta CAP_{j,t}$		$\Delta RISK_{j,t}$	
Variables	Coefficient	z-Value	Coefficient	z-Value
$Intercept$	.0125 ***	24.21	.0403 ***	13.94
$REG_{j,t-1}$	.0151 ***	34.27	- .0146 ***	-7.57
$SIZE_{j,t}$	.0000	0.19	.0011 ***	3.39
$ROA_{j,t}$	.1410 ***	19.69		
$\Delta RISK_{j,t}$	.0509 ***	37.10		
$CAP_{j,t-1}$	- .1268 ***	-42.72		
$SPEED_{j,t}$	- .2382 ***	-51.30		
$LLOSS_{j,t}$			- .7575 ***	-14.75
$\Delta CAP_{j,t}$			.9377 ***	28.99
$RISK_{j,t-1}$			- .0699 ***	-22.35
$dy2011$	.0012 ***	8.06	.0005	0.65
No. obs.	18565		18556	
R-squared	0.2766		0.1067	

***,** and * represent statistical significance at the 1%, 5% and 10% level respectively in a two-tailed t-test.

Third layer – EU well/under vs. US well/under.

Table 14: Summary statistics of the EU/well-capitalized dataset

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
$\Delta CAP_{j,t}$	1175	.0003775	.018453	-.1147157	.1775389
$ROA_{j,t}$	1656	.0048179	.0158931	-.1536283	.1822034
$SIZE_{j,t}$	1656	8.475602	2.215166	4.622521	14.60507
$CAP_{j,t-1}$	1198	.0936298	.0420468	.0059669	.3361702
$\Delta RISK_{j,t}$	1162	-.01124	.082788	-.5548199	.7760457
$LLOSS_{j,t}$	1605	.0072003	.0118431	-.0390517	.1618137
$RISK_{j,t-1}$	1190	.6132717	.2253681	.0129997	1.506971
$dy2011$	1656	.4480676	.4974459	0	1

Table 15: Means and standard deviations of model variables before and after announcement of Basel III for the EU/well-capitalized dataset

	Before announcement of implementation of Basel III			After announcement of implementation of Basel III			t-statistic
Variables	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
$\Delta CAP_{j,t}$	377	.0014513	.0189452	646	.000383	.0187153	0.8768
$ROA_{j,t}$	732	.0077597	.0143864	742	.0020331	.0177149	6.8074
$SIZE_{j,t}$	732	8.337661	2.271691	742	8.608294	2.16256	-2.3428
$CAP_{j,t-1}$	384	.093159	.0432542	659	.0929271	.0400041	0.0876
$\Delta RISK_{j,t}$	372	-.0135305	.088996	640	-.0093267	.0819948	-0.7618
$LLOSS_{j,t}$	706	.0050698	.009533	722	.00882	.0134124	-6.0783
$RISK_{j,t-1}$	381	.6525172	.2456167	656	.5876556	.2107371	4.4919
$dy2011$	732	0	0	742	1	0	.

Table 16: Three-stage least-squares regression on the simultaneous equations model with the EU/well-capitalized dataset

	$\Delta CAP_{j,t}$		$\Delta RISK_{j,t}$	
Variables	Coefficient	z-Value	Coefficient	z-Value
$Intercept$	.0185 ***	2.72	.0869 ***	3.22
$SIZE_{j,t}$	- .0006 **	-1.98	- .0050 ***	-3.94
$ROA_{j,t}$	.1049 ***	3.71		
$\Delta RISK_{j,t}$	.1215 ***	22.26		
$CAP_{j,t-1}$	- .0717 ***	-5.22		
$LLOSS_{j,t}$			- .0027	-0.02
$\Delta CAP_{j,t}$			2.425 ***	23.43
$RISK_{j,t-1}$			- .1209 ***	-10.58
$dy2011$	- .0004	-0.42	- .0015	-0.38
Country effects	No		Yes	
No. obs.	1162		1140	
R-squared	0.3717		0.4127	

***,** and * represent statistical significance at the 1%, 5% and 10% level respectively in a two-tailed t-test.

Table 17: Summary statistics of the EU/undercapitalized dataset

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
$\Delta CAP_{j,t}$	1074	.0005021	.0199208	-.1478748	.1220439
$ROA_{j,t}$	1405	-.0007655	.027801	-.6378987	.065597
$SIZE_{j,t}$	1405	9.156275	2.082853	4.706661	14.08414
$CAP_{j,t-1}$	1096	.0749703	.033712	-.0375675	.240429
$\Delta RISK_{j,t}$	1070	-.0181843	.1149535	-1.048141	.9095434
$LLOSS_{j,t}$	1382	.009258	.0221034	-.050557	.5497186
$RISK_{j,t-1}$	1094	.5867407	.2255475	-.4083425	1.357526
$dy2011$	1405	.4206406	.4938377	0	1

Table 18: Means and standard deviations of model variables before and after announcement of Basel III for the EU/undercapitalized dataset

	Before announcement of implementation of Basel III			**After announcement of implementation of Basel III**			**t-statistic**
Variables	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
$\Delta CAP_{j,t}$	388	.0000935	.0172784	541	.0007258	.0218859	-0.4731
$ROA_{j,t}$	650	.00443	.0110948	591	-.0065238	.0396063	6.7654
$SIZE_{j,t}$	650	9.089973	2.070775	591	9.220935	2.106981	-1.1035
$CAP_{j,t-1}$	394	.0715095	.0312381	554	.0773398	.0354131	-2.6220
$\Delta RISK_{j,t}$	386	-.0260828	.1160222	539	-.0163807	.1222608	-1.2156
$LLOSS_{j,t}$	638	.0054532	.0096857	581	.0132292	.0311125	-6.0018
$RISK_{j,t-1}$	392	.6438796	.2259653	554	.5493618	.2191179	6.4514
$dy2011$	650	0	0	591	1	0	.

Table 19: Three-stage least-squares regression on the simultaneous equations model with the EU/undercapitalized dataset

	$\Delta CAP_{j,t}$		$\Delta RISK_{j,t}$	
Variables	Coefficient	z-Value	Coefficient	z-Value
$Intercept$	.0303 ***	5.06	.1866 ***	3.22
$SIZE_{j,t}$	- .0011 ***	-3.11	- .0097 ***	-4.60
$ROA_{j,t}$	.1613 ***	8.73		
$\Delta RISK_{j,t}$	.0397 ***	8.52		
$CAP_{j,t-1}$	- .2326 ***	-11.98		
$LLOSS_{j,t}$			.7756 ***	5.47
$\Delta CAP_{j,t}$			1.409 ***	8.61
$RISK_{j,t-1}$			- .2247 ***	-11.97
$dy2011$	.0021 *	1.93	- .0176 ***	-2.66
Country effects	Yes		No	
No. obs.	1070		1056	
R-squared	0.2447		0.2047	

***,** and * represent statistical significance at the 1%, 5% and 10% level respectively in a two-tailed t-test.

Table 20: Summary statistics of the US/well-capitalized dataset

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
$\Delta CAP_{j,t}$	16183	.0006109	.0093511	-.0953419	.0896552
$ROA_{j,t}$	18229	.0087273	.008315	-.1592428	.1072961
$SIZE_{j,t}$	18229	6.217975	1.139299	4.61512	14.54545
$CAP_{j,t-1}$	16183	.1049603	.0230595	.042199	.3652735
$\Delta RISK_{j,t}$	16183	-.0038722	.0480896	-.4129257	.6166539
$LLOSS_{j,t}$	18218	.0034953	.0065064	-.0221239	.1983914
$RISK_{j,t-1}$	16183	.6969979	.12307	.1672206	1.896512
$dy2011$	18229	.4463218	.4971239	0	1

Table 21: Means and standard deviations of model variables before and after announcement of Basel III for the US/well-capitalized dataset

	Before announcement of implementation of Basel III			**After announcement of implementation of Basel III**			**t-statistic**
Variables	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
$\Delta CAP_{j,t}$	6030	-.0006889	.0105148	8129	.0012566	.0083689	-12.2516
$ROA_{j,t}$	8060	.0087284	.0089554	8136	.0091754	.0073055	-3.4822
$SIZE_{j,t}$	8060	6.067646	1.106402	8136	6.362993	1.154099	-16.6221
$CAP_{j,t-1}$	6030	.1036663	.0243968	8129	.106485	.0221269	-7.1730
$\Delta RISK_{j,t}$	6030	-.0029379	.0511762	8129	.0002819	.0445203	-3.9910
$LLOSS_{j,t}$	8059	.0036852	.0074959	8127	.0025814	.0046384	11.2749
$RISK_{j,t-1}$	6030	.725451	.1213505	8129	.6730732	.1209084	25.4492
$dy2011$	8060	0	0	8136	1	0	.

Table 22: Three-stage least-squares regression on the simultaneous equations model with the US/well-capitalized dataset

	$\Delta CAP_{j,t}$		$\Delta RISK_{j,t}$	
Variables	Coefficient	z-Value	Coefficient	z-Value
$Intercept$	.0109 ***	21.58	.0302 ***	10.90
$SIZE_{j,t}$	- .0001 **	-2.00	.0011 ***	3.59
$ROA_{j,t}$	.1197 ***	14.82		
$\Delta RISK_{j,t}$	.0546 ***	38.80		
$CAP_{j,t-1}$	- .1032 ***	-35.01		
$LLOSS_{j,t}$			- .7306 ***	-13.15
$\Delta CAP_{j,t}$			1.475 ***	39.08
$RISK_{j,t-1}$			- .0576 ***	-19.01
$dy2011$	.0010 ***	7.29	.0016 **	2.21
No. obs.	16183		16175	
R-squared	0.1630		0.1319	

***,** and * represent statistical significance at the 1%, 5% and 10% level respectively in a two-tailed t-test.

Table 23: Summary statistics of the US/undercapitalized dataset

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
$\Delta CAP_{j,t}$	2374	5.57e-06	.020721	-.1835676	.100327
$ROA_{j,t}$	2679	.0046403	.0185657	-.1154694	.2271863
$SIZE_{j,t}$	2679	6.524011	1.201836	4.634729	12.23568
$CAP_{j,t-1}$	2374	.1015907	.0357113	0	.526047
$\Delta RISK_{j,t}$	2374	-.0113604	.0775411	-1.083026	.5197757
$LLOSS_{j,t}$	2677	.0071748	.0114765	-.027361	.1331445
$RISK_{j,t-1}$	2374	.7395413	.1372655	0	1.99569
$dy2011$	2679	.4486749	.4974516	0	1

Table 24: Means and standard deviations of model variables before and after announcement of Basel III for the US/undercapitalized dataset

	Before announcement of implementation of Basel III			**After announcement of implementation of Basel III**			**t-statistic**
Variables	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	
$\Delta CAP_{j,t}$	875	-.004474	.0237792	1200	.0025765	.0165342	-7.9647
$ROA_{j,t}$	1177	.0044912	.0206194	1202	.0063743	.0155651	-2.5175
$SIZE_{j,t}$	1177	6.423876	1.199163	1202	6.613706	1.202168	-3.8555
$CAP_{j,t-1}$	875	.1024464	.0421828	1200	.1023587	.0320174	0.0538
$\Delta RISK_{j,t}$	875	-.007846	.0849307	1200	-.0054191	.0640949	-0.7417
$LLOSS_{j,t}$	1177	.0083187	.0124057	1200	.0043091	.0084869	9.2121
$RISK_{j,t-1}$	875	.7962307	.1349573	1200	.6924729	.1180139	18.6072
$dy2011$	1177	0	0	1202	1	0	.

Table 25: Three-stage least-squares regression on the simultaneous equations model with the US/undercapitalized dataset

	$\Delta CAP_{j,t}$		$\Delta RISK_{j,t}$	
Variables	Coefficient	z-Value	Coefficient	z-Value
$Intercept$	.0229 ***	10.23	.1289 ***	10.28
$SIZE_{j,t}$	.0008 ***	2.59	- .0005	-0.41
$ROA_{j,t}$	.3285 ***	15.71		
$\Delta RISK_{j,t}$	.0174 ***	3.72		
$CAP_{j,t-1}$	- .3051 ***	-28.77		
$LLOSS_{j,t}$			- 1.062 ***	-7.75
$\Delta CAP_{j,t}$			.0499	0.68
$RISK_{j,t-1}$			- .1664 ***	-13.88
$dy2011$	.0037 ***	5.09	- .0112 ***	-3.46
No. obs.	2374		2373	
R-squared	0.2863		0.1294	

***,** and * represent statistical significance at the 1%, 5% and 10% level respectively in a two-tailed t-test.

List of Figures

Figure 1: Scheme of the different types of datasets utilized for the regression analysis

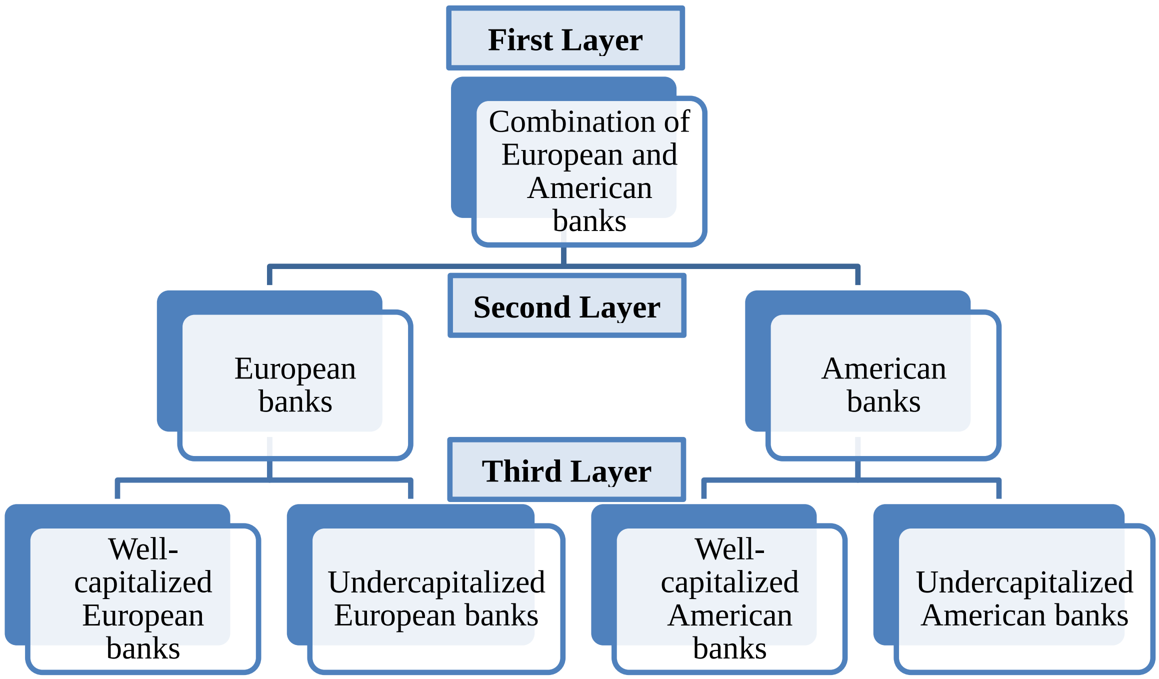


Figure 2: Evolution of the capital adequacy ratios of European financial institutions over the reference period (2006-2014)

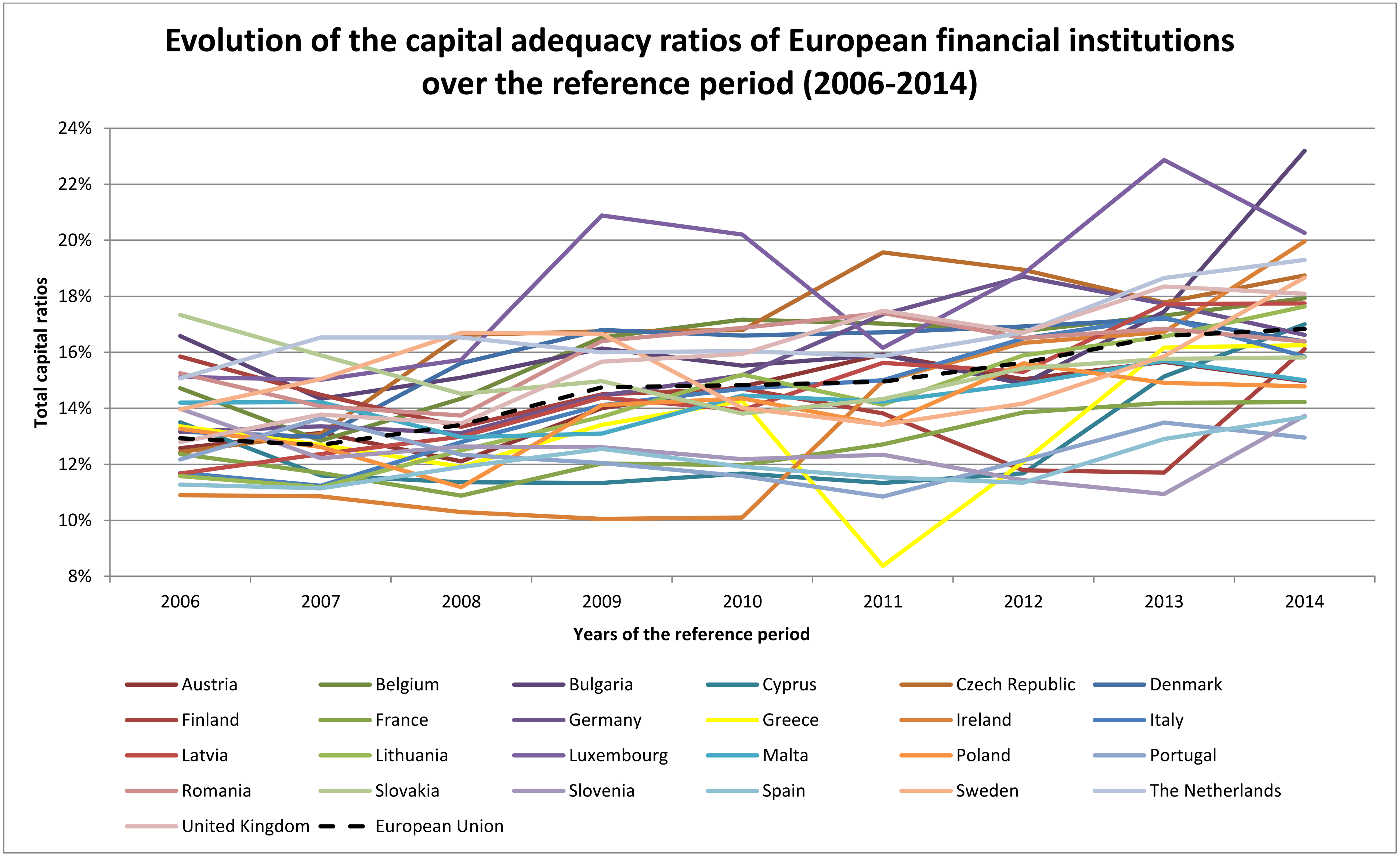


Figure 3: Zoom-in of Figure 2 for five countries in the years 2007-2010

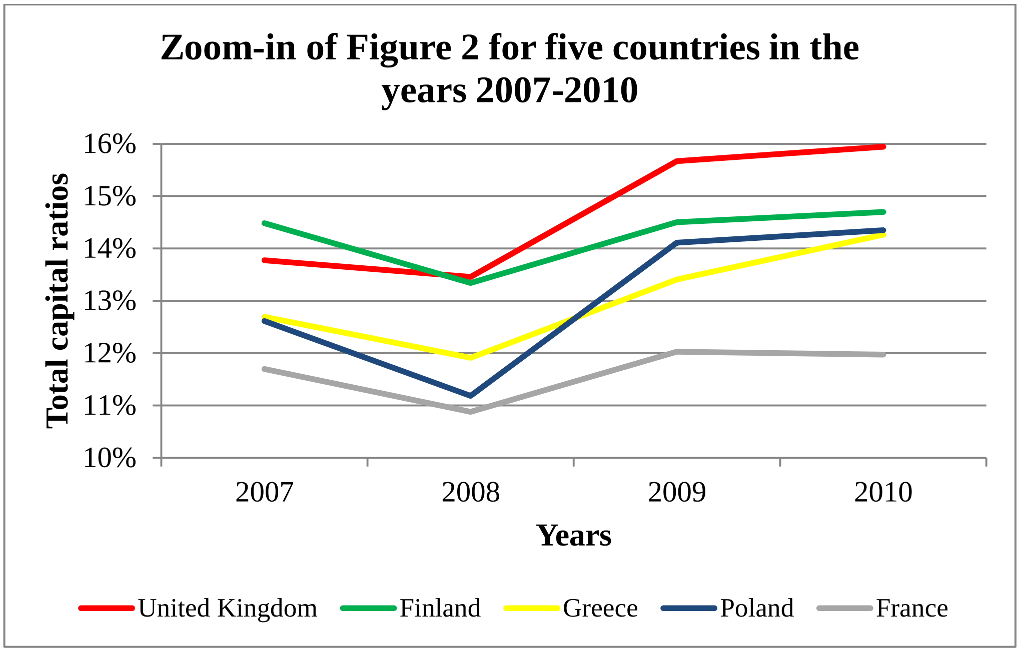


Figure 4: Evolution of the capital adequacy ratios in EU and US over the reference period (2006-2014)

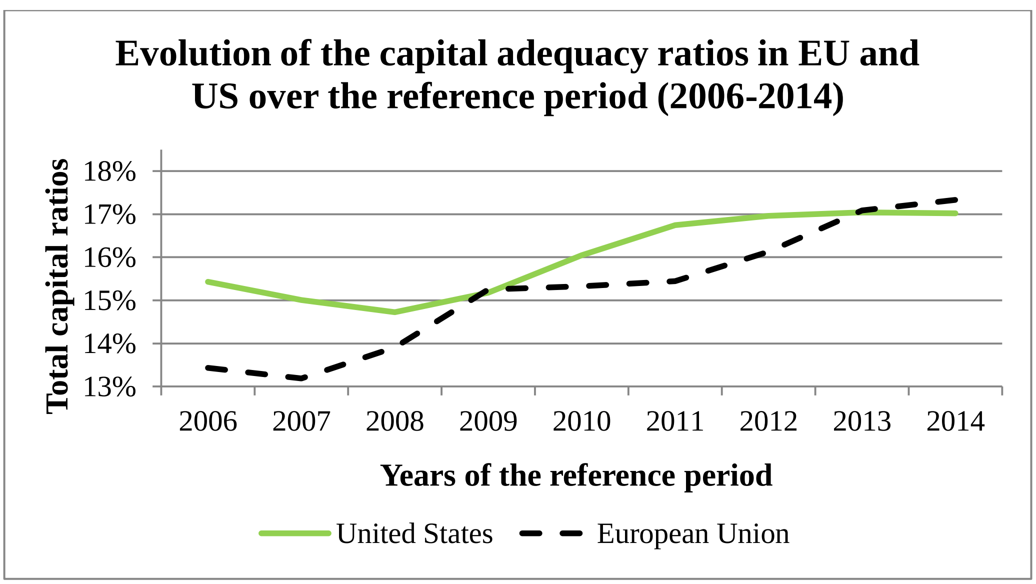


Figure 5: Evolution of the risk-weighted assets to total assets ratios of European financial institutions over the reference period (2006-2014)

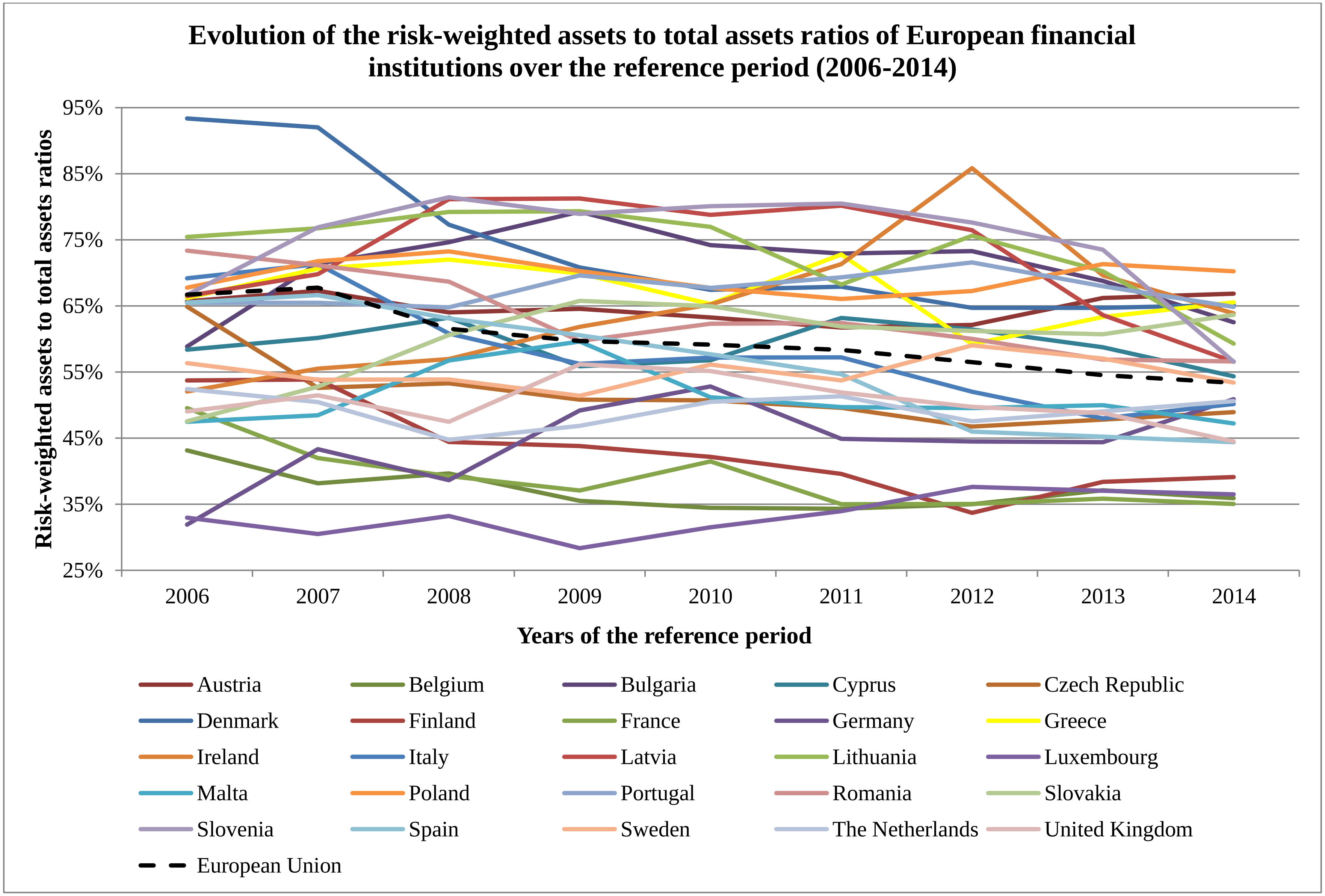
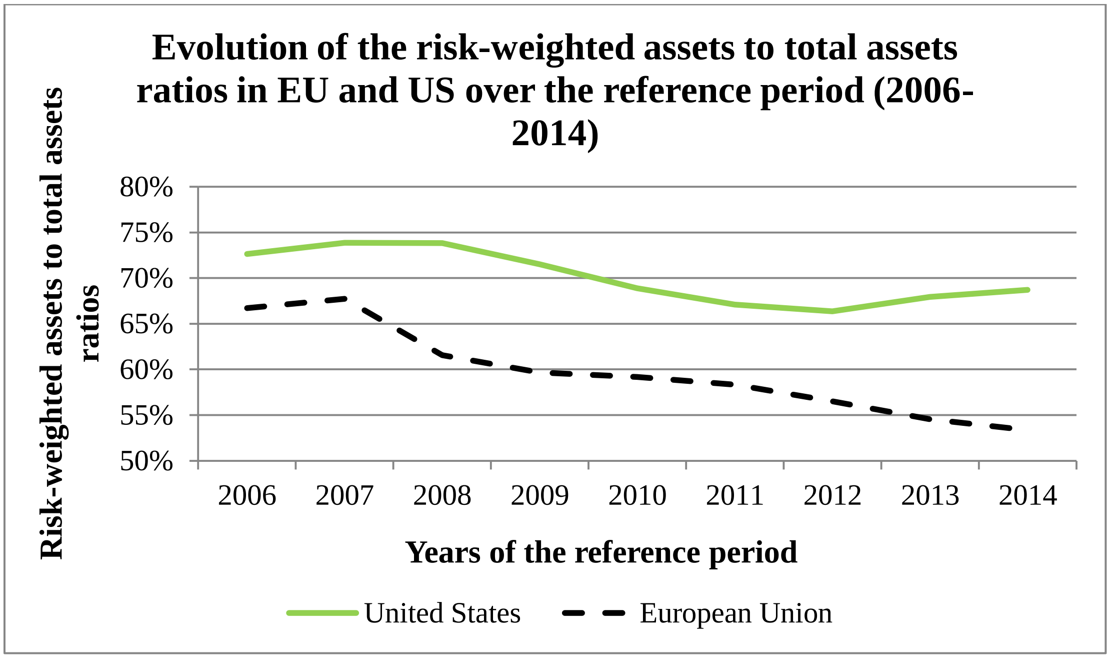


Figure 6: Evolution of the risk-weighted assets to total assets ratios in EU and US over the reference period (2006-2014)



Appendices

Appendix A: The Basel Accords

The Basel Accords are a set of agreements issued by the Basel Committee on Banking Supervision (BCBS) to regulate the banking sector. These agreements are called Basel as reference to the city Basel in Switzerland, in which the Committee has its meetings and where its secretariat is located (BIS, 2015a).

A.1. The beginning of the Basel Accords

In 1944, the Bretton Woods system was created as a result of the Bretton Woods Conference. This system was founded to govern commercial and financial relations between sovereign states. The Bretton Woods system is also at the basis of the foundation of the International Monetary Fund (IMF). The main characteristics of this arrangement include a compulsory enforcement of a monetary policy by member countries to fix the exchange rate to ± 1 percent, by pegging their currency to gold (Cohen, 2016). Nonetheless, this system crashed in 1973, leading to many bankruptcies in the banking industry: Bankhaus Herstatt and the Franklin National Bank of New York to name only a few. Indeed, banks had to face huge foreign currency losses. That is why, in 1974, the central-bank governors of the G10 countries (Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom and the United States) decided to erect a Committee on Banking Regulations and Supervisory Practices, which received later the name of Basel Committee on Banking Supervision (BIS, 2015b). Its objective is to enhance the quality of banking supervision all over the world. Banks are supervised in order to:

- ensure that they operate in a safe and sound manner;
- ensure that they have enough capital and reserves to face risks that could emerge in their business (Folkerts-Landau and Lindgren, 1998, p.55).

It is important to remind that decisions arising from this independent body have no legal binding force. The Committee only proposes supervisory guidelines in the expectation that national authorities will pass them. Though, if a country is member of the Committee, it is more than probable that it will implement its regulatory standards later on (BIS, 2015b).

A.2. Basel I: the 1988 Basel Capital Accord

As a response to the Latin American debt crisis of the 1980's and the related deterioration of capital ratios among many international banks, the G10 governors approved a capital measurement standard, the so-called 1988 Basel Capital Accord, which was released to banks in July 1988 (BIS, 2015b). More specifically, this Accord focused on a minimization of credit risk and risk-weighting of assets. Banks' assets needed to be grouped into five categories according to their associated credit risk (BCBS, 1988); each group received a weight representing its risk. The Accord required international banks to have a minimum ratio of capital to risk-weighted assets of 8%, to be respected by the end of 1992. For instance, if a bank held risk-weighted assets for an amount of €100 million, this bank needed to maintain at least €8 million of capital. Besides, financial institutions also needed to report off-balance sheet items (BCBS, 1988). The 1988 Basel Accord was transformed some years later to take other risks than only credit risk into consideration. Indeed, banks are also confronted to market risks. Therefore, the Committee released in 1996 the Market Risk Amendment to the Capital Accord, which was effective at the end of 1997 (BIS, 2015b).

A.3. Basel II: a solution to Basel I issues

Basel II has been published by the Committee in June 2004 to counter the problems arising from the first banking regulation (Basel I). This new framework is based on three different pillars.

Pillar 1 is the most important part of this regulation and deals with the minimum capital requirements. It states how banks should determine capital requirements and how they should meet them to face three major risks: credit risk, operational risk and market risk. The capital ratio needs to be computed as shown by Equation (13) and is required to be higher than 8% to satisfy the Basel II capital standards.

$$\frac{Total\ \ regulatory\ capital}{Credit\ risk\ RWA + Market\ risk\ RWA + Operational\ risk\ RWA} = Bank's\ capital\ ratio\ \geq 8\% \qquad \textbf{(13)}$$

Regulatory capital has been defined for the first time in the 1988 Basel Accord, and this definition did not change substantially in Basel II. Regulatory capital comprises three tiers of capital. An item can be classified in one of these tiers if it satisfies the following eligibility criteria: permanence, freedom (ability to absorb losses on an ongoing basis) and subordination to depositors and other creditors (Bakiciol et al., 2015). The item is categorized as Tier 1, Tier 2 or Tier 3 capital depending on how well it respects the eligibility criteria (Bakiciol et al., 2015). Tier 1 capital[8] is considered as the highest quality capital component and must help a bank to remain a going-concern (Baeten, 2015). Tier 2 capital[9] is limited to 100% of Tier 1 capital. It must provide loss absorption on a gone-concern basis (Baeten, 2015). The first two tiers of capital have as main purpose the coverage of market risks, but banks may also use a third tier of capital[10] to meet a proportion of market risk's capital requirements (Bakiciol et al., 2015). Looking at the denominator of Equation (13), risk-weighted assets are computed for credit risk, market risk and operational risk. Basel I only dealt with credit risk (in a very simple manner) and market risk, whereas operational risk was not mentioned at all. Each risk can be determined through different approaches (Maeyaert, 2015). First, credit risk is the risk that a counterparty to a financial transaction will fail to perform according to the terms and conditions of the contract, due to, for example, insolvency. It can be defined in three ways: the standardized approach, the internal ratings-based approach and the securitization framework. Secondly, market risk is the risk resulting of the uncertainties of incurring losses in on and off-balance sheet positions arising from adverse movements in market prices, resulting from movements in market prices, changes in interest rates, foreign exchange rates and equity and commodity prices. The preferred approach to determine market risk is the value-at-risk[11] method (VaR). Finally, operational risk is the risk of failure of people, systems, and procedures of banks. This risk can be measured through three approaches: the basic integrated approach, the standardized approach and the advanced measurement approach.

The second pillar of Basel II - supervisory review process – refers to principles with regard to supervisory review, risk management guidance and supervisory transparency (BIS, 2016c). Banks

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[8] Tier 1 capital is composed of issued and fully paid ordinary shares/common stocks and non-cumulative perpetual preferred stocks.
[9] Tier 2 capital is composed of undisclosed reserves, revaluation reserves, general provisions/general loan-loss reserves, hybrid debt capital instruments and subordinated debt.
[10] Tier 3 capital is composed of short-term subordinated debt with some limitations.
[11] Value-at-risk is a statistical measure of the risk of loss on a specific portfolio of financial assets (Maeyaert, 2015).

do not only need sufficient capital to support all possible risks, but also good risk management techniques to be able to monitor and control those risks.

Finally, the third pillar is a complement to the two others. Its purpose is to increase banks' market discipline by the introduction of disclosure requirements. Banks must inform the market on how they are exposed to the risks and which methodologies they use to assess them (BIS, 2016c).

A.4. Basel III: a new framework

Not a long time after the introduction of Basel II, the Committee released in December 2010 a comprehensive regulatory reform: Basel III. This reform needs to respond to the main failures of the previous Accord, which materialized during the financial crisis of 2008-2009: the insufficient loss absorbency capacity of capital, excessive banks' leverage, inadequate liquidity risk management, systemic risk due to a high interconnectedness of the financial institutions (Baeten, 2015). Even before the financial crisis, the Committee noticed that a reform of Basel II was urgent. Indeed, banks had too much leverage, inadequate liquidity buffers, poor governance and risk management. The crisis only showcased all these deficiencies (BIS, 2015b).

A.4.1. The six measures of Basel III

The new Basel framework revised and enhanced the three pillars introduced by Basel II using six measures: strengthening of the capital base, enhanced risk coverage, introduction of an overall leverage ratio, dealing with pro-cyclicality, addressing systemic risk and interconnectedness, and the introduction of global liquidity risk standards. This section is based on a lecture given by Baeten (2015).

A.4.1.1. Strengthening of the capital base

This section corresponds to the numerator of the pillar I-capital ratio (see on Figure 7). The Basel Committee wants to reinforce the quality, the consistency and the transparency of the capital base. Capital must be able to absorb losses as and when they occur (quality). By consistency, it wants that regulatory requirements are simplified and harmonized across jurisdictions. This is the case for Basel III in the European Union as they implemented a new legislative package containing the Directive 2013/36/EU (CRD IV) and the Regulation (EU) No. 575/2013. Furthermore, the transparency of the capital base must be enhanced. All components of capital need to be disclosed in detail. Regarding the capital types, there is an important change in comparison with Basel II: Tier 3 capital has been abolished.

As you can see on Table 26, banks are required to comply with a new set of minimum capital requirements: the ratio of common equity Tier 1 to risk-weighted assets is 4.5%, the ratio of Tier 1 to risk-weighted assets is 6% and the ratio of total capital to risk-weighted assets is now 8%. However, two new components must be added to each of these ratios: a capital conservation buffer of 2.5% and a countercyclical buffer ranging from 0% to 2.5%. In 2019, the minimum capital to risk-weighted assets ratio will thus be 10.5% + the countercyclical buffer if any. Banks will not have to respect these ratios immediately, there are some phase-in arrangements so that banks can increase their capital ratios over the years (see Table 26).

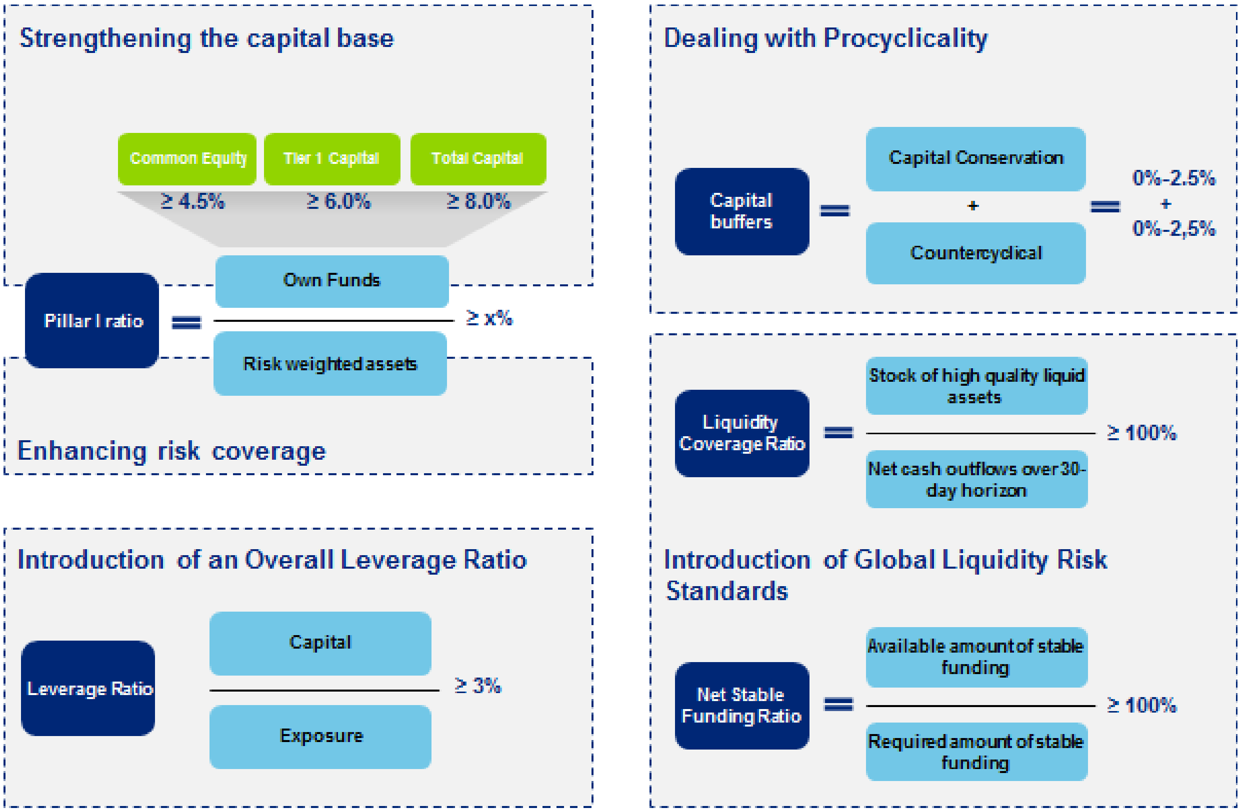
Table 26: Phase-in arrangements, including transition periods, of Basel III capital requirements (Baeten, 2015)

	2013	2014	2015	2016	2017	2018	2019
Minimum common equity ratio	3.5%	4.0%	4.5%	4.5%	4.5%	4.5%	4.5%
Capital Conservation buffer				0.625%	1.25%	1.875%	2.5%
Countercyclical buffer (maximum)				0.625%	1.25%	1.875%	2.5%
Minimum common equity ratio (+ buffer)	3.5%	4.0%	4.5%	5.125-5.75%	5.75-7.0%	6.375-8.25%	7.0-9.5%
Minimum Tier 1 Capital	4.5%	5.5%	6.0%	6.0%	6.0%	6.0%	6.0%
Minimum Total Capital	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Minimum Total Capital (+ buffer)	8.0%	8.0%	8.0%	8.625-9.25%	9.125-10.375%	9.875-11.75%	10.5-13.0%

A.4.1.2. Enhanced risk coverage

Pillar I-ratio's denominator (see Figure 7) is modified in Basel III in comparison with Basel II by an improvement of the risk coverage; particularly risks related to capital market activities as securitization products, trading book and counterparty credit risk. However, the different techniques to compute the risk-weighted assets remain the same as in Basel II (cfr. Section A.3.) (Hannoun, 2010).

Figure 7: Overview of five of the six measures introduced by Basel III (Baeten, 2015)



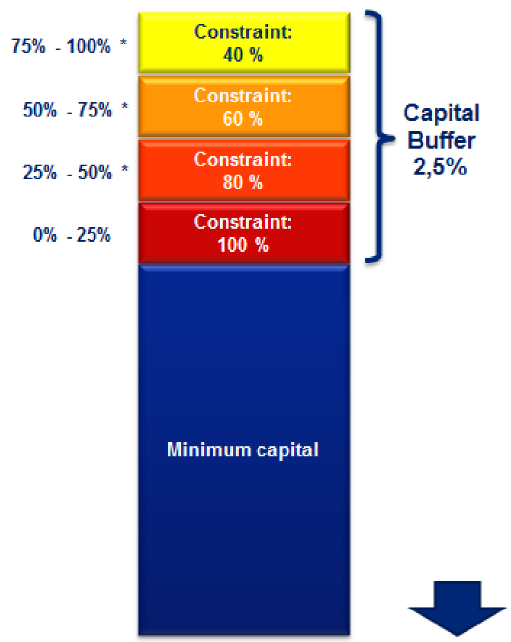
A.4.1.3. Introduction of an overall leverage ratio

The leverage ratio is introduced as a non-risk-based backstop in addition to the solvency ratios. It is aimed at stopping the excessive leverage of the financial institutions. The leverage ratio is computed as bank's Tier 1 capital divided by its assets plus off-balance sheet exposures and derivatives (Hannoun, 2010). And it must stay greater than 3%.

A.4.1.4. Dealing with pro-cyclicality

Pro-cyclicality is "*the tendency of financial activity to amplify business fluctuations which may lead/contribute to financial instability. It operates mainly through feedback mechanisms which may give rise to cumulative processes in the form of spirals and self-sustaining booms and busts*" (General Secretariat of the Council, 2009, p.9). The financial crisis has revealed pro-cyclical tendencies in the banking sector. Therefore, the Basel Committee has decided to create two buffers that must be added to the minimum capital requirements: (i) a fixed capital conservation buffer of 2.5%, which needs to be met with only common equity capital; (ii) an add-on countercyclical buffer ranging from 0% to 2.5% during periods of excessive credit growth. Concretely, if there is an excessive heating on the market, afterwards, there is always an economic downturn. To prepare banks for this downturn, a countercyclical buffer is added to the minimum total capital ratio. It is the relevant authority that sets the size of the countercyclical buffer.

Figure 8: Distribution constraints in case of non-compliance with the pro-cyclical requirements (Baeten, 2015)



The BCBS really wants that those new requirements are respected. Therefore, it has established some distribution constraints[12] in case banks would not esteem these buffers as necessary requirements. In fact, during the financial crisis, banks continued to distribute dividends, while their financial health and their capital levels crumbled every day. The Committee could not stand that banks put the interests of the recipients of these dividends above those of depositors. Consequently, distribution constraints increase as banks' capital ratios decrease and approach the minimum requirement. For instance, if there remains only 25%-50% of the capital conservation buffer, financial institutions are forced to retain at least 80% of their earnings (see Figure 8).

[12] Distribution constraints include ordinary dividends, buybacks, discretionary payments on capital instruments and bonus payments to staff.

A.4.1.5. Addressing systemic risk and interconnectedness

One of the failures of the financial crisis was a high interconnectedness between financial institutions leading to systemic risk. The Basel Committee wanted to avoid this in the future and therefore, it asked higher capital requirements for trading and derivative activities, for complex securitizations and for inter-financial sector exposures.

A.4.1.6. Introduction of global liquidity risk standards

Banks did not present adequate liquidity buffers during the financial crisis and even before. That is why the Basel Committee introduced two liquidity ratios: a liquidity coverage ratio (LCR) and a net stable funding ratio (NSFR). The LCR is computed as the stock of highly liquid assets divided by the net cash outflows over a period of 30 days, and it must be higher than 100%. This ratio is aimed at reinforcing banks' short-term liquidity profile and it pushes banks to have enough cash to cover liquidity requirements in case of a 30-day period of stress. The NSFR also needs to be higher than 100% but is computed as the ratio of the available amount of stable funding[13] to the required amount of stable funding. Its intention is to strengthen the medium- to long-term liquidity profile of banks. And it expresses the minimum required amount of stable funding in case of a lengthy stress scenario.

A.5. Towards Basel IV?

The Basel Committee has proposed a fourth Basel Accord to prevent the risk of a new financial crisis. This new agreement is expected to include even more stringent capital requirements and a greater need for financial disclosure.

[13] Stable funding comprises customer deposits, long-term wholesale funding and equity.

Appendix B: Utilization of Bankscope

Concerning Bankscope, several choices had to be made. Each of them, if wrong, could have a big impact on the regression results. First, Bankscope presents different types of data for each bank (Duprey and Lé, 2015):

- **RD**: statement available in the raw data format;
- **RF**: statement under processing by Fitch ratings;
- **BS**: branch of another bank with financial statement available;
- **BR**: branch with no statement;
- **DC**: no longer existing bank, with statements for previous years;
- **DD**: no longer existing bank, without statements;
- **NA**: banks with no statement; only the name and address are available.

We easily understand that observations under the form RF, BR, DD and NA are excluded since they will not bring more information to the regression analysis.

Second, consolidation codes are a big issue when dealing with Bankscope. There are eight different ways of how Bankscope gathers data about banks:

- **C1**: statement of a mother bank integrating the statements of its controlled subsidiaries or branches with no unconsolidated companion;
- **C2**: statement of a mother bank integrating the statements of its controlled subsidiaries or branches with an unconsolidated companion;
- **C***: additional consolidated statement;
- **U1**: statement not integrating the statements of the possible controlled subsidiaries or branches of the concerned bank with no consolidated companion;
- **U2**: statement not integrating the statements of the possible controlled subsidiaries or branches of the concerned bank with a consolidated companion;
- **U***: additional unconsolidated statement;
- **A1**: aggregated statement with no companion;

- **A2**: aggregated statement with one companion;
- **NA**: bank with no statement; only the name and address are available.

where **U** represents unconsolidated financial statements, **C** consolidated and **A** aggregated (Duprey and Lé, 2015).

A companion is an extra balance sheet for the same bank. For instance, if the consolidated financial statements of a bank have as consolidation code C2, it means that, somewhere else in the Bankscope database, there are unconsolidated financial statements (U2) for the same bank and for the same year. It is important to choose between the consolidated and the unconsolidated financial statements because picking up the two in the research datasets would lead to double counting issues. This decision totally depends on the research question (Duprey and Lé, 2015). As we need to investigate how balance sheets adjusted to meet capital requirements during the sample period, it is better to take the statements U2/U1/C1 to avoid balance sheet variations to be reduced at the group level. Though, keeping only that kind of statements for the EU dataset was not a good idea because all major European banks were excluded from it. These banks actually do not report their capital ratio on an unconsolidated basis and were therefore omitted in the datasets (cfr. Section 4.1.1.). To give an example, the four biggest commercial banks in Belgium (BNP Paribas Fortis, Belfius, KBC and ING) would not have been taken into account. Consequently, and by default, the statements C2/C1/U1[14] are used to sort banks in the datasets.

Third, all the reported data in Bankscope do not have the same unit; some are in thousands, others in millions, billions… depending usually on the size of the bank. We decided to put all the data in millions.

Finally, a last issue in Bankscope concerns the currency used by banks to present their financial statements. Currencies can be very different across EU countries. That is why we decided to convert all data from the local currency to the euro since most countries in the EU used the euro as currency during the reference period. Still, a valuation effect is added to the model due to the

[14] Statements C1 and U1 cannot be redundant as those statements always belong to different banks. C1 is a statement with no unconsolidated companion and U1 is a statement with no consolidated companion. So, they cannot be combined and cannot represent the same financial institution.

fluctuation in the exchange rates. All European data could have been converted in US dollars, but then, the valuation effect would have been even greater. Though, it is imperative to remember that the American dataset is in US dollars, while the European dataset is in euros.

Appendix C: The "too-big-to-fail" effect

Financial institutions are called "too-big-to-fail" (TBTF) when policy makers assess that their failure would have a disastrous effect on the economy. Institutions can also be TBTF because of their size and interconnectedness, so that they must be provided support by authorities to prevent their potential failure (Labonte, 2015). Larger organizations fear this effect because it could and would have several consequences on the way they operate. First, many financial experts and economists ask for a breaking up of these TBTF institutions into smaller ones to limit the risk imposed on the economy by those banks and to bar their political power, used for their own benefit (Mogulescu, 2011; Ritholtz, 2013). Second, the regulations that are enforced over the years want to reduce the risk-taking of TBTF banks. Third, an economist, called Buiter, even wants to implement a tax system to internalize the huge costs passed on by those institutions to the society (Buiter, 2009). This is the way Buiter (2009) formulates his proposal: "*When size creates externalities, do what you would do with any negative externality: tax it. The other way to limit size is to tax size. This can be done through capital requirements that are progressive in the size of the business (as measured by value added, the size of the balance sheet or some other metric)*". Finally, an increased monitoring is required for "too-big-to-fail" financial institutions (Financial Stability Board, 2011).