The effect of 'Basel IV' on the valuation of European banks

Master thesis Financial Economics

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Abstract

This paper investigates the impact of Basel IV on the market valuation of European banks, as well as the measures banks take with regard to mortgage portfolios to prepare for Basel IV. Abnormal returns on and around the announcement date of Basel IV are examined, as well as the relationship of various bank specific variables on these returns. Finally, the difference in portfolio development for banks with low NPL and high LTV ratios versus other banks is examined. The results show that the market reaction is mixed around the announcement for the entire sample, but returns are significantly higher for well-capitalized, and low NPL and high LTV ratio banks. An increase in size leads to lower returns. No significant difference is found in the portfolio development of low NPL, high LTV ratio banks versus other banks. The results indicate that the market is lightly optimistic about the implications of Basel IV and that further research is needed to examine the long term effect on asset allocation.

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1. Introduction

In 1988, in the aftermath of heavy volatility in the international banking and currency markets in the early seventies, the BCBS signed the first Basel accord which focus was on the capital adequacy of internationally active banks (Basel Committee on Banking Supervision, 2018). It came into effect in 1994. Since then, the Basel accords have evolved and become more complex. Despite the regulatory accords, the financial crisis of 2007 – 2008 showed the fragility of the financial system. In a short time, the developments in the financial sector exposed the main weaknesses of the belief in micro-prudential regulation and bank's ability to regulate their own risk models. The interconnectedness of the financial system and the tendency of banks to artificially optimize, and thus lower, risk exposures dragged the entire economy in a downward spiral. Clearly, the banks needed some help to stay on track.

The Basel Committee of Banking Supervision (BCBS) realized that the banking regulation up until that point was not effective enough and quickly proposed new regulation under the third Basel accord. According to McKinsey&Company, the main purpose of Basel III was "enhancing stability of the financial system by increasing both the quantity and quality of regulatory capital and liquidity" (2017, p. 6). While Basel III enhanced the resilience of the financial system, it was not complete. Quickly after the implementation of Basel III, the committee began proposing other measures to increase transparency and consistency in the approach of risk in different banks.

These proposals eventually mounted into the large reform of Basel III, which the BCBS announced in December 2017. The industry deems the impact of the revisions so large that the reforms go by the name Basel IV. Basel IV will have great implications for the regulatory capital charges and business models of banks. Therefore, it is likely that the market will reevaluate their view on banks in general. Besides the upside of theoretically safer banks with higher capital buffers, Basel IV could make way for a risk budget (Resti, 2016), further increase Cost of Equity (COE) to a point where it might even surpass Return on Equity (ROE) (European Banking Authority, 2017), and influence banks across Europe differently. These effects miss the point of creating a safer, equal banking industry (Basel Committee on Banking Supervision, 2017).

This thesis tries to answer how the announcement of Basel IV affects the equity valuation of European banks. To do so, various bank specific characteristics are tested to find out where the market believes Basel IV will have the largest impact. Among these characteristics are exposure to IRB model output, portfolio quality, capital ratios, geographical location and size. Then, this thesis goes into how banks prepare for the implementation of Basel IV by looking at movements in mortgage portfolios.

Gual (2011) argued that the increased capital requirements under Basel III would most likely lead to an increase in the cost of funding for banks, which would have adverse effects on the real economy. Šútorová and Teplý (Šútorová & Teplý, 2014) find that higher capital requirements will probably lead to a negative market reaction. On the other side, Caprio, Laeven, and Levine (2007) find no evidence

for differences in bank valuation across regions with different capital requirements. This indicates that the increase in capital requirements does not necessarily lead to a devaluation of banks. In a subsequent paper, Laeven and Levine (2009) show that the impact of regulatory requirements is strongly dependent on the individual ownership structure of a bank, and thus that there is no uniform effect of regulatory charges on the entire industry.

Since the point of interest is the markets perception of the impact of Basel IV, the main research methodology is an event study on the abnormal stock price reaction of European banks around the announcement date of Basel IV, which is December 7 2017. The abnormal returns are put to test to see if there is a general market reaction on the announcement date of Basel IV. To gain more insights in which aspects of a bank may influence the market reaction the second analysis goes more in depth and regresses various banks specific characteristics on the cumulative abnormal returns. Finally, this thesis tries to gain insights in behavior of banks leading up to the announcement of Basel IV with regard to their mortgage portfolio. To do so, a difference-in-difference test is used which looks at the development of mortgage portfolios between two types of banks in the years leading up to the Basel IV announcement.

The results indicate that there is small appreciation by the market around the announcement of Basel IV and that there are indeed significant differences in the market reaction based on the before mentioned characteristics. The results show a significant difference in mortgage portfolios between banks with low Non-performing loan (NPL) and high Loan-to-Value (LtV) ratios. However, there is no significant change in portfolio allocation between these two groups yet.

By answering these questions this thesis contributes to the literature by exploring the new terrain that came into existence with the announcement of Basel IV. Furthermore it tried to extend the knowledge on which bank specific characteristics are perceived as positive or negative by the market in the face of Basel IV. Valuable insights are gained with respect to the markets expectation of the impact of Basel IV on the European banking industry, but there is also a clear need for a repetition of this research in the future since some effects probably have not showed their full impact.

This thesis contains the following sections. Section 2 briefly discusses the history of the Basel accords, goes into the most influential changes implemented in Basel IV and discusses the relevant academic literature. Section 3 contains the hypothesis development. Section 4 contains the methodology and data description. Section 5 presents and discusses the results. Finally, the thesis ends in section 6 with concluding remarks.

2. Literature review

This chapter describes the history of the Basel regulation, the regulatory changes and the practical implications of these changes. Then, it describes how banks are valued and why Basel IV might affect the valuation of banks.

2.1. History of the Basel accords

In 1988, Basel I introduced the Risk Weighted Assets (RWA), which was limited to the credit risk exposure of banks. In 1995, an updated version of the accord allowed for netting of credit positions and in 1996, market risk was taken into account (Dionne, 2013).

In 2006, Basel II came into effect. The most notable changes were the risk sensitivity of the capital requirements, the introduction of operational risk and the introduction of the three pillars; minimum capital requirements, supervisory review and market discipline (Basel Committee on Banking Supervision, 2005). Besides, Basel II introduced new risk models for credit risk. Banks could now choose between the Standardized Approach (SA), Foundation Internal Rating Based approach (F-IRB) and the Advanced Internal Rating Based approach (A-IRB). The IRB models allowed freedom on the banks side to estimate some, or all, input parameters, while the SA approach relies on regulatory parameters. The parameters include probability of default (PD), loss given default (LD), and exposure at default (EAD) (Basel Committee on Banking Supervision, 2005).

The Basel Committee developed Basel III as a response to the crisis and aimed for it to be a foundation for a resilient banking system (Basel Committee on Banking Supervision, 2017). Basel III introduced liquidity requirements and raised capital requirements for the trading book, securitization exposures and securitizations in the banking and trading books.

Various studies (e.g. Aggarwal & Jacques (1997); Ediz, Michael, & Perraudin (1998); and Rime (2001)) find that the first Basel accord pushed undercapitalized banks to higher capitalization ratios. However, Danielsson et al. (2001) find there was a lack of risk sensitivity for the RWA calculation under Basel I, it did not take into account risk-mitigation techniques and it did not lead to market discipline by disclosure of key information. According to Danielsson et al. (2001) most of these shortcomings were resolved with Basel II. However, they also argue Basel II increased the instability of the financial system and the procyclicality of capital charges. The subprime mortgage crisis uncovered the greatest weaknesses of Basel II as it exposed the lack of regulatory and supervisory integrations, the extreme risk taking of too-big-to-fail banks and the importance of solvency for the existence of banks (Blundell-Wignall & Atkinson, 2010). For the sake of readability, please refer to Appendix 1 and Appendix 2 for a more in depth and detailed explanation of the developments in the Basel accords up until Basel IV and the academic research that has been done on their implications.

2.2. Basel IV

The BCBS acknowledged that Basel III was still incomplete and created Basel IV as a finalization of the regulation under Basel III. Basel IV will become the new standard on January 1, 2022. The output floor is phased in over the course of six years, also starting on January 1 2022 (Basel Committee on Banking Supervision, 2017). The following paragraphs touch upon the most notable changes.

To improve the SA models, the Basel Committee improved their granularity and risk sensitivity. The Committee introduced granularity within asset classes such that loans within the same asset class but with different characteristics (such as LtV) can have a different risk weight. Furthermore, to reduce the dependency on credit ratings, a more granular system is set up for non-rated exposures to banks and corporates (Basel Committee on Banking Supervision, 2017). In general, the Committee increased the granularity of the categories or they recalibrated the risk weight to represent more realistic risk.

CVA risk, the risk of mark-to-market losses of derivatives due to a decrease in the creditworthiness of the counterparty, was one of the largest loss drivers during the financial crisis (Basel Committee on Banking Supervision, 2017). Under Basel IV, the BCBS aimed to improve the risk sensitivity, robustness and consistency of the CVA framework. First, the exposure component is taken into account. Second, internal models are no longer allowed. Finally, the standardized models are made consistent with the revised market risk framework (Basel Committee on Banking Supervision, 2017).

Under Basel III, the capital requirements for operational risk were insufficient and the internal models did not adequately calculate exposures. Now, all banks need to use a new standardized approach which is driven by size and historical losses. The Committee assumes that operational risk increases with size and that once a bank has faced large operational losses before, it is more likely to do so in the future.

Globally systemically important banks (G-SIBs) pose an extra systemic risk due to their highly connected, international structure. To protect against artificially low levels of leverage and to mitigate gaming risk for models, the BCBS proposed a leverage ratio buffer for G-SIBs, which is at least 50% of the higher-loss absorbency requirements (Basel Committee on Banking Supervision, 2017).

According to the Basel Committee, the IRB approaches to credit risk became too complex, incomparable and not robust enough under Basel III. To resolve these problems, the Committee removed the A-IRB approach for certain exposures that were impossible to model in a robust manner (Basel Committee on Banking Supervision, 2017). Next, the Committee introduces input floors for certain parameters (e.g. LGD, EAD and PD) to ensure conservatism. Finally, the BCBS proposes an output floor. The output floor limits the advantages a bank can gain from using the IRB approach by setting the output to a minimum of 72.5% of the SA. The main purpose of this floor is to create and maintain a level playing field across banks, to improve the credibility of IRB calculations and to improve comparability across banks (Basel Committee on Banking Supervision, 2017). The combination of the input restrictions and output floor is named a “System of Floors” (SOF).

2.2.1. Potential risk and side effects of the System of Floors

While the BCBS proposed Basel IV to create more risk sensitive and realistic outputs from IRB models, the SOF seems to miss this goal on a number of points. The implementation of an output floor creates a 'risk budget' for banks that currently have a portfolio and IRB model that leads to outcomes below the floor (Resti, 2016). This implies that the bank has an incentive to engage in more risk taking activities to make use of the headroom, as it has to hold the regulatory capital as if it has a riskier portfolio. This will lead to an increase of risk in the entire system. Besides the risk budget, the output floors are set to 72.5% of a new, and untested, standardized model. Resti (2016) suggests that the BCBS should test the standardized model in practice before calibrating the output floor with it.

2.1. Main implications for banks

Basel IV does not only lead to a more leveled playing field, increased credibility of IRB calculations and an improved comparability across banks. It also leads to an increase in regulatory capital requirements, especially for banks that are heavy IRB users and have a high quality portfolio.

For banks with mortgage portfolios containing low non-performing loan (NPL) ratios and high LtVs, the impact of Basel IV will be significant but manageable according to Carrara, Yeterian and Rudman (2018). The low NPL and high LtV ratios can currently lead to low model outputs due to low historical PDs. Under Basel IV, the high LtV leads to an increase in the RWA of high LtV portfolios.

Eyssell and Arshadi (1990) researched the impact of announcements of the BCBS to implement minimum equity levels for banks and found a negative relation with bank valuations. Higher regulatory capital buffers do not only increase the banks loss absorbency capacity (Arnold, Borio, Ellis, & Moshirian, 2012) or decrease the risk on equity (Giordana & Schumacher, 2012), which should lower the cost of equity. It also lowers the banks efficiency as it may want to hold equity higher than the regulatory requirement to evade potential penalties (Rime, 1985) and it decreases the return on equity by increasing the equity base without increasing revenues (Koller, Goedhart, & Wessels, 2015).

Gual (2011) argued that the increased capital requirements under Basel III would most likely lead to an increase in the cost of funding for banks, which would have adverse effects on the real economy. Šútorová and Teplý (Šútorová & Teplý, 2014) find that higher capital requirements will probably lead to a negative market reaction. On the other side, Caprio, Laeven, and Levine (2007) find no evidence for differences in bank valuation across regions with different capital requirements. This indicates that the increase in capital requirements does not necessarily lead to a devaluation of banks. In a subsequent paper, Laeven and Levine (2009) show that the impact of regulatory requirements is strongly dependent on the individual ownership structure of a bank, and thus that there is no uniform effect of regulatory charges on the entire industry.

This in the context of a banking sector in Europe in which profitability is under pressure with returns on equity already being below cost of equity (European Banking Authority, 2017).

2.2. Differences across Europe

There are large difference in portfolio quality, profitability, balance sheet structure and use of IRB models across banks in Europe (European Banking Authority, 2017). McKinsey&Company (2017) show that Basel IV will likely affect current Common Equity Tier 1 (CET1) ratios in various degrees across Europe. They expect the largest relative drop in current CET1 ratio for banks in Sweden, Denmark, Belgium, the Netherlands and Ireland. This is due to the relative high quality portfolios, which lead to low PD and LGD estimates in their models (McKinsey&Company, 2017). Fender & Lewrick (2016) show an overall expected increase of required CET1 by approximately 2.7% - 3.4%, supporting the research by McKinsey&Company (2017). Not coincidentally, the reliance on IRB approaches is high in Sweden, the Netherlands and Denmark. In these countries, banks use IRB models to calculate over 70% of the capital requirements. In countries such as Austria, Italy, Portugal and Greece, IRB models only account for less than 33% of the total output (Resti, 2016) Appendix 3 shows an overview of the CET1 and output floor effects of Basel IV across Europe and the average LtV for loans in Europe. Given the wide dispersion in IRB output and portfolio quality across Europe, the implications of Basel IV will likely differentiate on a country-to-country basis.

2.3. Bank valuation

Why would changes in the regulatory environment have an impact on the value of a bank? One uses the equity DCF method to value a bank (Koller, Goedhart, & Wessels, 2015):

$$V_e = \sum_{t=1}^{\infty} \frac{CFE_t}{(1 + k_e)^t} \tag{1}$$

Where Cash Flow to Equity (CFE) is discounted by the cost of equity and is calculated as:

$$CFE_t = NI_t - \Delta E_t + OCI_t \tag{2}$$

In which NI equals net income, ΔE is the change in book value of equity and OCI is noncash other comprehensive income (Koller, Goedhart, & Wessels, 2015). One has to deduct ΔE from net income since the bank cannot pay out locked in capital to shareholders (Koller, Goedhart, & Wessels, 2015).

From equitation (2) we can derive that an increase in regulatory capital leads to a decrease in CFE as the locked in capital increases without an increase in NI. This theoretically leads to a decrease in bank value. In a non-financial company, the new capital structure, with an increased equity part, would lead to a re-levered beta, which reflects the lower risk related to the lower possibility of default. However, since cash flow is valued to equity and similar capital structure for all banks is assumed, this levering of beta does not take place and thus k_e remains stable. The absence of re-levering beta and the CFE model indicate that an increase in regulatory capital devaluates the same company under stricter regulation since, assuming no increase in revenue, ROE relative to COE decreases. When it comes to the point that ROE is below COE, the bank is destroying value since it has to pay more for its funding than it earns on its investments (Koller, Goedhart, & Wessels, 2015).

3. Hypotheses development

This section goes into the testable hypotheses posed based on the theoretical framework under section 2. The section presents seven hypotheses, which support the research question:

Research question: *What is the effect of the announcement of Basel IV on the equity valuation of European banks?*

Eyssell and Arshadi (1990) show that the announcement of higher capital requirements under Basel I had a negative impact on bank valuation. Resti (2016) argues that banks can become riskier under Basel IV and face significant missed future profits due to the redundancy of their high cost internal models. The European Banking Authority (2017) states that even before Basel IV European banks had ROE below COE. This ratio is likely to deteriorate further under the new regulation, as the required regulatory capital will increase without a corresponding increase in returns. According to Koller, Goedhart & Wessels (2015) this must lead to a decrease in the value of a bank. Given this research, the following hypothesis is posed:

Hypothesis 1: *The announcement of Basel IV has a **negative** impact on the equity prices of European Banks around the announcement date.*

Basel IV implements a SOF for banks that use an IRB approach. The output floor of 72.5% of the standardized model can be higher than the current output levels of these IRB models (McKinsey&Company, 2017). Furthermore, the usage of IRB models differentiates significantly between countries within Europe (European Banking Authority, 2017). In Sweden, the Netherlands and Denmark, IRB models account for over 70% of the capital requirement calculations (Resti, 2016). Given the restrictions Basel IV imposes on the use and output of IRB models the second hypothesis is:

Hypothesis 2: *Banks that rely heavily on IRB model output face a stronger **negative** effect on their equity prices around the announcement date of Basel IV than banks that rely on the Standardized Approach.*

According to McKinsey&Company (2017) the largest drop in actual CET1 ratio due to the implementation of Basel IV will take place in Belgium, Ireland, the Netherlands, Denmark, and Sweden (BINDS countries) due to their high quality portfolios. The risk dashboard published by the European Banking Authority (2017) supports this claim as it shows that the portfolios in the BINDS countries have below average NPL ratios, forbearance ratios, and non-performing exposure ratios (except Ireland). The combination of these publications leads to the following hypothesis:

Hypothesis 3: *Banks in the BINDS countries face a stronger **negative** effect on their equity prices around the announcement date of Basel IV than banks in non-BINDS countries.*

The implementation of Basel IV leads to higher capital requirements over the whole spectrum. The driver for value loss of the share price is the increase in regulatory capital a bank needs to hold. Increasing this buffer leads to a lower return on equity given all else stays equal (Koller, Goedhart, & Wessels, 2015). As the report of McKinsey&Company (2017) shows, the impact of Basel IV is partly based on when the capital floor exceeds the current capital reserve. If a bank has better capital ratios ex ante, the impact of Basel IV is expected to be later or non-existent. Therefore, the following hypothesis is posed:

Hypothesis 4: *Banks with higher capital ratios face a stronger **positive** effect on their equity prices around the announcement date of Basel IV than banks with lower capital ratios.*

Large banks have the resources to implement IRB models and thus are more likely to rely on these models. Given the increased output of these models, in combination with the extra leverage ratio buffer for GSIBs (Basel Committee on Banking Supervision, 2017), and the missing out on expected profits from developing the costly IRB models (Resti, 2016), the expectation is that large banks face more negative announcement effects than small banks. This leads to the following hypothesis:

Hypothesis 5: *Large banks face a stronger **negative** effect on their equity prices around the announcement date of Basel IV than smaller banks.*

Mortgage portfolios with high LtV and low NPL ratios face an increase in risk weight due to the changing risk weights and the introduction of the output floor (Carrara, Yeterian, & Rudman, 2018). According to McKinsey&Company (2017) banks with highly focused business models and significant SOF impacts will either make changes to their asset mix or take their portfolios off balance sheet. Based on this research the following two hypotheses were developed:

Hypothesis 6: *Banks with low NPL and high LtV mortgage portfolios face a stronger **negative** effect on their equity prices around the announcement date of Basel IV other banks.*

Hypothesis 7: *Banks with low NPL and high LtV mortgage portfolios will move away from on-balance sheet mortgage portfolios in the face of Basel IV.*

Table 1 summarizes the stated hypothesis. The following chapter covers the methodology and data used to test the hypotheses.

Table 1
Overview of hypotheses

H1	The announcement of Basel IV has a negative impact on the equity prices of European Banks around the announcement date.
H2	Banks that rely heavily on IRB model output face a stronger negative effect on their equity prices around the announcement date of Basel IV than banks that rely on the Standardized Approach.
H3	Banks in the BINDS countries face a stronger negative effect on their equity prices around the announcement date of Basel IV than banks in non-BINDS countries.
H4	Banks with higher capital ratios face a stronger positive effect on their equity prices around the announcement date of Basel IV than banks with lower capital ratios.
H5	Large banks face a stronger negative effect on their equity prices around the announcement date of Basel IV than smaller banks.
H6	Banks with low NPL and high LtV mortgage portfolios face a stronger negative effect on their equity prices around the announcement date of Basel IV other banks.
H7	Banks with low NPL and high LtV mortgage portfolios will move away from on-balance sheet mortgage portfolios in the face of Basel IV.

4. Methodology & Data

This chapter covers the methodology applied and the data that has been used to test the hypotheses as outlined in chapter 3.

4.1. Methodology

The following sections go into the methodology used in this thesis to test the hypotheses and to find an answer to the research question. The first subsection goes into the event study methodology as applied in this thesis. The second and third subsections cover the univariate and multivariate analysis. The fourth and final subsection covers the panel data analyses that is used to test the seventh hypothesis.

4.1.1. Event study

To research the impact of Basel IV on bank valuation as perceived by the market, this thesis uses an event study. The purpose of an event study is to measure the impact of an event on the stock price of a company. The dependent variable in the first part of this thesis is the Cumulative Abnormal Return (CAR) of European banks based on daily stock returns over one year leading up to the announcement date of Basel IV, which is December 7, 2017.

The event study methodology assumes that all information is directly reflected in the price of a security (MacKinlay, 1997). A strong assumption that leads back to the Efficient Market Hypothesis (EMH) which was introduced in the works of Fama (1965) and Fama, Fisher, Jensen & Rolls (1969). The idea is that the current stock price reflects the discounted value of all expected future cash flows. This can only be the case if investors are informed, rational and utility maximizing while continuously updating their positions in the stock market with the arrival of new information. Various studies (Schwert, 1996; Duso, Gugler, & Yurtoglu, 2006) find strong evidence for the ability of investors to incorporate information in their market position in a merger environment. Based on the existing literature one can agree to a satisfactiary extent with the EMH and thus the application of the event study.

This thesis follows the event study methodology as posed in the paper by MacKinley (1997). The first step is to identify the event of interest. The event study in this thesis assesses the impact of the announcement of Basel IV on the valuation of European banks. On December 7, 2017 the Group of Central Bank Governors and Heads of Supervision, the BCBS oversight body, published their endorsement of the "Basel III post-crisis regulatory reforms", also known as Basel IV. The announcement of the final version of reforms is the event of interest and thus the event date is December 7, 2017. This date is set as t = 0. The event windows are set at t = [-1,+1] (CAR3), t = [-2,+2] (CAR5), t = [-3,+3] (CAR7), and t = [0,+3] (CAR+3) where t = 1 is equal to one trading day. Three out of the four windows start before the announcement date to include the effect of pre-release and speculative information. The longest window is set to seven trading days to incorporate potential delayed effects due to the complexity of the regulation while simultaneously keeping the window short enough to minimize the effect of external factors. Multiple event windows are used to capture the initial effect and

measure if the effect is persistent over time. As described by Kriving, Patton, Rose & Tabak (2003) for a large sample it does not make sense to estimate the event window on a case-by-case basis as the law of large numbers averages potential short-term misinterpretations of news by the market.

As presented in more detail in section 4.2, the firms to include are European banks that have been listed since 2012 and have had revenue in 2017 of at least € 10 million. After excluding the banks with no available data, this results in a list of 166 banks.

The final step in this section is the calculation of the abnormal returns. According to MacKinley (1997) the abnormal return (AR_{it}) for firm *i* and event date *t* is the actual return of the stock during time period *t* (R_{it}) minus the expected return ($E(R_{it}|X_t)$) during the event window and can be defined as:

$$AR_{it} = R_{it} - E(R_{it}|X_t) \quad (3)$$

The stock return, R_{it}, stems from the DataStream database. X_t from equation (3) is conditioning information for the Market Model and represents the market return.

MacKinley (1997) proposes two statistical methods to estimate the expected normal return. These are the Constant Mean Return Model (CMRM) and the Market Model (MM). MacKinley (1997) argues that the MM is an improvement over the CMRM as it removes the part of the return that relates to variance in the market return. This could lead to an increase in the detection of event effects. Therefore, this thesis applies the Market Model. The MM assumes a linear relation between the security return and the market return.

An estimation period is defined to estimate the regression coefficients. In this estimation period, the movement of the share price in relation to the movement of the market as a whole is used to estimate α_i and β_i. To capture all the effects that might occur due to seasonality the estimation window is set to one year, or 250 trading days, and it ends, following MacKinley (1997), on the day before the start of the first event window (t = -4). The 250 trading day estimation window is in line with the studies by Armitage (1995) and Peterson (1989) in which they use estimation windows of between 100 and 300 days, which they deem appropriate for studies using daily data.

With the MM parameters, one can estimate abnormal returns. Substituting the expected return in equation (3) with the expected return using the MM parameters leads to:

$$AR_{it} = R_{it} - \alpha_i - \beta_i R_{mt} - \varepsilon_{it} \quad (4)$$

From this equation, one can see that the abnormal return is the excess return over the return that one would expect given the market return and the MM parameters. In this thesis, the abnormal return is the return of a bank in the sample over the expected return based on its correlation with the market over the past year.

To be able to say something about the effect during the event window we need to calculate CARs. $CAR_i(t_1,t_2)$ is the CAR per bank over the event window and is defined as:

$$CAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{it} \quad (5)$$

Where t_1 is the start and t_2 is the end of the event window (MacKinlay, 1997).

Due to the complexity of some regulations, and thus the time needed by the market to process the information, and the public process before official announcements, which leads to incremental stock price changes instead of a clear announcement effect, event studies of regulatory reforms may be of low statistical significance. Binder (1998) states that regulation that involves legislative approval may have little power to reject the null hypothesis of no effect since information becomes public periodically.

According to Mackinley (1997), one can increase the power of an event study by using short-term event windows, broad samples and daily returns. This thesis does all three to increase the explanatory power of the event study with regard to the regulatory effect.

To analyze the CARs over the cross-section of banks the CARs are aggregated and averaged. This results in the Cumulative Average Abnormal Returns (CAAR), which is defined as:

$$CAAR = \frac{1}{N}\sum_{i=1}^{N} CAR_i \quad (6)$$

This thesis uses t-tests to see if the CAARs for the different windows are significantly different from zero. The t-test equals:

$$t = \frac{1}{\sqrt{N}}\left(\frac{CAAR}{SD(CAAR)}\right) \quad (7)$$

To test if bank specific variables significantly influence the CARs for the different windows various t-tests are used. The results of these t-tests will provide evidence for the acceptance or rejection of the hypotheses.

4.1.2. Univariate analysis

To gain a first insight in the impact of firm specific characteristics on the CARs, a univariate analysis is done on each discrete, or dummy, variable. The univariate analysis tests if there is a significant difference in CAR between two groups, one group for which the dummy is equal to one and the other group for which the dummy is equal to zero. In other words, it tests if banks specific characteristics lead to statistically significant different CARs. The univariate analysis tests if there is a difference for the banks in BINDS countries versus the banks in other countries, for high capitalized versus low capitalized banks, for large versus small banks and finally for banks with low NPL and high LTV ratios versus the other banks.

4.1.3. Multivariate analysis

The third analysis is a multivariate analysis to test hypotheses two to six and give an indication for hypothesis seven. All variables are put in the same regression to control for the effects of each other. To control for non-normal measurement errors and statistical outliers a robust regression model is applied. There are three robust cross-sectional OLS regression models for each event window:

$$CAR_i(t_1, t_2) = \alpha_i + \beta_1 IRBOUTPUT_i + \beta_2 BINDS_i + \beta_3 WELLCAPITALIZED_i + \beta_4 LARGE_i + \beta_5 LOWNPLHIGHLTV_i + e \quad (8.1)$$

$$CAR_i(t_1, t_2) = \alpha_i + \beta_1 IRBOUTPUT_i + \beta_2 BINDS_i + \beta_3 WELLCAPITALIZED_i + \beta_4 LARGE_i + \beta_5 LOWNPLHIGHLTV_i + \beta_6 MBRATIO_i + \beta_7 ROE_i + e \quad (8.2)$$

$$CAR_i(t_1, t_2) = \alpha_i + \beta_1 IRBOUTPUT_i + \beta_2 \text{CFE} + \beta_3 WELLCAPITALIZED_i + \beta_4 LARGE_i + \beta_5 LOWNPLHIGHLTV_i + \beta_6 MBRATIO_i + \beta_7 ROE_i + e \quad (8.3)$$

In all models, $CAR_i(t_1, t_2)$ is the dependent variable and it is calculated via the methods described in section 4.1.1. The IRBOUTPUT is the level of country specific model output that is due to IRB models. In line with hypothesis two, the coefficient is expected to be negative. The dummy variable BINDS represents whether the bank is incorporated in one of the BINDS countries and, in line with hypothesis three, the coefficient is expected to negative. The dummy variable WELLCAPITALIZED is set to one if the capital ratio of the bank is above the mean of the sample. In theory, a better-capitalized bank should be able to withstand higher regulatory capital requirements better than an undercapitalized bank. In line with hypothesis four, the coefficient is expected to be positive. The variable LARGE represents a dummy variable, which is equal to one if the banks total assets are above € 1 billion. Hypothesis five expects a negative relation between bank size and CAR around the announcement of Basel IV. The coefficient is expected to be negative. Finally, LOWNPLHIGHLTV is one if the bank has below average NPL ratios and is incorporated in a country with an above average LtV ratio. A significant outcome can support the further analysis under 4.1.4., where the difference in change in asset allocation to mortgages between banks with low NPL and high LtV ratios and other banks over the years leading up to the Basel IV announcement is tested. The second and third models contain the variables MBRATIO and ROE as control variables. The Return on Equity (ROE) is an important indicator of profitability and therefore can interfere in the CARs. Because, a high or low ROE can influence the return of the bank independent of the announcement of Basel IV. Similarly, the Market-to-book ratio (MBRATIO) is a measure of growth and profitability (Chen & Zhao, 2006). These factors can influence the price shareholders are willing to pay for the equity and thus can influence the CAR independent of the announcement of Basel IV. Finally, in the third model the BINDS variable is replaced by the CFE variable that contains dummy variables for all countries in the sample. This is done to test if there are statistically significant difference between countries, other than those captured in the BINDS variable.

4.1.4. Panel data analysis

The final test in this thesis is performed to see if banks move away from mortgage portfolios and if this effect is stronger for banks that have low NPL ratios and high LtV. For this test a panel dataset is used. First, the data set is converted to panel data and total assets are converted to their natural logarithm to use in the regression as control variables. To test whether there is a difference in asset allocation over time between the two subsamples the following two robust fixed effects regressions are constructed:

$$MtoL_i = \beta_0 + \beta_1 LOWNPLHIGHLTV_i + \beta_2 LOGASSETS_i + \beta_3 YearFixed_i + \beta_4 CFE_i + \mu + e \quad (9.1)$$

$$MtoA_i = \beta_0 + \beta_1 LOWNPLHIGHLTV_i + \beta_2 LOGASSETS_i + \beta_3 YearFixed_i + \beta_4 CFE_i + \mu + e \quad (9.2)$$

In which MtoL is the percentage of mortgage loans compared to the total loan portfolio and MtoA is the percentage of mortgage loans to total assets. The first model checks for a difference in the allocation of funding in relation to the total asset position while the second checks for a difference in mean within the loans asset class. The control variable LOGASSETS explains the difference in percentage allocated due to growth of the entire asset base. Country and year fixed effects are taken into account as control variables. The results of these regressions show if there is a difference in MtoL (MtoA) between LOWNPLHIGHLTV banks and non-LOWNPLHIGHLTV banks over the past 6 years.

The difference-in-differences method tests differences in the change of MtoL (MtoA) ratio over time between LOWNPLHIGHLTV banks and non-LOWNPLHIGHLTV banks. The treatment point is set to 2015 as the BCBS published their first output floor plans at the end of 2014. A difference in asset allocation is expected from this point forward to prepare for the new regulation. The dummy variable (TIME) is equal to one for all years after 2014. The variable DID is an interaction term between TIME and LOWNPLHIGHLTV. To test if there is a change in the mean percentage of assets dedicated to mortgages after the first announcement of the SOF, the following two tests are performed:

$$MtoL_i = \alpha_i + \beta_1 TIME_i + \beta_2 LOWNPLHIGHLTV_i + \beta_3 DID_i + e \quad (10.1)$$

$$MtoA_i = \alpha_i + \beta_1 TIME_i + \beta_2 LOWNPLHIGHLTV_i + \beta_3 DID_i + e \quad (10.2)$$

The next section describes the data that is used in the beforementioned tests.

4.2. Data

The next paragraphs go into the data collection methods and parameters applied in the sample selection and construction of the database. Then, descriptive statistics of the sample are provided.

4.2.1. Sample selection

The initial sample consists of all public banks with their geographic location in Europe.[1] Minimum total revenue over the last twelve months has to be at least € 10 million. To ensure that enough data is available the companies have to be listed since 2012 or earlier. These criteria lead to a preliminary

[1] The screening tool of S&P CapitalIQ serves as a base for the initial sample.

cross-sectional sample of 173 banks. After deleting entries with missing data, this results in a sample of 166 European banks.[2]

Next, daily adjusted returns are retrieved for all banks in the sample as well as the daily adjusted return of the MSCI Europe index, which serves as the market index input in the event study.[3] By including the effects of dividends and stock splits, a more realistic view on the price development is achieved. The information is retrieved for the period of -254 trading days before December 7 2017 up until 3 trading days after the event date.

Next to the daily adjusted returns and continuous firm specific variables, multiple discrete dummy variables have been included in the analysis. Following Carter and McNulty (2005), a bank is large if the total assets are above € 1 billion and thus the dummy variable LARGE is set to one if a bank satisfies this criteria. The dummy BINDS is set to one if the country of incorporation is in one of the BINDS countries. The variable IRBOUTPUT uses the percentage of IRB model output per country as an proxy for the IRB model use per bank in that country. The IRB model output per country is in line with the research as presented by Resti (2016). A bank is well capitalized if the total capital ratio is above the average capital ratio in the sample, which is equal to 17.98%. To create dummy variables for banks in countries with low NPL and high LtV ratios, data on LtV and NPL is collected. The LtV is retrieved per country from the review of Europe's mortgage and housing markets by the European Mortgage Federation (2017). The NPL as percentage of total loans is retrieved per bank. If banks have below average NPL ratios (<6.88%) and above average LtV (>73.67%), the dummy LOWNPLHIGHLTV is equal to one. Finally, to make outcomes better comparable and deal with large outliers in the right tail, the total assets are all retrieved in euros and scaled with the natural logarithm and captured in the variable Log(Assets).

For the panel data analysis a separate database is constructed based on the same company list as used in the cross-sectional dataset. Data is collected on the percentage of the total loan portfolio that are mortgage loans, the percentage of the total assets that are mortgage loans and the banks total assets on a yearly basis. The data spans the 2012-2017 period to have a pre-event window of three years before the first hint of a system of floors, which was published at the end of 2014 (Basel Committee on Banking Supervision, 2014). The variable LOWNPLHIGHLTV is constructed by means of the NPL level of the bank and the LTV level of the country of incorporation. For this test, a subsample is created where all observations with missing data on either NPL or LTV ratios are deleted since no LOWNPLHIGHLTV variable can be constructed. This results in a sample of 105 banks.

[2] Company specific data is retrieved through the S&P CapitalIQ Excel plug-in, which retrieves data directly from the S&P Capital IQ database.

[3] Daily stock returns are retrieved via the DataStream tool from the Thomson database.

4.2.2. Descriptive statistics

The final cross-sectional sample consists of 166 bank in Europe. Of these banks, 145 are large banks and the average total assets amount to € 132 billion. Of the 166 banks, 27 are incorporated in a BINDS country, 60 are categorized as low NPL and high LtV, and 57 are well capitalized. The average market to book ratio is 0.89 and the average ROE is 8%. On average, 43% of the total loan portfolio consists of mortgage loans while this accounts for 15% of the total assets. Table 2 shows the geographical separation of the sample.

Table 2
Number of banks per European country according to their country of incorporation

Country	Obs.	Country	Obs.
Austria	6	Lithuania	1
Belgium	1	Malta	4
Bulgaria	3	Netherlands	2
Croatia	6	Norway	18
Cyprus	1	Poland	12
Czech Republic	1	Portugal	2
Denmark	19	Romania	2
Finland	1	Russia	8
France	17	Serbia	1
Germany	5	Slovakia	4
Greece	5	Spain	6
Greenland	1	Sweden	4
Hungary	1	Switzerland	12
Ireland	1	Ukraine	3
Italy	10	United Kingdom	9

Panel A in Table 3 shows descriptive statistics of all continuous variables. Panel B shows descriptive statistics on the discrete, or dummy, variables. All variables have been tested for Skewness and Kurtosis and none poses a potential problem in interpreting the results.

Table 3
Summary statistics on continuous and discrete variables. The sample consists of European banks with total revenue over 2017 of at least € 10 million.

Panel A shows the number of observations, mean, median, standard deviation, minimum, and maximum value of the continuous variables. Capital ratio is retrieved from the CapitalIQ database and represents the total regulatory capital to risk weighted assets per bank. IRB output is the percentage of RWA that is produced by IRB models on a country level as described by Resti (2016). The country-level IRB output is matched with banks incorporated in that country. Loan-to-value shows the relative size of the loan to the underlying securities and is retrieved on a country level from the European Mortgage Federation (2017). The LtV per country is matched with banks on basis of country of incorporation. Non-performing loans is the percentage of total assets that is non-performing, which is retrieved from CapitalIQ on a bank-by-bank basis. Market-to-book ratio and Return on Equity are both directly retrieved from CapitalIQ on a bank-by-bank basis. Log(Assets) is the natural logarithm of total assets converted to euros on a bank-by-bank basis which is retrieved from CapitalIQ.

Panel A: Descriptive statistics continuous variables

	Obs.	Mean	Median	Std. Dev.	Min	Max
Capital ratio	125	18.0%	17.9%	4.0%	7.4%	40.9%
IRB output	141	42.5%	39.8%	23.4%	0.0%	81.5%
Loan-to-Value	117	73.7%	75.0%	7.8%	55.0%	100.0%
Non performing loans	127	6.9%	3.5%	10.2%	0.0%	53.5%
Market-to-book ratio	136	89.4%	69.8%	97.6%	9.9%	1070.0%
Return on Equity	164	8.3%	8.0%	6.9%	-20.5%	53.6%
Log(Assets)	166	4.17	4.16	0.93	2.56	6.32

Panel B shows the four discrete, or dummy, variables used in this research. The first column shows the variable name, second column shows the number of observations, and the third column shows the mean value of the variable which is equal to the percentage of firms that are included in the dummy variable. BINDS countries is equal to one if the bank is incorporated in Belgium, Ireland, the Netherlands, Denmark or Sweden. LowNPL-HighLtV is equal to one if the bank has below average NPL ratios and above average LTV ratios. Large is equal to one if the total assets are more than € 1 billion. Well capitalized is equal to 1 if the bank has above average capitalization.

Panel B: Descriptive statistics discrete variables

	Obs.	Mean
BINDS Country	166	16.0%
LowNPL-HighLtV	105	57.0%
Large	166	87.0%
Well Capitalized	125	45.6%

Table 4 shows the correlation matrix of all continuous variables used in the multivariate analysis. Econometricians are indecisive on the thresholds for correlation in regression models, proposing thresholds ranging between 0.35 (Farrar & Glauber, 1967) and 0.90 (Mela & Kopalle, 2002). Collinearity creates highly unstable coefficients and make it hard to interpret results. While there are significant coefficient correlations, almost none of them raises mayor concerns on collinearity, as they remain relatively low. However, Return on Equity is excluded from the model as it shows a relatively high collinearity coefficient of 0.496 with the Market-to-book ratio, which is significant at the 1% level.

Table 4
Correlation matrix of all continuous variables used in this thesis. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Capital ratio	1.000						
(2) IRB output	0.349***	1.000					
(3) Loan-to-Value	0.052	-0.066	1.000				
(4) Non performing loans	-0.132	-0.3361***	-0.127	1.000			
(5) Market-to-book ratio	0.306**	0.113	-0.110	-0.110	1.000		
(6) Return on Equity	0.256**	0.338***	-0.168*	-0.123	0.496***	1.000	
(7) Log(Assets)	0.135	-0.010	0.009	0.021	-0.031	-0.147*	1.000

The next section describes the results which stem from the methodologies as described in this chapter.

5. Results

This chapter presents the results of the statistical tests outlined in chapter 4. The chapter consists of three sections. The first section presents the results of the event study and the summary statistics of the different CARs. The second section goes into the effect of the various bank specific characteristics on the CARs. The third and final section contains the results with regard to the Panel data analysis.

5.1. Event study

Table 5 shows the summary statistics for the various CAR windows, which result from the event study as described in section 4.2. From the summary statistics, one can see that the mean and median CAR are close to zero for all windows, with the exception of the CAR+3 window. The minimum and maximum range between -17.6% and +13.9%, which indicate economically significant impacts for those banks in the sample. However, while the impact is severe, one cannot conclude that these high deltas are solely due to the announcement effect of Basel IV.

Table 5
Cumulative Abnormal Returns for European banks around the announcement of Basel IV. Table 5 shows the descriptive statistics on the Cumulative Abnormal Returns for all four windows; [-1,+1], [-2,+2], [-3,+3], and [0,+3]. CAR3, CAR5, CAR7, CAR+3 respectively. All intervals are trading days relative to the announcement date of Basel IV, December 7 2017.

	Obs.	Mean	Median	Min	Max	Std. Dev.
CAR3	166	0.26%	0.13%	-9.74%	7.31%	2.19%
CAR5	166	-0.09%	0.00%	-9.56%	7.44%	2.54%
CAR7	166	0.08%	-0.02%	-17.60%	13.94%	3.17%
CAR+3	166	0.98%	0.66%	-5.56%	13.54%	2.53%

Table 6 presents the results of the first hypothesis test. It tests if the CAARs are significantly different from zero and thus if the announcement of Basel IV has an effect on the share price of all European banks. Based on the CAR3, CAR5 and CAR7 windows, no evidence can be found for the rejection of the null hypothesis and thus for these windows one cannot conclude that the announcement of Basel IV has a significant effect on the abnormal share price returns during these windows. For the CAR+3 window there is a statistical effect, but the effect is opposite of what was expected under the first hypothesis. The results indicate that the announcement of Basel IV has a positive effect of 0.98% on the share prices of the banks in the sample in the period between the announcement day and three trading days later. This result is statistically significant at the 1% level. It is interesting to see that the only window that shows statistically significant results is the one that does not include pre-announcement information. One reason might be that market participants overestimated the negative impact of the new regulation before the announcement and thus pressed the share price down, which went up after the announcement did not show mayor surprises. Furthermore, the means are all but one positive. An interesting result if one takes into consideration the results of Eyssell and Arshadi (1990) who show that higher capital requirements under Basel I had a negative impact on bank valuation.

Also, the risk headroom as described by Resti (2016) seems to be overlooked by the market as an appreciation of this effect should theoretically lead to a decrease in market value. After all, banks would become riskier without an increase in return.

Table 6
T-test results of the test if the Cumulative Average Abnormal Returns are significantly different from zero for all four windows. ***, **, * shows statistical significance at the 1%, 5%, and 10% level, respectively.

	Obs.	Mean	Std. Dev.	*t*	*p*
CAAR3	166	0.26%	2.19%	1.518	0.131
CAAR5	166	-0.09%	2.54%	-0.460	0.646
CAAR7	166	0.08%	0.25%	0.336	0.737
CAAR+3	166	0.98%***	2.53%	5.006	0.000

5.2. Univariate analysis

The univariate analysis tests if there is a significant difference in CARs between the two groups in a dummy variable. The following sub sections present the results of the univariate analyses: 1) BINDS Countries; 2) Capitalization; 3) Size; and 4) NPL LTV ratios.

5.2.1. BINDS Countries

Table 7 contains the comparison of CAARs between BINDS and non-BINDS countries for all four windows. As stated in the hypothesis, one would expect that banks in BINDS countries experience the impact of Basel IV stronger than banks in other countries. Looking at the results, there is a significant difference in market reaction between BINDS and non-BINDS countries for the CAAR3, CAAR5 and CAAR+3 windows. The significance being respectively at the 5%, 10% and 1% level. However, the evidence does not allow for a straightforward conclusion. The market reaction is less positive for BINDS countries during the CAAR3 window while the opposite is the case for the CAAR5 and CAAR+3 window. During the CAAR3 window BINDS countries experience a smaller market reaction by 0.99% (0.10% versus 1.09%), while the abnormal return is still positive for both groups. In the CAR5 and CAR+3 window the BINDS countries experience a larger abnormal return by respectively 0.97% (0.72% versus -0.25%) and 1.36% (2.12% versus 0.76%).

Table 7
Univariate analysis of BINDS dummy variable on all four event windows. Cumulative Average Abnormal Returns (CAARs) show the average abnormal return per event window. The windows are [-1,+1],[-2,+2],[-3,+3],[0,+3] or CAAR3, CAAR5, CAAR7 CAAR+3, respectively. ***, **, and * show statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are presented in parentheses.

	BINDS	Non-BINDS	Difference	*t*	*p*
	(1)	(2)	(1)-(2)		
CAAR3	0.10%	1.09%	-0.99%**	-2.183	0.031
	(0.004)	(0.002)	(0.005)		
CAAR5	0.72%	-0.25%	0.97%*	-1.823	0.070
	(0.005)	(0.002)	(0.005)		
CAAR7	0.45%	0.01%	0.44%	-0.654	0.514
	(0.006)	(0.003)	(0.007)		
CAAR+3	2.12%	0.76%	1.36%***	-2.601	0.010
	(0.006)	(0.002)	(0.005)		
Obs.	27	139			

5.2.2. Capitalization

Table 8 contains the comparison of CAARs between above average capitalized banks and below average capitalized banks for all four windows. There is a significant difference in abnormal returns for all four windows at respectively the 1%, 5%, 10% and 5% level. For the measure of capitalization, one can conclude a trend, as all returns are higher for well-capitalized firms. During the CAAR3 window, the returns for well-capitalized banks are 1.18% higher. For the CAAR5 window, the returns are 1.09% higher and for the CAAR7 and the CAAR+3 the returns are 1.02% and 1.01% higher for well-capitalized firms. This is in line with the hypothesis that well-capitalized firms are better equipped to deal with the effect of Basel IV.

Table 8
Univariate analysis of Well capitalized dummy variable on all four event windows. Cumulative Average Abnormal Returns (CAARs) show the average abnormal return per event window. The windows are [-1,+1],[-2,+2],[-3,+3],[0,+3] or CAAR3, CAAR5, CAAR7 CAAR+3, respectively. ***, **, and * show statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are presented in parentheses.

	Well capitalized	Under capitalized	Difference	*t*	*p*
	(1)	(2)	(1)-(2)		
CAAR3	1.08%	-0.10%	1.18%***	-2.955	0.004
	(0.003)	(0.002)	(0.004)		
CAAR5	0.67%	-0.42%	1.09%**	-2.293	0.024
	(0.003)	(0.003)	(0.005)		
CAAR7	0.90%	-0.12%	1.02%*	-1.685	0.095
	(0.003)	(0.005)	(0.006)		
CAAR+3	1.85%	0.84%	1.01%**	-2.116	0.036
	(0.003)	(0.004)	(0.005)		
Obs.	57	68			

5.2.3. Size

Table 9 contains the comparison of CAARs between large and small banks for all four windows. As mentioned in section 4.2, a bank is classified as large when it has total assets of over € 1 billion. For the difference in size, the CAAR7 and CAAR+3 windows show statistically significant differences in cumulative average abnormal returns. Large banks have a better return than small banks by 1.20% during the CAAR7 and 0.80% during the CAR+3 window. These differences are both significant at the 10% level. These findings show that large banks indeed face different abnormal returns after the announcement of Basel IV, supporting the hypothesis. However, since large banks tend to rely more on IRB models and some of the larger banks are also GSIBs and thus exposed to extra regulatory capital charges, the sign of the difference is opposite of what was expected.

Table 9
Univariate analysis of Large dummy variable on all four event windows. Cumulative Average Abnormal Returns (CAARs) show the average abnormal return per event window. The windows are [-1,+1],[-2,+2],[-3,+3],[0,+3] or CAAR3, CAAR5, CAAR7 CAAR+3, respectively. ***, **, and * show statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are presented in parentheses.

	Large	Small	Difference	*t*	*p*
	(1)	(2)	(1)-(2)		
CAAR3	0.20%	0.30%	-0.10%	0.033	0.974
	(0.002)	(0.003)	(0.005)		
CAAR5	-0.10%	-0.30%	0.20%	-1.387	0.169
	(0.002)	(0.003)	(0.006)		
CAAR7	0.20%	-1.00%	1.20%*	-1.813	0.073
	(0.003)	(0.004)	(0.007)		
CAAR+3	1.10%	0.30%	0.80%*	-1.884	0.062
	(0.002)	(0.003)	(0.006)		
Obs.	145	21			

5.2.4. NPL LTV Ratios

The final univariate analysis cover the difference in NPL and LTV ratios. Table 10 shows the comparison of CAARs between banks with low NPL and high LTV ratios versus the other banks. There is a significant difference in abnormal returns during the CAAR7 and CAAR+3 window, both at the 10% significance level. While during the CAAR7 window the banks in the dummy group have positive returns, those in the other group have negative returns. The difference is 1.21%. During the CAAR+3 window both groups show positive abnormal returns, with the in group banks showing a 0.97% higher cumulative average abnormal return. The results can serve as an indication for the sixth hypothesis.

While it does not tell us whether banks move away from mortgages, it does indicate that on the first sight they are significantly underperforming compared to the other banks, which one would expect if no precautious measures were taken. Section 5.4 discusses if there is a difference in mortgage portfolios and if this changed over time.

Table 10
Univariate analysis of Low NPL high LTV dummy variable on all four event windows. Cumulative Average Abnormal Returns (CAARs) show the average abnormal return per event window. The windows are [-1,+1],[-2,+2],[-3,+3],[0,+3] or CAAR3, CAAR5, CAAR7 CAAR+3, respectively. ***, **, and * show statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are presented in parentheses.

	Low NPL high LTV	Other	Difference	*t*	*p*
	(1)	(2)	(1)-(2)		
CAAR3	0.38%	0.40%	-0.01%	0.033	0.974
	(0.003)	(0.003)	(0.004)		
CAAR5	0.23%	-0.47%	0.70%	-1.387	0.169
	(0.003)	(0.004)	(0.005)		
CAAR7	0.66%	-0.55%	1.21%*	-1.813	0.073
	(0.004)	(0.005)	(0.007)		
CAAR+3	1.37%	0.40%	0.97%*	-1.884	0.062
	(0.004)	(0.003)	(0.005)		
Obs.	60	45			

5.3. Multivariate analysis

The multivariate analysis tries to explain to what extent the various bank characteristics have an effect on the market reaction to the share price of the bank around the announcement of Basel IV. The multivariate analysis consists of three models. Model one is a robust OLS regression of the variables on each car without consideration of the control variables. Model two is a robust OLS regression of the variables on each CAR with consideration of the control variables and model three replaces the BIND variables in the second model with country fixed effects to test if the a more detailed country level separation can be discovered.

Table 11 presents the results of the three regression models in the multivariate analysis per event window. The dependent variable is the CAR per window and the independent variables test for the effect of level of IRB output, level of capitalization, size, low NPL high LtV ratios and country of incorporation. The coefficients show the direction and strength of the effect of the independent variable on the CAR.

Table 11
Robust regression analysis of CAR3, CAR5, CAR7 and CAR+3, all calculated for the respective windows of [-1,+1], [-2,+2], [-3,+3], and [0,+3] trading days around December 7, 2017. The CARS are regressed against independent variables as described in section 4.1.3. and section 4.2.1. Robust standard errors in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	CAR3			CAR5		
	(1)	(2)	(3)	(1)	(2)	(3)
IRBOUTPUT	0.009	0.009	0.037	-0.006	-0.018	0.046
	(0.013)	(0.015)	(0.029)	(0.022)	(0.023)	(0.037)
WELLCAPITALIZED	0.012**	0.010*	0.009	0.009	0.012*	0.006
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)
LARGE	-0.007	-0.005	-0.003	-0.023***	-0.016**	0.015
	(0.005)	(0.005)	(0.004)	(0.008)	(0.007)	(0.019)
LOWNPLHIGHLTV	-0.000	-0.001	0.002	0.012	0.010	0.011
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.009)
MBRATIO		-0.002	-0.002		0.001	-0.003
		(0.004)	(0.005)		(0.006)	(0.006)
BINDS	0.005	0.006		0.010	0.011	
	(0.009)	(0.010)		(0.013)	(0.014)	
Belgium			0.024***			0.014***
			(0.006)			(0.005)
Croatia			0.011			0.021
			(0.011)			(0.016)
Denmark			-0.017			-0.037
			(0.024)			(0.030)
Finland			0.019**			-0.035***
			(0.009)			(0.009)
France			0.001			-0.009
			(0.009)			(0.009)
Germany			0.016			0.004
			(0.013)			(0.012)
Greece			0.041			-0.001
			(0.029)			(0.036)
Italy			0.019			0.015
			(0.013)			(0.013)
Lithuania			-0.029***			-0.059***
			(0.006)			(0.007)
Malta			0.019			0.055**
			(0.013)			(0.025)
Netherlands			0.009			0.008
			(0.007)			(0.008)
Norway			-0.005			0.009
			(0.008)			(0.012)
Poland			0.006			0.006
			(0.010)			(0.015)
Portugal			0.000			-0.001
			(0.016)			(0.016)
Slovakia			-0.005			-0.013
			(0.007)			(0.011)
Spain			0.022**			0.015
			(0.008)			(0.013)
Sweden			0.005			0.002
			(0.009)			(0.008)
United Kingdom			-			-
Constant	0.005***	0.007	-0.013	0.014***	0.014**	-0.038
	(0.000)	(0.005)	(0.012)	(0.000)	(0.006)	(0.025)
Observations	81	72	72	81	72	72
R-squared	0.116	0.119	0.405	0.103	0.122	0.463

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11 – continued

Robust regression analysis of CAR3, CAR5, CAR7 and CAR+3, all calculated for the respective windows of [-1,+1], [-2,+2], [-3,+3], and [0,+3] trading days around December 7, 2017. The CARS are regressed against independent variables as described in section 4.1.3. and section 4.2.1. Robust standard errors in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

	CAR7			CAR+3		
	(1)	(2)	(3)	(1)	(2)	(3)
IRBOUTPUT	-0.002	-0.027	0.083*	-0.005	-0.022	0.016
	(0.034)	(0.036)	(0.048)	(0.029)	(0.033)	(0.044)
WELLCAPITALIZED	0.010	0.010	-0.000	0.009*	0.012**	0.004
	(0.007)	(0.007)	(0.009)	(0.006)	(0.006)	(0.008)
LARGE	-0.048***	-0.036***	-0.003	-0.035***	-0.030***	0.009
	(0.013)	(0.011)	(0.046)	(0.009)	(0.009)	(0.036)
LOWNPLHIGHLTV	0.018*	0.018**	0.018	0.012	0.014	0.020
	(0.010)	(0.009)	(0.016)	(0.008)	(0.008)	(0.013)
MBRATIO		0.000	-0.009		0.001	-0.001
		(0.007)	(0.007)		(0.006)	(0.007)
BINDS	0.013	0.019		0.020	0.022	
	(0.016)	(0.017)		(0.013)	(0.014)	
Belgium			0.024***			0.023**
			(0.007)			(0.009)
Croatia			0.028**			0.001
			(0.014)			(0.013)
Denmark			-0.043			0.001
			(0.033)			(0.037)
Finland			-0.036**			-0.014
			(0.014)			(0.013)
France			-0.018			-0.009
			(0.014)			(0.012)
Germany			0.006			-0.002
			(0.013)			(0.014)
Greece			-0.018			0.016
			(0.016)			(0.018)
Italy			0.007			-0.006
			(0.014)			(0.013)
Lithuania			-0.093***			-0.049***
			(0.011)			(0.010)
Malta			0.072			0.052
			(0.047)			(0.037)
Netherlands			-0.005			0.005
			(0.011)			(0.012)
Norway			0.017*			0.015
			(0.010)			(0.012)
Poland			0.026			-0.003
			(0.018)			(0.016)
Portugal			0.012			-0.019
			(0.025)			(0.022)
Slovakia			-0.020			-0.022**
			(0.016)			(0.011)
Spain			0.008			0.008
			(0.013)			(0.011)
Sweden			-0.003			0.016
			(0.012)			(0.014)
United Kingdom			-			-
Constant	0.037***	0.037***	-0.027	0.036***	0.035***	-0.015
	(0.001)	(0.008)	(0.048)	(0.001)	(0.006)	(0.037)
Observations	81	72	72	81	72	72
R-squared	0.117	0.141	0.440	0.158	0.189	0.407

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The OLS regressions on the CAR3, and thus shortest, window shows significant results for the capitalization dummy under the first model. The coefficient is 0.012 and is significant at the 5% level. The implication is that above average capitalization increases the abnormal return in the three days surrounding the announcement of Basel IV by 1.2%. Model 2 adds the control variable for Market-to-book ratio, which has an effect on the significance and coefficient of the capitalization dummy. The abnormal returns decrease to 1.0% and the statistical significance decreases to the 10% level. Under model (3) the BINDS dummy variable, which has no significant effect on CAR3 under model (1) and (2), is replaced by country fixed effects. As described in section 4.1.3., this is done to find a more detailed result on the effect of country of incorporation. From the results under model (3) one can conclude that incorporation in Belgium, Finland and Spain has a positive effect on the CAR3 with the coefficient ranging between 1.9% and 2.4%. Banks incorporated in Lithuania experience a highly significant (1% level) negative abnormal return of 2.9%.

For the CAR5 window, one can observe a significant negative effect for large banks in the first model. The 2.3% lower CAR is significant at the 1% level. This implies that large banks face 2.3% lower returns than small banks during the five days surrounding the announcement of Basel IV. This result is somewhat surprising when compared to the univariate analysis, which did not show significant difference between large and small banks for the CAR5 window, and presented a very light negative mean abnormal return of 0.1% for large banks. Model (2) shows similar results for large banks, though the coefficient decreases to -1.6% and the significance level is 5%. Next to the size of the bank, capitalization also plays a role in the second model for CAR5. The variable shows a coefficient of 1.2%, which is significant at the 10% level. These results imply that the market decreases its valuation of large banks while this might be somewhat mitigated if the bank is well capitalized. The third model, which incorporates country fixed effects instead of the BINDS variable, again shows significant effects for banks incorporated in Belgium, Finland and Lithuania. Besides, banks in Malta show significant positive abnormal returns of 5.5% at the 5% significance level. Banks in Belgium face a 1.4% higher abnormal return during the 5-day window, which is statistically significant at the 1% level. Finland on the other hand, while showing positive significant coefficients for the CAR3 window, shows a coefficient of -3.5%, which is significant at the 10% level. Lithuanian banks see their cumulative abnormal returns decreasing further with a coefficient of -5.9%, which is significant at the 1% level.

At the CAR7 window, similar patterns occur for the large banks. Under the first model, there is a 4.8% lower abnormal return at the 1% significance level. Under model (2) the coefficient reduces to 3.5% while the significance remains stable. Under model (3) the coefficient has no significant impact anymore. For the CAR7 window, the banks with low NPL and high LTV ratios face a 1.8% (1.8%) higher return under model (1) ((2)). The coefficients show significance at the 10% and 5% level. Model (3) shows significant coefficients for the IRB output, indicating that increase in IRB output by 1% leads to an increase in cumulative abnormal returns during the 7 days surrounding the announcement of Basel

IV by 0.83%. This result is significant at the 10% level. Again, under the country fixed effects, significant coefficients are shown for Belgium, Finland and Lithuania. Furthermore, banks in Croatia and Norway face significant positive cumulative abnormal returns in the CAR7 window. Belgium shows a positive coefficient of 2.4%, which is significant at the 1% level. Croatia shows similar results with a coefficient of 2.8%, which is significant at the 5% level. Finland shows similar results as under the CAR5 window with a coefficient of -3.6%, which is significant at the 5% level. Lithuania shows an extreme negative coefficient of -9.3%, significant at the 1% level. Banks incorporated in Norway face a 1.7% increase in abnormal returns, which is significant at the 10% level.

The fourth, and final, window relates to the window from the announcement day until three days after. The model shows 0.9% higher abnormal returns for well-capitalized banks (10% significance level) and 3.5% lower returns for large banks (1% level). Under the second model, the coefficients change to 1.2% for the well-capitalized banks, with a significance level of 5%, and -3.0% for large banks with a significance level of 1%. These results are in line with the multivariate analysis on capitalization, which shows a consistent better abnormal return for well-capitalized banks. The results on size are conflicting, as the univariate analysis shows a more positive abnormal return for large banks while the multivariate analysis shows the opposite. The final model shows significant coefficients for banks incorporated in Belgium, Lithuania and Slovakia. For the CAR+3 window Belgian banks face a positive abnormal return of 2.3% (5% level) while Lithuanian and Slovakian banks face abnormal returns of -4.9% (1% level) and -2.2% (5% level) respectively.

The results of the country fixed effects should be interpreted with caution, as the number of banks in the countries with significant coefficients is generally low. Belgium, Finland, and Lithuania have only one bank in the sample. This implies that bank specific effects might distort the results.

The R-squared statistic, the percentage of the change in the dependent variable explained by the model, ranges between 10.3% and 15.8% for the first model. Model (2) shows R-squared statistics between 11.9% and 18.9%. The third model, which contains the country fixed effects, shows R-squared statistics between 40.5% and 46.3%.

5.4. Panel data analysis

The final analysis in this thesis regards the asset position of banks during the years leading up to the announcement of Basel IV. Based on the existing literature and statistics from the European Banking Authority (2017) banks with low NPL ratios in countries with high LtV ratios are expected to move away from mortgages on their balance sheet. This can be done by selling mortgage portfolios, increasing the total loan portfolio in different categories to decrease the share of mortgage portfolios to total loans or by placing the mortgage off balance sheet in special purpose vehicles. A bank is incentivized to do so due to the SOF introduced under Basel IV, which restricts the input parameters of the IRB models and increases the risk weight of these portfolios as it makes risk weights dependent on the LtV ratio of the mortgages. Under the predecessors of Basel IV, these banks could assign low risk weights to the portfolio as they had historically low losses due to the low NPL ratio.

The first analysis looks at the historic difference in portfolio composition with regard to mortgages. Two metrics indicate how much of the bank portfolio is dedicated to mortgages. The first metric, Mortgages to Loans (MtoL) shows the percentage of mortgages relative to the total loan portfolio. The second metric, Mortgages to Assets (MtoA) shows the percentage of mortgages relative to total assets. The time span of the analysis is six years from 2012 to 2017.

Table 12 shows the results of the first two regressions, which tests for significant differences between the mortgage portfolios of the two types of banks. The dependent variables are MtoL (MtoA) and the independent variables are the dummy variable for low NPL high LtV and size. Year fixed effects and country fixed effects are taken into the regression as well. For readability purposes the full CFE outcome is presented in appendix 4.

The results show that banks with low NPL and high LtV ratios have 11.9% higher MtoL ratios, which is significant at the 5% level. Low NPL high LtV banks have 7.4% higher MtoA ratios at the 10% significance level. This implies that before Basel IV banks with low NPL and high LtV ratios have a larger mortgage portfolio on their balance sheet, both relative to the total loan portfolio as to total assets. Next to the low NPL high LTV dummy, the size of the company has an impact on the relative size of the mortgage portfolio to total assets. As Table 12 shows, a 1% increase in total assets leads to a 0.034% decrease in the MtoA ratio.

Table 12
Robust fixed effects regression results. Sample consists of 106 banks for which data is collected on the percentage NPL to total assets, total assets, mortgage to loans and mortgages to total assets on a yearly basis between 2012 and 2017. LTV values are retrieved on country level and matched by country of incorporation. The average LTV is assumed constant over the 6-year window due to data limitations. LOWNPLHIGHTLTV is set to 1 if a bank has below average NPL and above average LTV ratios. Robust standard errors between parentheses. ***, **, and * show significance levels at the 1%, 5%, and 10% level, respectively.

	Mortgages to Loans	Mortgages to Assets
	(1)	(2)
LOWNPLHIGHLTV	0.119**	0.074*
	(0.047)	(0.038)
LOGTOTALASSETS	-0.009	-0.034*
	(0.021)	(0.018)
2013	0.006	-0.009
	(0.036)	(0.027)
2014	0.004	-0.009
	(0.035)	(0.027)
2015	0.010	-0.003
	(0.033)	(0.025)
2016	0.015	-0.019
	(0.033)	(0.026)
2017	0.031	-0.007
	(0.033)	(0.026)
CFE	Please refer to Appendix 4	Please refer to Appendix 4
Constant	0.268**	0.315***
	(0.113)	(0.101)
Observations	312	293
R-squared	0.543	0.530

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

From Table 12 one can see there is a difference in the asset allocation between the two types of banks. To test hypothesis seven an analysis is done to see if this metric changed over time to prepare for the implications of Basel IV. After all, as described earlier, banks with low NPL and high LtV ratios on their balance sheet will face a large increase in capital requirements. The expectation is that the exposure to mortgages will decrease to avoid this increase in regulatory capital and that the delta over time is significantly different for low NPL high LTV banks compared to other banks.

Table 13 shows the results form the difference-in-differences test, where the DID variable shows the difference in mean mortgage allocation after the first announcement of the SOF at the end of 2014.

Table 13
Difference-in-difference test result for the mortgage portfolio of European banks between 2012 – 2017. Sample consists of 106 European banks for which data is collected on the percentage NPL to total assets, total assets, mortgage to loans and mortgages to total assets on a yearly basis between 2012 and 2017. LTV values are retrieved on country level and matched by country of incorporation. The average LTV is assumed constant over the 6-year window due to data limitations. LOWNPLHIGHTLTV is set to 1 if a bank has below average NPL and above average LTV ratios. The TIME dummy variable is set to 1 for the years 2015 – 2017. The DID variable is an interaction variable between TIME and LOWNPLHIGHLTV. Robust standard errors between parentheses. ***, **, and * show significance levels at the 1%, 5%, and 10% level, respectively.

	Mortgages to Loans	Mortgages to Assets
	(1)	(2)
TIME	-0.005	0.022
	(0.030)	(0.038)
LOWNPLHIGHLTV	0.088**	0.149***
	(0.034)	(0.045)
DID	0.032	0.014
	(0.041)	(0.055)
Constant	0.175***	0.280***
	(0.024)	(0.032)
Observations	293	312
R-squared	0.102	0.113

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The difference-in-difference test does not show a significant difference in the changes in the mean between the two groups of banks for both metrics. This implies that from this data one cannot reject the null hypothesis of no difference between the asset allocation changes between low NPL high LtV banks and other banks.

5.5. Discussion

First, with the help of a t-test on the CAAR for several windows, results show that the announcement of Basel IV has an impact of 0.98% on the Cumulative Average Abnormal Returns for the entire European banking sector for the post event window that ranges from zero to three days after the announcement day. For the three other windows, which incorporate pre-announcement information, no significant deviation from zero is observed. Therefore, one can conclude that indeed the market showed an abnormal reaction in the wake of the announcement of Basel IV, but whether this is due to a correction of pre-announcement devaluation or a true appreciation of the Basel IV regulation on European banks remains unclear. This result is contrary to the findings of Eyssell and Arshadi (1990) who find a negative announcement effect in the increased regulatory capital charges under Basel I. One might argue that during the iterations of the Basel accord since then the regulation became more refined

and goal oriented. Surprisingly is also the absence of a negative market reaction when one keeps the results of Resti (2016) in mind. Apparently, in the eyes of the market, the risk headroom that Basel IV creates does not weigh up against the benefits of an even better capitalized banking industry. While the capital charges increase over almost the entire spectrum, for now the effect on the ROE/COE ratio for the entire industry remains limited. This could be explained by market expectations of banks pricing the increase in COE through to consumers and in that way keeping the ratio stable. Time will tell if this is going to be the case.

The results show no conclusive evidence that IRB model reliance, the second hypothesis, is of impact on the market reaction. Therefore, the null hypothesis cannot be rejected. This implies that even though Basel IV increases the output levels of IRB models, the market expects that banks that rely on these models will be able to manage the increase in regulatory capital in a sufficient matter. Alternatively, the IRB output alone might not be a pure proxy for increases in capital requirements. Banks with high IRB reliance but low performing portfolios can currently have RWA above the proposed output floor and thus will remain unaffected.

The univariate analyses show differences in CAAR for the four discrete variables. The results of these analyses are as follows. Banks incorporated in BINDS countries experience significant different results compared to other countries of between -0.99% and 1.36%. In all cases, the average abnormal returns are positive for BINDS countries. It is interesting to see that the difference is positive for the CAAR7 and CAAR+3 as these windows incorporate the most 'after announcement' information. The reason for this might be the slow incorporation of the information by the market. Due to regulatory complexity, it might take time to incorporate all information in the market, which would explain the stronger effect in the right side of the event window.

For bank capitalization, the univariate analysis finds consistent significant results for all four windows. Indeed, it seems that higher capital adequacy leads to a more positive abnormal return around the announcement. This is in line with the report of McKinsey&Company (2017) which states that the impact of Basel IV is dependent on when the new regulatory capital measures exceed the current capital holdings. Logically, higher capital ratios lead to higher threshold for this measure and thus to a delayed or nonexistent effect of the higher capital floors on a bank. Another interesting result of the capitalization analysis is that the returns for under average capitalized banks are negative for three out of four windows. This further strengthens the argument that the level of capitalization is a driver for market reaction in the face of Basel IV.

Differences in size play a small but significant role in the market reaction during the announcement of Basel IV. While the market appreciates large banks by 0.80% to 1.20% more than small banks during the CAR7 and CAR+3 window, the difference is statistically insignificant and near 0 for the CAR3 and CAR5 window. For the windows in which there is a difference, the coefficient is to a difference reaction

than one would expect based on the IRB model theory. An explanation could be that larger banks have more capital, in monetary and human form, and thus are better equipped to deal with regulatory changes than small banks.

Finally, the low NPL and high LTV banks are better, not worse, off than other banks in the days surrounding the announcement of Basel IV. An interesting result as, based on the proposed SOF, one would expect banks in this category to effected negatively by the new regulation. One possible explanation is that banks in this category undertook mitigation actions in the run-up period to Basel IV to prepare for the regulatory changes. Section 5.4 tests if this is the case.

In general, the difference in results between dummy variables and the CAARs of the entire sample show interesting insights. While at the aggregate level there is no significant market reaction to the announcement of Basel IV for all windows except CAR+3, under the split samples there is a more expressed difference. This indicates that the market indeed revalues banks in the face of Basel IV based on bank specific characteristics.

The multivariate analysis provides evidence for the rejection of the null hypothesis for hypothesis four, five and six. Indeed, the data shows that reliance on IRB output has a significant effect on the CAR7 window. However, the significance is low and only present in one out of 12 regression. Therefore, one can conclude that the models show no evidence for the rejection of the second null hypothesis. In this dataset, there is no significant difference in CAR for banks in BINDS countries compared to other countries. However, from model (3) one can conclude that the country of incorporation indeed can have an effect on the experienced CAR during the event windows. The results are mixed and further research is needed to find the source of variation. Based on these results, one cannot rule out that bank specific characteristics or country specific events influence the results. The results do show evidence for the rejection of the fourth null hypothesis. Well-capitalized banks experience more positive abnormal returns over the entire spectrum. The size of a bank also plays an important role in the abnormal returns during the announcement window of Basel IV. While the results of the univariate analysis shows that large banks experience, on average, higher abnormal returns, the multivariate analysis shows that this mean comparison might be skewed by outliers. The regression shows that large banks face significant lower cumulative abnormal returns, ranging between -1.6% to -4.8%. Next to the statistical significance, this is also of economic significance as it means that large banks lose up to 4.8% of their market capitalization in a period of 7 days. The combination of the univariate and multivariate analysis leads to the conclusion that the sixth null hypothesis is likely to be rejected. Banks with low NPL and high LTV ratios face different, higher, cumulative abnormal returns than other banks. However, this positive coefficient is opposite of what was expected ex ante. One explanation could be that low NPL high LTV banks already prepared for the announcement of Basel IV by optimizing their asset allocation. However, the results of the difference-in-difference test seem to debunk this theory.

From the difference-in-difference test, no evidence can be found for a different portfolio development between low NPL high LTV banks and other banks. While asset positions are slow moving, the lack of result might be due to the relatively long horizon that still remains until the actual implementation of Basel IV in 2022. Banks might be aware of the challenges on the horizon but did not see a reason to implement changes just yet. From current activities in the Dutch financial sector one can conclude that the process is started at the end of the sample period in the difference-in-difference test. It is recommended to repeat the research at the implementation of Basel IV, in 2022, to see whether there has been a significant change in asset allocation by that time.

6. Conclusion

The purpose of this thesis is to research the impact of Basel IV on the valuation of the European banking sector. Specifically, this thesis tries to examine the announcement effect of Basel IV on the valuation of European banks. To create a better understanding, the research question is split in various sub questions, which each on its own tries to explain a smaller aspect of the bigger picture. Finally, to place the impact of Basel IV in a practical and real life context, this thesis researches the actions banks take to mitigate potential risks to their own valuation with regard to the mortgage portfolio.

The results show evidence for a positive abnormal market reaction in the 4-day period beginning at the announcement of Basel IV. The other three windows do not show significant results and therefore no definite answer can be given to the question if there is an impact on the entire European banking industry. No evidence is found for the effect of IRB model reliance on the market valuation of banks and thus the second hypothesis cannot be accepted. Banks incorporated in BINDS countries do experience significantly different CARs during three out of the four windows. The coefficients are in two directions so no conclusion can be drawn on the direction of the impact. Besides, the regression models show no explanatory power for the BINDS variable. The combination of these two results lead to a partial acceptance of hypothesis three. Yes, it is likely that a difference between BINDS countries and non-BINDS countries exists, however, this difference might not be directly related to Basel IV.

The results do indicate that the market appreciates better capitalization, as well-capitalized banks show constant higher returns than under-capitalized banks. Therefore, the fourth hypothesis can be accepted. Large banks show a slightly higher average abnormal return compared to small banks. However, the regression models show that large banks do face significant lower returns. This mixed result can be due to outliers in the sample which the t-test does not control for while the robust regression does. Based on the results it is likely that the null hypothesis can be rejected and that large banks indeed face significant different, lower, effects on the announcement of Basel IV. Finally, the results show a difference in market reaction to low NPL high LTV banks compared to other banks. The coefficient however is different from what was expected. Initially, the market appreciates low NPL high LTV banks more than other banks. Based on these results the sixth hypothesis can be rejected as the effect is in the opposite direction of what was expected.

Finally the difference-in-difference method is applied to test for difference in portfolio development between low NPL high LTV banks. The results show a significant difference in mortgage allocation between the two groups, where low NPL high LTV banks have more than 10% higher mortgage to loan ratios. The results do not show a difference in portfolio development over time.

This study was performed under various limitations. First of all, since it concerns regulation and information is made available prior to the official announcement, the shock effect is relatively low. Despite this, the results still showed valuable insights in the market reaction to Basel IV. Furthermore,

the short time span between the announcement and this research implies that the true market effects are likely to crystalize beyond the grasp of this research. Follow up research could look into the actual portfolio development in the face of the implementation of Basel IV in 2022. Various publications and news articles show that the discussion is still very lively and banks try to find ways to optimize their position with regard to Basel IV. Whether this is by placing certain assets in special purpose vehicles, moving away from certain asset classes all together or simply increasing the capital buffer is not yet known and is interesting food for a follow up research. Until then, one can conclude that the market is taking its time to see how the industry develops. Indeed, some bank characteristics are likely to have a positive or negative impact in the end, such as size and capitalization, but the true long-term impact of Basel IV remains to be seen.

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8. List of abbreviations

Abbrevation	Meaning
A-IRB	Advanced Internal Rating Based approach
BCBC	Basel Committee of Banking Supervision
BINDS	Belgium, Ireland, Netherlands, Denmark, Sweden
CAAR	Cumulative average abnormal return
CAR	Cumulative abnormal return
CET1	Common equity tier 1
CFE	Cash flow to equity
CMRM	Constand mean return model
COE	Cost of equity
CVA	Credit valuation adjustment
DCF	Discounted cash flow
EAD	Exposure at default
F-IRB	Fundamental Internal Rating Based approach
G-SIB	Global systemically important bank
IRB	Internal Ratings-Based approach
LCR	Liquidity Coverage Ratio
LGD	Loss given default
LtV	Loan-to-value
MM	Market model
NPL	Non-performing loan
NSFR	Net Stable Funding Ratio
PF	Probability of default
ROE	Return on equity
RWA	Risk weighted assets
SA	Standardized approach
SOF	System of floors

9. Appendix 1 – Basel accords

9.1. Basel I

Basel I introduced the Risk Weighted Assets (RWA) and was limited to the credit risk exposure of banks. Under the Cooke ratio, each bank was required to hold a capital reserve of 8% of the RWA in its portfolio. The granularity of the risk weights was low under Basel I as it handled assets based on their class, and not on their rating (Basel Committee on Banking Supervision, 1998). In 1995, an updated version of the accord allowed for netting of credit positions and in 1996, market risk was taken into account (Dionne, 2013). Appendix 1 goes further in depth in the technicalities of Basel I. The capital reserve consists of two components, Tier 1 and Tier 2 capital. Tier 1 capital, or core capital, encompasses common stock and post-tax retained earnings. Tier 2 capital consists of undisclosed reserves, asset revaluation reserves, provisioning, hybrid capital instruments and subordinated debt. Tier 2 capital had to be smaller or equal to 50% of the total reserve capital (Basel Committee on Banking Supervision, 1998).

Criticizers deemed the accord to have a conservative stance on credit risk and saw a missed opportunity in the absence of any regulation on market risk. The BCBS always thought of the Basel accord to be an evolving legislation. In line with this thought, it did not take long for the first amendments to occur. In 1995, the accord allowed for netting of credit positions and in 1996, market risk was taking into account (Dionne, 2013). With these amendments came the introduction of the internal model to assess the Value at Risk (VaR) for asset returns, interest rates, exchange rate, and commodity price risk.

9.2. Basel II

In 2004, the Basel Committee introduced Basel II. The revised framework came into effect in 2006 (Basel Committee on Banking Supervision, 2005). The most notable change in comparison to Basel I are the risk sensitivity of the capital requirements, the introduction of a charge for operational risk and the introduction of the three pillars.

Basel II introduced three regulatory pillars: minimum capital requirements, supervisory review and market discipline (Basel Committee on Banking Supervision, 2005).

Under Pillar 1, the regulation seeks to incorporate a more realistic representation of reality. Therefore, it added a charge for operational risk in addition to the credit and market risks known from Basel 1. Besides this addition, the committee revised the calculation methods of credit risk. The Basel committee introduced pillars 2 and 3, supervisory review and market discipline, to increase the validation of the statistical methods and data and to make the banks more exposed to consequences by the market if they do not meet the minimal capital requirements (Basel Committee on Banking Supervision, 2005).

The credit risk calculations became more risk sensitive by considering counterparty risk. Besides, banks have the option to choose for the Standardized Approach (SA), the Foundation IRB (F-IRB) and the Advanced IRB (A-IRB).

Under the standardized approach, the risk granularity increased by taking the rating of the counterparty into the calculation. Under the F-IRB and A-IRB approach, a bank can take correlations among assets into account to take diversification into consideration (Dionne, 2013). In addition, with the introduction of internal credit rating calculations the banks could react to economic cycles more effectively than when relying on rating agencies.

The IRB approach uses a calculation for the probability of default, the loss given default, and the risk exposure at time of default. With the F-IRB approach, a bank uses its own loss probability models, for inputs such as credit ratings, but still uses the prescribed loss given default ratios based on these ratings. The A-IRB approach allows banks calculate their own loss given default ratios (Basel Committee on Banking Supervision, 2005).

9.3. Basel III

Basel III came into existence after the global financial crisis of 2007 - 2009 uncovered systemic vulnerabilities in the regulatory framework. The Basel Committee developed Basel III as a response to the crisis and aimed for it to be a foundation for a resilient banking system (Basel Committee on Banking Supervision, 2017). Before Basel III, the regulation assumed that micro prudential regulation was sufficient to keep the system safe. The idea was that if each individual institution is safe, the entire system must be safe as well. The crisis of 2007-2009 revealed that this is not always the case.

Basel III introduced liquidity requirements and raised capital requirements for the trading book, securitization exposures and securitizations in the banking and trading books. The regulation also increased the quality of Tier 1 capital by focusing on common equity. It harmonizes Tier 2 capital instruments and dismisses Tier 3 capital, which had been introduced under Basel II. Banks need to disclose all capital forms to increase the transparency to both the regulator and the market.

Under Basel III, Tier 1 capital consists of two parts, CET1 and additional Tier 1. The share of CET1 may not fall below 4.5% of RWA and total Tier 1 capital (common equity and additional) can be no less than 6%. Tier 1 and Tier 2 still have to be equal to a minimum of 8% of RWA (Kubat, 2014). On top of this, Basel III introduced a capital conservation buffer and an optional countercyclical capital buffer. The capital conservation buffer increases the common equity Tier 1 capital to a minimum of 7% and the total regulatory capital to a minimum of 10.5% of RWA.

The countercyclical capital buffer can be up to 2.5% of RWA and only applies to G-SIBs. The Financial Stability Board (FSB) identifies these banks based on their systemic risk to the global financial system. The extra capital charge depends on the risk an institution brings to the financial system. The FSB publishes the charges per G-SIB on a yearly basis (Koller, Goedhart, & Wessels, 2015).

Basel III introduced three new ratios, the leverage ratio, the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR). The leverage ratio is simply defined as Tier 1 capital over total non-risk weighed exposure. The LCR is equal to high quality liquid assets over expected net cash outflows over the next thirty days. The NSFR is equal to the amount of stable funding over the required amount of stable funding. Both the LCR and NSFR ratio has to be greater than or equal to one. The BCBS introduced the liquidity ratios to ensure that banks would have enough liquidity available to survive periods of stress (Basel Committee on Banking Supervision, 2014).

10. Appendix 2 – Research on previous Basel accords

Various studies (e.g. Aggarwal & Jacques (1997), Ediz, Michael, & Perraudin (1998), and Rime (2001)) find that, in line with its goals, the first Basel accord pushed undercapitalized banks to higher capitalization ratios. Furthermore, banks try to manage their RWA to stay in line with the capital it holds by either reducing the risk exposure or maintaining an adequate capital level. Van Roy (2005) concludes that the Basel I accord was effective and that it helped increase capitalization for undercapitalized banks while keeping stable credit risk levels. However, Danielsson et al. (2001) find there is a lack of risk sensitivity for the RWA calculation under Basel I. Also, it does not take into account risk-mitigation techniques and it does not lead to market discipline by disclosure of key information.

Research on the impact of Basel II is indecisive on whether Basel II is an improvement in comparison to Basel I. By taking into account more risk sensitive capital charges, covering the risk mitigation techniques, and emphasizing supervision and market discipline the second accord tackles important shortcomings of Basel I (Danielsson, et al., 2001). However, Danielsson et al. (2001) also argue that the new risk calculations increase the instability of the financial system and the models used have been proven inconsistent and biased. Furthermore, they criticize the reliance on credit rating agencies, as they are not regulated nor independent. The last, and maybe most severe, conclusion by Danielsson et al. (2001) is that the proposed regulation under Basel II increases the procyclicality of capital charges which implicates that banks hold less capital at the top of a cycle, right at the moment where the danger of an impending crisis is the greatest. By doing so, the regulation misses the point of enhancing stability in the financial system.

The subprime mortgage crisis uncovered the greatest weaknesses as it exposed the lack of regulatory and supervisory integrations, the extreme risk taking of too-big-to-fail banks and the importance of solvency for the existence of banks (Blundell-Wignall & Atkinson, 2010). Institution came in troubled water as not their capital adequacy was limiting them but their ability to provide liquidity in a timely manner. Gual (2011) argues that the increased capital requirements under Basel III will most likely lead to an increase in the cost of funding for banks, which has adverse effects on the real economy. Šútorová and Teplý (Šútorová & Teplý, 2014) find that higher capital requirements will probably lead to a negative market reaction. Furthermore, they state that it is likely that Basel III is not sufficient and will not prevent financial crisis in the future. On the other side, Caprio, Laeven, and Levine (2007) find no evidence for differences in bank valuation across regions with different capital requirements. This indicates that the increase in capital requirements does not necessarily lead to a devaluation of banks. In a subsequent paper, Laeven and Levine (2009) show that the impact of regulatory requirements is strongly dependent on the individual ownership structure of a bank, and thus that there is no uniform effect of regulatory charges on the entire industry.

11. Appendix 3 – Impact in Europe

11.1. Impact on current CET1 ratios across Europe

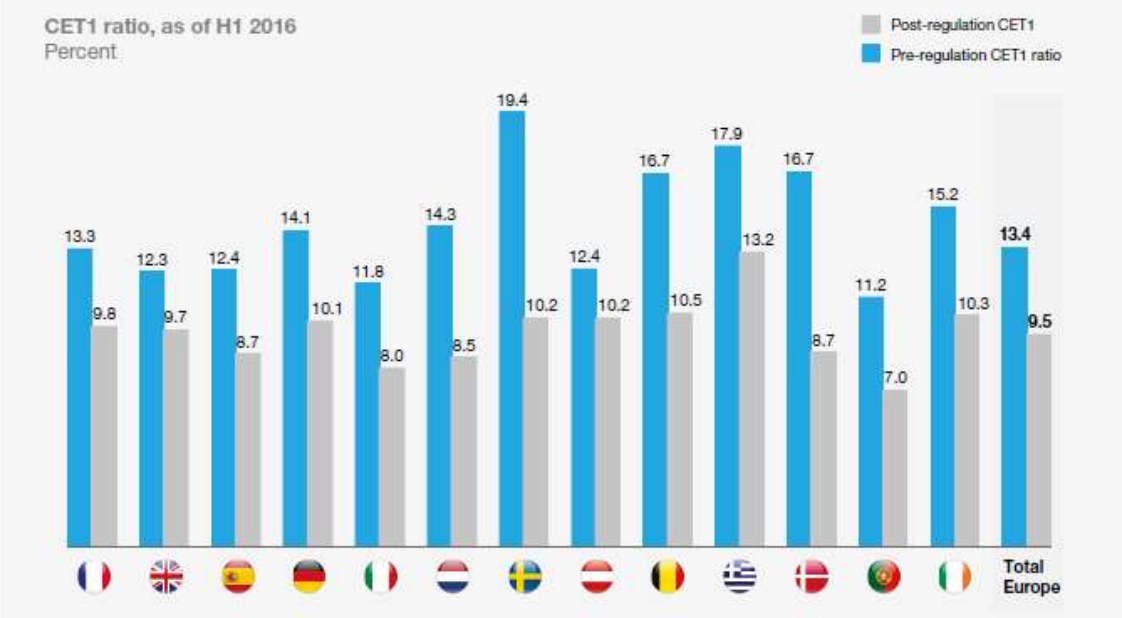

Figure 1: Differences in actual CET1 ratio pre- and post-regulation per country. Reprinted from "Basel 'IV': What's next for banks?" by McKinsey&Company, 2017, *Global Risk Practice*, p.10.

Figure 2: The effect of the IRB output floor on the CET1 ratios per country. Reprinted from "Basel 'IV': What's next for banks?" by McKinsey&Company, 2017, *Global Risk Practice*, p.11.

11.2. IRB output per country

Country	*Share of capital requirements for credit risk originated by internal models*	*Share of institutions using internal models*	*IRB-generated capital by portfolio*		
			Corporate	*Retail*	*Other*
Austria	30.1%	8.6%	49.5%	20.5%	30.1%
Belgium	62.6%	25.7%	54.4%	24.2%	21.3%
Bulgaria	17.0%	4.2%	71.0%	20.3%	8.7%
Cyprus	0.0%	0.0%			
Czech Republic	63.1%	29.4%	55.9%	30.4%	13.7%
Germany	37.7%	2.6%	63.0%	14.7%	22.3%
Denmark	81.5%	22.9%	47.3%	23.2%	29.5%
Estonia	73.0%	50.0%	73.2%	24.8%	2.0%
Greece	19.1%	10.0%	73.3%	26.1%	0.7%
Spain	38.8%	26.7%	50.5%	31.7%	17.8%
Finland	60.0%	58.0%	41.5%	24.5%	34.0%
France	47.5%	61.9%	47.7%	27.8%	24.5%
United Kingdom	64.9%	14.5%	47.1%	42.1%	10.8%
Croatia	12.1%	5.7%	64.9%	32.2%	3.0%
Hungary	38.0%	4.4%	50.7%	31.5%	17.8%
Ireland	45.7%	62.5%	39.0%	50.9%	10.1%
Italy	27.0%	9.0%	74.9%	17.3%	7.8%
Lithuania	54.2%	30.0%	73.3%	26.0%	0.7%
Luxembourg	36.1%	16.1%	42.4%	10.2%	47.4%
Latvia	37.2%	5.6%	67.6%	29.7%	2.7%
Malta	1.8%	8.3%	4.2%	0.0%	95.8%
Netherlands	79.0%	20.6%	49.3%	26.9%	23.8%
Poland	16.2%	0.7%	64.3%	28.2%	7.5%
Portugal	24.7%	12.7%	65.2%	23.4%	11.4%
Romania	14.3%	9.7%	66.3%	25.9%	7.8%
Sweden	78.8%	21.9%	*n. a.*		
Slovenia	2.2%	5.0%	92.8%	0.0%	7.2%
Slovakia	47.1%	23.1%	69.4%	27.5%	3.1%
Norway	39.8%	11.5%	58.4%	13.4%	28.1%
Weighted average	*48.4%*	*24.2%*	*51.6%*	*26.0%*	22.3%

Figure 3: The percentage of capital requirements for credit risk produced by internal models and the share of institutions using internal models. Reprinted from "Banks' internal rating models – time for a change? The 'system of floors' as proposed by the Basel Committee.", by A. Resti, 2016, *European Parliament Economic Governance Support Unit,* p.10.

12. Appendix 4 – Tables

12.1. Panel data analysis

	Mortgages to Loans	Mortgages to Assets
	(1)	(2)
LOWNPLHIGHLTV	0.119**	0.074*
	(0.047)	(0.038)
LOGTOTALASSETS	-0.009	-0.034*
	(0.021)	(0.018)
2013	0.006	-0.009
	(0.036)	(0.027)
2014	0.004	-0.009
	(0.035)	(0.027)
2015	0.010	-0.003
	(0.033)	(0.025)
2016	0.015	-0.019
	(0.033)	(0.026)
2017	0.031	-0.007
	(0.033)	(0.026)
Belgium	0.040	0.017
	(0.047)	(0.038)
Bulgaria	0.062	-0.095
	(0.090)	(0.074)
Croatia	-0.148***	-0.132***
	(0.048)	(0.028)
Czech Republic	-0.143***	-0.107***
	(0.017)	(0.015)
Denmark	-0.238***	-0.131***
	(0.052)	(0.044)
Finland	0.343***	0.266***
	(0.035)	(0.029)
France	-0.092	-0.112**
	(0.060)	(0.044)
Germany	0.235*	0.332***
	(0.132)	(0.046)
Greece	0.062***	0.040*
	(0.022)	(0.023)
Italy	0.253***	0.140***
	(0.027)	(0.026)
Lithuania	-0.329***	-0.247***
	(0.073)	(0.062)
Malta	0.085	-0.045
	(0.075)	(0.045)
Netherlands	0.284***	0.201***
	(0.061)	(0.045)
Norway	-0.064***	-0.045**
	(0.023)	(0.020)
Poland	0.011	-0.008
	(0.061)	(0.047)
Portugal	0.166***	0.092**
	(0.053)	(0.046)
Romania	-0.068	-0.055
	(0.041)	(0.035)
Slovakia	-0.120	-0.113
	(0.080)	(0.069)
Spain	0.164***	0.127***
	(0.030)	(0.021)
Sweden	0.357***	0.275***
	(0.053)	(0.049)
United Kingdom	0.167***	0.093**
	(0.058)	(0.046)
Constant	0.268**	0.315***
	(0.113)	(0.101)
Observations	312	293
R-squared	0.543	0.530

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1