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Determinants of Bank Capital Structure

The Impact of Basel III

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Abstract

This paper examines which determinants of bank capital structure are reliably decisive for 15 publicly traded European and American banks from 2006 to 2015. Common factors of leverage such as *Profit*, *Size*, *Growth*, *Risk*, *Asset Structure* and *Interest Rate* are used and additionally, a systematic risk proxy *Financial Shock* as well as a regulation dummy variable *Basel III* are included. We find a positive statistically significant relationship between leverage and *Size*, *Interest Rate* and *Financial Shock*, whereas leverage exhibits a negative statistically significant relationship with *Risk*, *Assets Structure* and *Basel III*. Notably, using different leverage measures yield considerably diverse estimates for most determinants. We find no specific regional patterns but the estimates vary depending on the region. Therefore, regional variation may influence the reliability of determinants.

Keywords: Bank capital structure, Financial crisis, Basel III regulation.

1 Introduction

Leverage for banks has been increasing ever since the beginning of the deregulation process of the financial market in the 1970's up until 2007, when the subprime crisis occurred. The financial crisis uncovered banks' solvency issues in periods of financial distress and their exposure to bank-runs. These potential bankruptcy threats and the implementation of new capital requirements have increased the focus on banks' capital structure. The aftermath of the subprime crisis (2007 - 2009) and the European sovereign debt crisis (2009 - 2012) revealed that the Basel II regulation, implemented in 2008, did not sufficiently reduce banks' risk towards financial distress. Therefore, a new regulatory framework, Basel III, was partly implemented in 2013 and will be fully implemented in 2019. It aims to further increase capital requirements and thereby decrease excessive levels of leverage according to the Basel Committee (2010).

Specifically which factors affect leverage reliably has been a popular research topic for many years. However, the vast majority of research has studied determinants of capital structure regarding non-financial firms. This paper therefore focuses exclusively on the financial sector and in particular on large publicly traded banks. We hope to offer new insights on which factors are important and reliable for banks' capital structure. Moreover, our focus is directed towards the impact of Basel III and financial distress. Our results are extracted from sample of 15 publicly traded banks, from Europe and USA, during the period 2006 to 2015.

This paper uses common variables that are related to the capital structure of non-financial firms and investigate if these variables may also be reliably important for banks. Furthermore, we test if the variables' effect on leverage is analogous for financial and non-financial firms. In order to investigate these propositions we use the standard factors discussed in the paper of Frank and Goyal (2009) among others. Furthermore, we include a proxy for financial distress and a dummy variable for the Basel III regulation. To our knowledge, there are no other studies that use this approach. These issues and implications of this paper may be of importance for primarily financial authorities and governments. Generally, it is interesting for economists to investigate exactly which factors are the main drivers for banks' leverage.

We mainly use leverage as the debt over equity ratio in this paper, but also debt over book value of assets and debt over market value of assets. These three leverage measures and firms' financing decisions have been researched substantially by Rajan and Zingales (1995), Baker and Wurgler (2002) and Frank and Goyal (2009). Firms' financing decision has been a popular topic ever since the irrelevance proposition by Modigliani and Miller in 1958. They claim that the value of a firm is not affected by how they finance themselves when markets are efficient, there is no asymmetric information and if there are no bankruptcy costs and taxes. The trade-off theory tries to determine an optimal capital structure by adding imperfections - such as taxes, bankruptcy costs and agency cost among others - to the irrelevance proposition and at the same time keeping the assumptions of market efficiency and symmetric information according to Kraus and Litzenberger (1973). The other prominent capital structure theory, namely pecking order theory suggest that managers prefer funding that reveals the least amount of information about the firm as stated by Myers (1984). Overall, the financing choice depends on cost of minimizing asymmetric information and other financing costs as argued by Myers (1984).

Against this background we investigate two main hypotheses in this paper. First, the most common determinants of capital structure for non-financial firms are also reliably important for financial firms. That is, our factors of choice have a significant effect on banks' capital structure. Second, the Basel III regulation has had a significant negative effect on banks' leverage. Meaning that the effect of the new regulation has had its desired effect on leverage. In order to test these hypotheses the effect of capital structure determinants are estimated in several steps. First, we investigate if it is reasonable to assume that there has been a gradual adjustment towards the new Basel III regulations. Second, we estimate our preferred econometric model with respect to our sample. Third, we use different leverage specifications and discuss differences in the outcomes. Fourth, we test if there may be regional patterns when we split up our sample by regions. Nordic is included as a region since it is of special interest to us.

Our results yield a strong positive relationship between leverage and *Size* and our macroeconomic conditions proxy *Interest Rate*, whereas we find weak evidence for a positive correlation between leverage and *Financial Shock*. On the contrary we find a

strong negative relationship between leverage and *Basel III* and only a weak correlation between leverage and *Risk* and *Asset Structure*. Overall, our results indicate that we have found some reliable determinants of banks' capital structure. These results are important since they contradict Baker and Wurgler (2002) findings that determinants for non-financial firms are also reliable factors for financial firms. Moreover, the negative and statistically significant effect of *Basel III* indicates that the new regulation has decreased the excessive leverage to a certain extent thus far.

The rest of this paper is organized as follows. Section 2 provides the theoretical framework for the capital structure theories and their predictions on banks' leverage. In section 3 the data is described. Section 4 presents the econometric framework and a macroeconomic outlook. The empirical results are presented in section 5. Furthermore, a sensitivity analysis is given in section 6. Section 7 provides the conclusion.

2 Literature Review and Theoretical Background

In this section we present two commonly used capital structure theories that have been used since the irrelevance proposition. We explain what costs and benefits these two theories reveal regarding firms' financing decision. Thereafter, we discuss leverage measures and provide an explanation of what capital structure theory predicts about the relationship between leverage and the determinants used in this paper.

2.1 Capital structure theory

In contrast to the Modigliani-Miller theorem, Modugo (2013) argues that firms' capital structure impacts the valuation of the firm. Capital structure consists of debt as well as internal and external equity. Only increasing debt levels or solely issuing equity may be very risky for firms. If a firm does not repay its debt it may result in a credit rating downgrade, which consequently reduces the ability to acquire more debt in the future. On the other hand, issuing equity may have negative connotations, since it often raises questions about the firm's solvency according to Narayanan (1988). Thus, it is essential to find a balance between these two financing decisions. Previous research such as Rajan and Zingales (1995) among others, discovers that varying the debt to equity

ratio is decisive for the overall value of firms. Thus, the capital structure balance may influence the well-being of firms profoundly.

The trade-off theory introduced by Kraus and Litzenberg (1973), which is based upon the irrelevance proposition is one of the theories that tries to explain firms' capital structure. It attempts to determine an optimal capital structure level by adding imperfections such as taxes, bankruptcy costs and agency cost among others to the irrelevance proposition, while keeping the assumptions of market efficiency and symmetric information. When including taxes into the Modigliani-Miller theorem, debt becomes advantageous as it can be used as a tax shield for earnings. However, there is also a bankruptcy cost included in the trade-off theory that outweighs some or all of the gains of using debt. Firms can therefore achieve an optimal debt level by balancing the benefits of tax shields and the costs associated with higher probability of financial distress. Kraus and Litzenberger (1973) claim that the optimal leverage exhibits a balance between tax benefits of debt and the deadweight costs of bankruptcy.

The pecking order theory is another commonly used theory, modified by Myers and Majluf (1984), which argues that managers prioritize funding that reveals the least amount of information. They claim that internal funding (retained earnings) is preferred within the pecking order theory. He supports this claim by highlighting that less information has to be revealed when financing with retained earnings and that no asymmetric information problems are involved. When internal funding is exhausted firms turn to less risky debt. Using less risky debt includes relatively negligible asymmetric information problem compared to riskier forms of debt and is therefore preferred when financing with debt. Equity is referred to as a last resort of financing. Overall, the financing choice depends on the costs of minimizing asymmetric information and other financing costs. We use these two theories to reinforce previous empirical findings and their predictions of determinants of capital structure.

2.2 Previous findings on determinants of leverage

Prior studies have used several definitions of leverage and the opinion on which definition is best differs. The primary discussion is regarding whether market values or book values should be used. Myers (1977) argues that managers mainly focus on book

values. Graham and Harvey (2001) claim that managers do not consider equity market changes in their choice of re-balancing their capital structure. On the other hand, book value is generally a "plug number" rather than a number relevant for managers according to Welch (2004). Overall, market values are argued to be forward looking, whereas book values are backward looking. Thus, these two measures do not need to match as Barclay et al. (2006) discover. Furthermore, corporate finance literature has for a time tried to converge to standard factors that determine firms' capital structure. Frank and Goyal (2009) among others, discover that *Profit*, *Size*, *Growth*, *Asset Structure*, *Risk* and *Macroeconomic Conditions* are the most reliable determinants of capital structure.

We continue by providing predictions from earlier studies on this set of standard factors. Appendix A presents a description of these factors as well as other factors used in this paper. A negative sign for *Profit* is supported empirically by many studies including Booth et al. (2001) and Fama and French (2002). Furthermore, the higher cost of issuing equity is used as a possible explanation, by Akthar and Oliver (2009). These empirical findings are in line with the pecking order theory which assumes *Profit* to have a negative effect on firms' leverage over time, holding investments and dividends fixed. However, a positive between leverage and profitability finds support in the papers of Baral (2004) and Frank and Goyal (2004). Baral (2004) argues that higher profitability signifies more debt capacity and lower default risk for lenders because firms with high profitability are more likely to fulfill their debt contracts. These findings are predicted by the trade-off theory which claims that profitable firms are expected to have a lower expected cost of financial distress and find more value in interest tax shields. Moreover, since interest payments are tax-deductible firms with higher profits will take on relatively more debt to take advantage of the tax shield. Thus, higher debt capacity and advantage of tax shields predicts a positive relationship between profitability and leverage.

Frank and Goyal (2009) find an inverse relationship between leverage and *Size*. They argue that large firms are better known since they have been in the industry for a longer period. Thus large firms can more easily issue equity since the adverse selection problems are less severe because of lower information asymmetry as claimed by

Bauer (2004). These empirical findings advocated by the pecking order theory, however Frank and Goyal (2007) argue that the pecking order theory is ambiguous because the adverse selection problem increases if it infringes on a large scale. On the contrary, Ezeoha and Francis (2010) discover that larger more well known firms normally have better access to the capital market. They argue that large firms are more likely to have lower risk of default and better credit ratings. Larger firms use relatively more debt to take advantage of the lower cost of financial distress and lower interest rates provided by financial institutions. The results provided by Ezeoha and Francis (2010) confirms the trade-off theory that predicts that the risk for default is lower for large firms. It states that relatively more debt is assumed to be held by larger firms.

Growth rate is argued to increase debt since the financing deficits are increasing according to Shyam-Sunder and Myers (1999). This positive relationship is further verified by the work of Frank and Goyal (2009), Baral (2004) and proposed by the pecking order theory. The pecking order theory argues that firms that have more *Growth* also should collect more debt over time. Baker and Wurgler (2002) find contradicting results. They argue that firms with higher growth rates also are more exposed to losses when making investments using debt. Their cost of bankruptcy is therefore relatively larger and thus lower leverage is assumed for companies with higher growth potential. Additionally, Frank and Goyal (2004) and Erotis et al. (2007) claim that firms with high growth rates prefer equity to debt. Thus, a negative relationship between leverage and growth rates is predicted which also finds support in the trade-off theory. The trade-off theory predict that growth potential lowers the leverage since it increases the costs of financial concerns, lowering the problems of free cash flow as well as worsens the agency problems associated with debt.

Baral (2004) support a positive relationship between *Risk* and leverage and claims that firms with high business risk will borrow more since their agency costs of debt may be lower. Theoretically a positive relationship between *Risk* and leverage is predicted by the pecking order theory. On the other hand, Frank and Goyal (2009) propose that riskier firms face a higher cost of financial distress and therefore use less debt. Graham and Harvey (2001), Singh et al. (2003) and Deesomsak et al. (2004) also support this inverse relationship. The trade-off theory, on the other hand, argues for a negative

association. These findings are proposed by the trade-off theory.

The valuation of various asset types may differ considerably for instance it is difficult to valuate intangible assets such as patents, goodwill et cetera. The degree of tangibility is measured as a ratio of intangible or tangible assets over total assets and is oftentimes referred to as *Asset Structure*. Chen and Strange (2005) support a positive relationship between *Asset Structure* and leverage. They claim that the problem of asymmetric information gets more severe for firms with more intangible assets resulting in a higher agency costs (higher monitoring costs). A positive relationship between tangibility and leverage is in accordance with the trade-off theory. Lim et al. (2014) debate that intangible assets can be negatively correlated with leverage since intangible assets may be feeble collateral. Hence, equity is preferred to debt as a financing source. The pecking order theory suggests a negative relation between leverage and tangibility. The suggested negative relationship is contributed to lower cost of issuing equity due to lower asymmetric information related to tangible assets.

Another important factor determining capital structure are the *Macroeconomic Conditions*. Barry et al. (2008) suggest that low interest rates (relative to historic levels) trigger firms to issue more debt, since borrowing becomes cheap. Interest rates are generally low when an economy is in distress, i.e. recession or depression. Furthermore, firms also issue more debt during periods of expansion according to Frank and Goyal (2009). During such times the bankruptcy cost is relatively low. The studies by Barry et al. (2008) and Frank and Goyal (2009) are in line with the trade-off theory. On the contrary, Eriotis et al. (2007) stress that companies must consider financial distress costs when borrowing money. Their arguments is that a highly leveraged company becomes exposed to high interest rates. With increasing interest rates they may have to pay an increasing amount on their debt. Their argument finds support in the pecking order theory which suggests that leverage should decline during times of expansion.

Ksantini et al (2014) prove that financial crises have a negative impact on investment. That a negative relationship transcends onto leverage seems like a reasonable assumption, however an opposite relationship can also be argued for. In times of financial distress (*Financial Shock*) firms might increase their leverage in order to cover increased losses (decreased profits). Therefore a positive relationship seems plausible

as well. Moreover, excessive on and off-balance sheet leverage was one of the central factors for the financial crisis in 2007 as argued by the Basel Committee (2010). The underlying reason for this was the gradual decrease in capital base by banking sectors of many countries in levels and quality. Therefore, the most reasonable assumption is that financial distress has a positive relationship with leverage.

The new regulatory framework, *Basel III*, aims to decrease banks' leverage with an overall objective to work alongside Basel I and Basel II. In addition, the new regulation aims to strengthen banks' ability to resist losses and to lower the probability of new financial crises according as argued by Riksbanken (2011). Regulations on the financial markets are widely argued to distort the economic activities as well as to cause inefficiency. Allen et al. (2012) argue that the Basel III reforms will reduce the availability of credit. Hoshi (1990) claims that high leverage increases the likelihood that firms will be unable to make their debt repayments, and raises concerns about what happens to these distressed firms. Due to the severe impact and the speed of transmission of the financial crisis, it is critical for the banking sector to increase protection to internal and external shocks. Nonetheless, Michel and Ligon (2014) argue that the Basel III regulation is inefficient since the too-big-to fail status remains as an implicit insurance. According to the Basel Comittee (2010) the new regulation will be gradually implemented from 2013 with full and mandatory implementation in 2019. Before 2019 some milestones will be fulfilled, however the total effect will not be recognized until then. Nevertheless, the requirements are enhanced since 2013.

3 Data

In this section the sample collection is described. In addition, we show descriptive statistics for our selected banks and our data. Lastly, the data is discussed briefly.

3.1 Sample collection

The sample consists of reported financial statement values for banks and macroeconomic data for the period 2006 to 2015. We use quarterly financial report data measured in Euros from Bloomberg. The macroeconomic data is collected from numerous

different databases. The interest rates is gathered from the Organisation for Economic Co-operation and Development (OECD) database and the exchange rates are extracted from the European Central Bank (ECB). Daily stock prices and stock indices are acquired from Bloomberg and Thompson Reuters database. Financial statement items in other currencies than Euro are converted to Euros, based on the corresponding exchange rate for that quarter reported by OECD. Because we are using banks from Europe and US, the accounting standards differ and could therefore affect the outcomes in this study. All European banks are following the accounting standards from IAS/IFRS whereas the American banks are following the US GAAP accounting standards throughout all the studied period. However, accounting standards and their possible effects are outside the scope of this thesis. The same banks are observed for each period.

In cases of missing data we solve it with replacements, using the last observation carried forward approach. Some banks in our sample are less likely to be reported for all quarters in Bloomberg. Moreover, some balance sheet items are not reported consistently for all quarters in Bloomberg. We impute missing data only if there are small gaps in the data (maximum two consecutive quarters), otherwise the financial statement item is not used. Since we have few missing values we do not expect this procedure to have a large impact on our findings. We argue that we are missing data at random, meaning that certain responses are not more likely to be missing. We argue that the recent value is the most suitable value for the missing data, since values in our sample do not fluctuate very much between quarters. Replacing missing data makes our panel variable strongly balanced. In order to to replace outliers and the most extreme misrecorded data we winsorize the variables at a 5 percent level in both tails of the distribution, which is a common approach in similar studies. To winsorize at a 5 percent level is relatively high, however our data includes very few extreme outliers, which may impact the standard errors significantly. Only a negligible amount of data is affected by this procedure. After correcting for missing, misrecorded and extreme data, the sample consists of quarterly observations from 15 public banks over 10 years yielding 600 observations. We choose to include 6 Nordic banks, 4 European banks, and 5 American banks. These 15 banks meet the following criteria:

1. Are amongst the largest banks regarding total assets in their region[1]

2. Are mainly active in the financial sector, i.e. no conglomerates

As can be seen in table 1 the Nordic banks and US Bancorp are relatively small compared to the other banks within the sample. Moreover, the largest bank (BNP Paribas) is almost ten times larger than the smallest bank (Swedbank) in our sample. Additionally, the European banks have been the largest banks by total assets on average during the sample period. The American banks have substantially lower levels of leverage compared to the other banks. Moreover, leverage has decreased for all banks except for Nordea since the implementation of Basel III. Since our sample is biased towards the largest banks within each region, it may not be perfectly representative for the banking sector in general.

Table 1: Descriptive statistics for banks

Bank	Country	Total Assets	Debt/Equity		
			All periods	Before Basel III	After Basel III
BNP Paribas	France	1 934 458	8.85	9.89	6.42
Deutsche Bank	Germany	1 799 802	7.59	8.95	4.41
Barclays	Great Britain	1 747 187	9.25	10.61	6.08
Credit Agricole	France	1 584 808	13.44	13.97	12.22
JP Morgan	USA	1 571 732	4.03	4.35	3.29
Bank of America	USA	1 533 474	3.49	3.82	2.72
Citigroup	USA	1 450 310	5.04	5.94	2.92
Wells Fargo	USA	907 122	1.97	2.26	1.30
Nordea	Sweden	535 500	8.92	8.80	9.19
Danske Bank	Denmark	438 501	14.99	16.40	11.70
SEB	Sweden	257 512	9.58	10.38	7.71
DNB	Norway	249 092	7.83	8.29	6.77
Handelsbanken	Sweden	247 864	14.37	15.13	12.61
US Bancorp	USA	240 433	2.38	2.76	1.50
Swedbank	Sweden	201 259	10.63	11.15	9.42

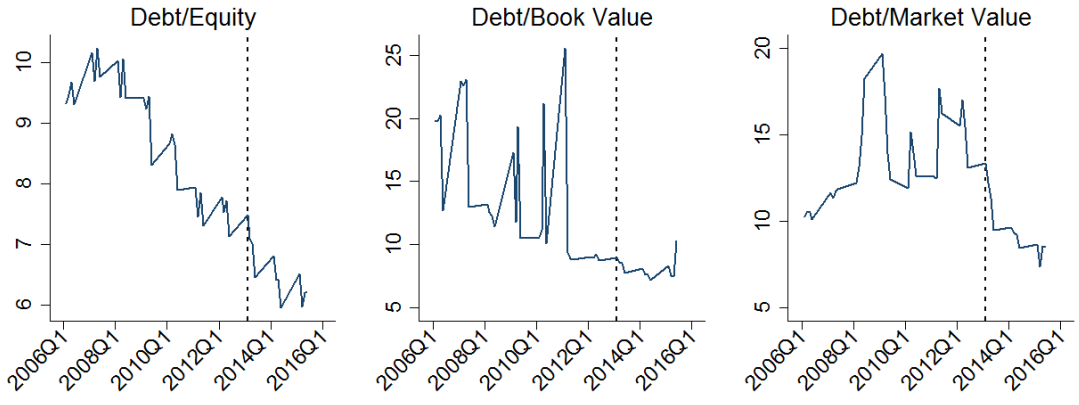
Note: All banks have 40 observations. All variables are winsorized at the 5% level at both tails of the distribution.

[1]The American banks are chosen according to their ranking on bankrate.com (2015). The European and Nordic banks are chosen according to their ranking on relbanks.com (2015).

3.2 Data description

Table 2 presents descriptive statistics for our leverage measures and determinants. Our leverage measures debt over equity, debt over book value (D/BV) and debt over market value (D/MV) show large variations indicating that the banks differ substantially in their leverage levels. The median leverage differs slightly from the mean leverage. The mean value of 0.6 for our crisis variable indicates that economy has been relatively unstable during our sample period, which includes the subprime crisis and the sovereign debt crisis. Moreover, figure 1 shows that leverage specified as debt over equity had an increasing trend until 2007 and decreased thereafter. Thus, leverage for banks has decreased after the subprime crisis. Leverage measured as debt over book value of assets has had a relatively volatile development prior to 2012 but stabilized thereafter. Moreover, no clear trend prior to the financial crises is observable. Lastly, debt over market value of assets displays an inverse u-shape except for two upswings, during the subprime crisis and the sovereign debt crisis. Thus, indicating that this leverage measure is relatively volatile to market risk. The dotted lines in all figures in this paper indicate the implementation of Basel III in 2013.

Figure 1: Changes in leverage measures over time



Note: The dotted lines depict the implementation of Basel III. All variables are winsorized at the 5% level at both tails of the distribution.

Table 2: Descriptive statistics

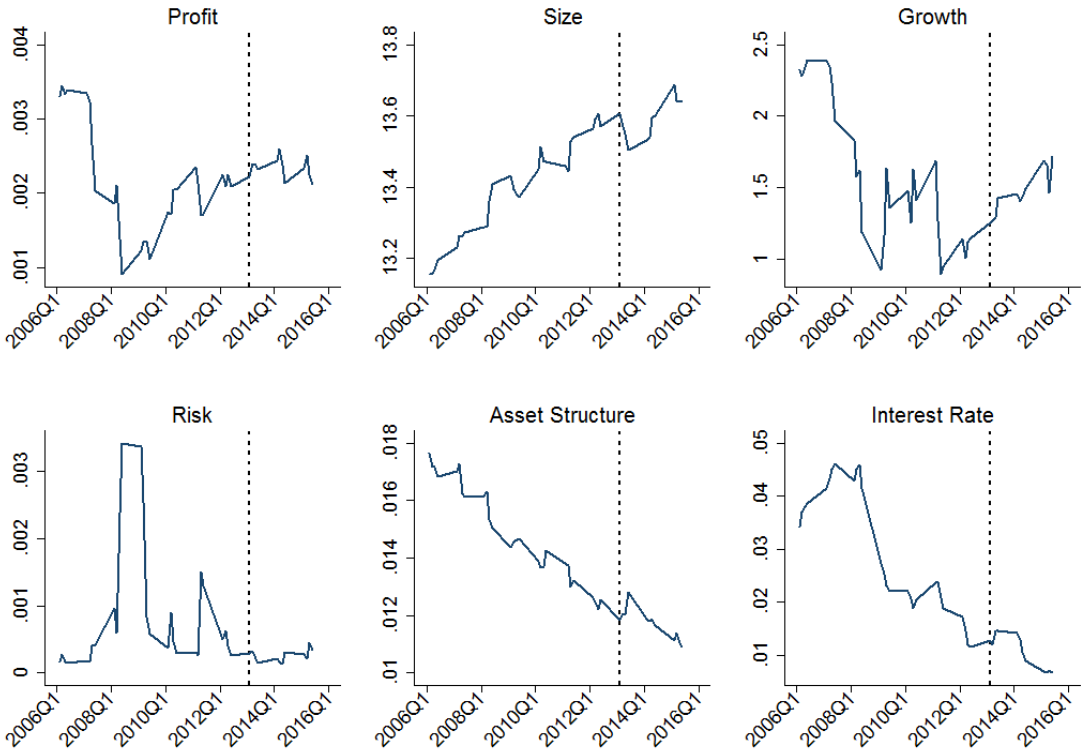
	Mean	St.Dev.	Min.	Max.	Distribution (Percentile)		
					10^{th}	50^{th}	90^{th}
Leverage							
Debt over Equity	8.158	4.472	1.101	21.541	2.601	8.320	14.451
Debt over Market Value	11.903	14.306	1.026	59.111	1.462	7.348	25.848
Debt over Book Value	10.610	6.190	2.182	25.756	3.618	9.831	19.289
Profit							
Profitability	0.002	0.002	0.000	0.002	0.000	0.002	0.005
Return on Assets	0.001	0.001	-0.002	0.005	0.000	0.001	0.003
Size							
Log of Assets	13.449	0.899	12.090	14.537	12.212	13.770	14.471
Log of employees	11.055	1.146	9.340	12.522	9.479	11.274	12.486
Growth							
Market to book	1.551	0.919	0.229	3.875	0.498	1.352	2.805
Delta assets	0.012	0.049	-0.076	0.121	-0.052	0.001	0.085
Risk							
Stock return variance	0.001	0.001	0.000	0.004	0.000	0.000	0.002
Asset structure							
Intangibility	0.014	0.012	0.002	0.051	0.004	0.008	0.033
Macroeconomic conditions							
Interest rate	0.024	0.013	0.007	0.046	0.008	0.021	0.045
GDP Growth	0.004	0.004	-0.006	0.010	-0.004	0.004	0.009
Financials							
Dividend	0.940	0.238	0	1	1	1	1
Financial strength	0.118	0.034	0.070	0.194	0.075	0.114	0.173
Cash	0.032	0.035	0.003	0.189	0.008	0.018	0.070
Financial Shock							
Crash	0.133	0.324	0.000	1.000	0.000	0.000	0.947
Crisis	0.600	0.490	0	1	0	1	1
Regulation							
Basel III	0.300	0.459	0	1	0	0	1

Note:All variables have 600 observations. All variables are winsorized at the 5% level at both tails of the distribution. The variables are described in Appendix A.

To examine the changes of the main factors of our study for our banks, the average values per quarter throughout the studied period are visualized in figure 2. *Profit* fell drastically during the financial crash but has built back up to a higher level afterwards. *Size* has been increasing throughout the whole period with a relatively stable and upward sloping trend. *Growth* fluctuates with ups and downs. It decreases sharply in the

start of the sample period and increases in 2009 for approximately two years. Thereafter it falls yet again but recovers in 2011 and has an increasing trend afterwards. *Risk* is relatively stable except for a big jump in the years of the financial crisis in 2007. *Asset Structure* and has had a fairly linear negative trend during the entire sample period. *Interest Rate* (macroeconomic conditions) increased in the first two years of our sample period, but fell considerably afterwards.

Figure 2: Changes in core factors over time



Note: The dotted lines depict the implementation of Basel III. All variables are winsorized at the 5% level at both tails of the distribution. Profit is measured as profitability, size as log of assets, growth as MtB value, Risk as stock return variance, asset structure as intangibility and interest rate is the aggregated long term and short term interest rate. Further explanations are given in Appendix A.

4 Econometric Estimation & Macroeconomic Perspective

This section provides our main econometric model as well as a detailed decomposition of its components. Furthermore, we illustrate precisely how these components were

generated and address methodological issues. After discussing the econometric framework we provide an outlook of the macroeconomic conditions of the sample regions.

4.1 Econometric framework

At this stage of the paper, the aim is to estimate the effect of the previously stated explanatory variables on leverage (see Appendix A for description). For this purpose we estimate the following model:

$$Lev_{it} = \alpha + \beta z_{it} + \beta f_{it} + \beta D_{it} + \epsilon_{it} \tag{1}$$

where Lev_{it} is the dependent variable, measuring leverage for all 15 banks in the sample. Leverage is measured as total debt over total equity and alternatively, as total debt over book value of assets (D/BV) and total debt over market value of assets (D/MV). z_{it} is a vector of covariates including bank-specific and macroeconomic characteristics. The vector z_{it} contains the following bank characteristics and also a macroeconomic factor:

$$z_{it} = (Profit_{it-1}, Size_{it-1}, Growth_{it-1}, Risk_{it-1}, AssetStructure_{it-1}, Macro_{it-1}) \tag{2}$$

where $Profit_{it-1}$ is measured as a ratio of operating income over total assets. The size variable, $Size_{it-1}$, is measured as the log of assets for each period of time. $Growth_{it-1}$ measures the value of book value of assets relatively to market value of assets of the bank, i.e. market value over book value. The market-to-book asset ratio is the most reliable measure for growth potential according to Adam and Goyal (2008). $Risk_{it-1}$ measures the quarterly variance calculated from daily stock return data. The last bank characteristic variable that is used is *Asset Structure*$_{it-1}$. We divide intangible assets by total assets and use this as our *Asset Structure* variable. The variable $Macro_{it-1}$ is the aggregated average long-term and short-term interest rate for our bank sample's countries (Sweden, Denmark, Norway, Germany, France, Great Britain and USA) and will be denoted *Interest Rate* henceforward. We lag all our variables in the z_{it} vector by one time period, which is a common approach in earlier studies. Furthermore, the

explanatory variable f_{it} reflects the financial crash triggered by the subprime mortgage crisis in 2007. The f_{it} vector contains the crash variable as the financial shock proxy:

$$f_{it} = (FinancialShock_{it}) \tag{3}$$

The $Financial\ Shock_{it}$ variable is generated with an IMAX-formula approach in line with Patel and Sarkar (1998). We use a common definition of a stock market crisis as a swift decline in stock indices. A variable $IMAX_{it}$ is generated with the purpose of detecting unusual levels of stock indices. In order to do so, the highest index level during our observed time period is determined and then daily stock index observations are divided by this maximum. Specifically, the IMAX formula looks as follows:

$$IMAX_{it} = \frac{I_{it}}{max(I_{it}, I_{it-1}, ..., I_{it-n})} \tag{4}$$

IMAX is a value between 0 and 1. A value of about 1 means that the index is close to the maximum and a value close to 0 implies that the index is in distress. We use the average IMAX minus the standard deviation to define a threshold for a stock market crash. This financial crash threshold looks the following way:

$$CRASH_{it} = IMAX_{it} < \overline{IMAX_{it}} - \sigma \tag{5}$$

If the index falls below this threshold it is consider a day of financial crash. For our dataset we calculate the percentage of crash days for each quarter from the daily observations, which we define as the variable $Financial\ Shock_{it}$. This variable has values between 0 and 1. A value of 0.5 implies that 50 percent of the trading days in the quarter were below the threshold specified in equation 5. We also define a stock market crisis. The start of the stock market crisis is the index value maximum prior to the financial crash. Accordingly, the economic recovery takes place when the index exceeds this maximum level after the crash. Further triggers that occur within a crisis are contributed to the current crisis and are not specified as the beginning

of a new crisis. For our IMAX calculation we use the following stock indices: MSCI World (World), EURO STOXX 50 (Europe), OMXS 30 (Sweden), OSEBX (Norway), OMXC 20 (Denmark), DAX (Germany), CAC 40 (France), FTSE 100 (Great Britain) and S&P 500 (USA). For our model we use the MSCI World index. Finally, the last determinant of capital structure is the dummy variable regressor D_{it}. D_{it} is coded 1 for the Basel III time period and zero otherwise.

$$D_{it} = \begin{cases} 1, & \text{if Basel III} \\ 0, & \text{otherwise} \end{cases} \tag{6}$$

After completing the model specification, we address methodological issues. Bevan and Danbolt (2001) argue that changing the OLS to a fixed effect model can give opposite and statistically significant effects. Hence we carefully run tests choosing the most suitable and correct model specification. The sample is structured as panel data and therefore the focus lies on models that are appropriate for this type of data set. First, we conduct tests to determine if we should use a pooled OLS, a random effect or a fixed effect model. The Breusch Pagan Lagrangian multiplier test for random effects rejects the null hypothesis ($p - value = 0.0000$), which argues for a random effect model in favor of a pooled OLS model. Thus, the variances across entities are not zero. Second, we run a F-test ($prob > F = 0.0000$) that all dummy parameters, except for the dropped one, are all zero. The test is based on loss of goodness-of-fit and we can state that a fixed effect model is preferred to a pooled OLS model. We suspect that individual errors (u_i) are correlated with at least one of the regressors in the model and thus the random effect model is questionable. However, in section 5 we find that our model is robust when random effect is used. Concluding, a fixed effect model is used as our preferred model specification.

With the sample we also face other methodical issues, in particular potential heteroskedasticity and serial correlation. Through the modified Wald test for groupwise heteroskedasticity we can reject the null hypothesis (same variance for all banks) at a one percent significance level, implying that we suffer from heteroskedasticity. At the same time, we do not reject the null hypothesis ($prob > F = 0.2950$) in the Wooldridge test for autocorrelation in panel data. This indicates that our data suffers from first-

order autocorrelation. To resolve these methodological issues of heteroskedasticity and serial correlation we follow the suggestion by Bertrand et al. (2002) to use cluster-robust standard errors.

4.2 Macroeconomic Perspective

In order to put the regression results into a macroeconomic perspective this part of the paper starts with a discussion of the results from the IMAX calculations as well as brief comments on our sample period's interest rate and GDP growth development. Table 3 below shows a more detailed overview of the crash and crises periods in our observed timeline, split up by regions.

Table 3: Crisis and Crash

Region	Average IMAX	St.Dev	Crisis	Crash
World	0.627	0.141	Jul 2007 - May 2013	Oct 2008 - Mar 2010
				Jul 2011 - Sep 2011
Europe	0.570	0.116	Jul 2007 - Ongoing	Oct 2008 - Sep 2009
				Jul 2011 - Dec 2012
Sweden	0.656	0.150	Jul 2007 - Mar 2013	Jul 2008 - Mar 2010
Norway	0.659	0.156	Oct 2007 - Nov 2013	Jul 2008 - Dec 2009
Denmark	0.565	0.154	Oct 2007 - Jan 2013	Oct 2008 - Dec 2009
Germany	0.589	0.147	Jul 2007 - May 2013	Jan 2006 - Jun 2006
				Oct 2008 - Sep 2009
				Jul 2011 - Sep 2011
France	0.611	0.119	Jun 2007 - Ongoing	Oct 2008 - Sep 2009
				Jul 2011 - Dec 2012
Great Britain	0.753	0.138	Jun 2007 - May 2013	Oct 2008 - Sep 2010
				Jul 2011 - Dec 2011
USA	0.555	0.169	Jun 2007 - Feb 2013	Oct 2008 - Dec 2009

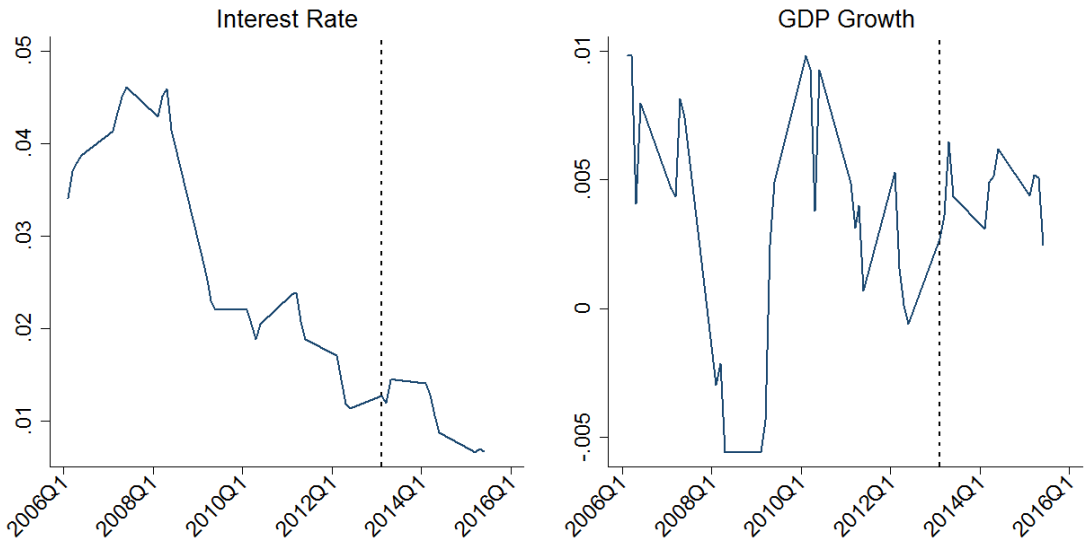
Note: For the IMAX calculation we use the MSCI World (World), EURO STOXX 50 (Europe), OMXS 30 (Sweden), OSEBX (Norway), OMXC 20 (Denmark), DAX (Germany), CAC 40 (France), FTSE 100 (Great Britain) and S&P 500 (USA). For our model we use the MSCI World index.

In table 3 we observe that the beginning of the crisis was between June and October in 2007 for our sample of banks. According to our calculations both Europe overall and France by itself have not yet recovered from the financial crises triggered in 2007. This result implies that the European (EURO STOXX 50) and the French (CAC 40) main stock index have not yet exceeded their maximum levels of 2007. We can clearly see how closely the global the financial markets are connected and the potential contagion effect, when we examine the beginning of the crash period (triggered by the subprime crisis). It starts within a timespan of 4 months for all observed regions. The results imply that the observed indices fell below the extreme value threshold specified in equation 5. The recovery periods (indices exceed the crash-threshold) from the crash however differ considerably depending on the region. The average IMAX loosely conveys the severity of the financial crises. Recall that the maximum index value during our sample period yields an IMAX value of 1. Therefore, the results indicate that Great Britain, Sweden and Norway overall did not suffer from as severe index declines as for instance USA or Denmark.

Two of the most important macroeconomic indicators are the interest rate and GDP growth. As can be seen in figure 3, the interest rate increased prior to the crisis and fell dramatically thereafter. This implies that banks' cost of taking on more debt decreased and still decreases (relatively cheap to borrow money). Historically interest rates have been very low since the financial crisis in 2007 and appear to fall even closer towards 0. Our alternative proxy for macroeconomic conditions, GDP growth, has had a more volatile trend. A substantial decline in GDP growth can be observed during the period of the most severe financial crash. Thereafter, GDP growth has partially been positive, but overall the growth has been modest (between 0 and 1 percent).

Concluding, the macroeconomic indicators interest rate and GDP growth as well as the IMAX approach reveal that our sample's countries suffered severely from the most recent financial crises, especially the subprime crisis and the sovereign debt crisis in Europe.

Figure 3: Changes in macroeconomic conditions over time



Note: The dotted lines depict the implementation of Basel III. All variables are winsorized at the 5% level at both tails of the distribution. All variables are explained in detail in Appendix A.

5 Empirical Evidence & Implications

In this section we proceed to define the most suitable Basel III time period. Subsequently, we obtain our preferred model and investigate differences when alternative leverage specifications are used. Finally, we examine if there are noticeable regional trends.

5.1 Establishing the Basel III period

We suspect that firms may adjust to a new regulation even before its implementation. Therefore, the Basel III regulation may have affected firms in the time period between its announcement in 2010 and its first implementation in 2013. For that reason, we (1) test if we find a significant effect for Basel III even before the implementation and (2) discuss if it is plausible to extend the time period for the Basel III dummy in our model, if there appears to be a gradual adjustment.

To investigate if there might be a gradual adjustment we create different time periods for the Basel III dummy variable. We extend the Basel time frame by 6 months for each tested Basel III variable all the way back to the initial announcement of Basel III

in 2010. In column 1 in table 4 the Basel III dummy includes all quarters starting in 2010 and forward. Analogously, the Basel III dummy in column 7 includes all quarters starting in 2013 and forward. As we can see in table below, there is a negative statistically significant effect on leverage prior to the Basel implementation. However, the negative effect when Basel III was initially announced is not statistically significant. All other time periods are statistically significant. According to our results, it appears that banks adjust gradually to the new regulatory framework prior to its implementation. It therefore becomes crucial to determine if the Basel dummy period should be extended or not. In order to do so, we need to consider other economic circumstances that might affect leverage during the observed time period. Factors that might play significant roles are for instance, the Basel II regulation and also the financial crises.

Additionally, the level of tier 1 capital ratio is compelling to investigate within this context. The Basel III regulation implements a minimum requirement for the tier 1 capital ratio of 4.5 percent in 2013. The requirement increases to 5.5 percent in 2014 and to 6.0 percent in 2015. These tier 1 capital requirements were proposed by the Basel Committee in 2010. Our observed banks have a level of tier 1 capital well above the requirements before the Basel III implementation. In the table in Appendix B, we observe that the smallest level of tier 1 capital ratio before 2013 is 9.3 percent and hence already more than twice the required ratio in 2013. Subsequently, banks did not have to adapt their tier 1 capital ratio in order to meet the Basel III requirements. Overall, we argue that the negative effects on leverage prior to 2013 cannot solely be contributed to the Basel III regulation. We cannot determine if there has been a gradual adjustment towards the new regulatory framework with certainty. The initially high levels of tier 1 capital rations prior to the Basel III implementation diminish the likelihood of a gradual adjustment further. Thus, we refrain from including time periods before the Basel III implementation and define our Basel III period, D^*_{it}, as the period from quarter 1 in 2013 and forward. Hence, we investigate the actual effect of the Basel III implementation.

Table 4: Regression with different Basel III time periods

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Debt/Equity	Debt/Equity	Debt/Equity	Debt/Equity	Debt/Equity	Debt/Equity	Debt/Equity
Core determinants (7)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Basel III	**-0.66**	**-1.53*** **	**-1.52*** **	**-1.26*** **	**-1.03** **	**-1.05*** **	**-1.10*** **
	(0.48)	(0.35)	(0.41)	(0.39)	(0.35)	(0.34)	(0.28)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	585	585	585	585	585	585	585
R-squared	0.48	0.51	0.53	0.51	0.50	0.51	0.51
Number of banks	15	15	15	15	15	15	15

Note: The variables included in the core determinants are: Profit, Size, Growth, Risk, Asset Structure, Interest Rate and Financial Shock. Each column is the baseline regression with different time frames for Basel III. Column 1 is Basel III starting in quarter 1 in 2010. Column 2 is Basel III starting in quarter 3 in 2010. Column 7 is Basel III starting in quarter 1 2013. All variables have 585 observations from 15 banks for all quarters between 2006 and 2015. All variables are winsorized at the 5% level at both tails of the distribution

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

5.2 Baseline Regression

In the previous part we determined which Basel III time period is most suitable. We can therefore now estimate our preferred model. In this part we (1) test if our choice variables are reliable determinants of bank capital structure, (2) show differences when debt over book value of assets and debt over market value of assets are used as the dependent variable and (3) discuss the central variables *Financial Shock* and *Basel III* at length. For these estimations we use equation 1 with D^*_{it}, which subsequently looks the following way:

$$Lev_{it} = \alpha + \beta z_{it} + \beta f_{it} + \beta D^*_{it} + \epsilon_{it} \tag{7}$$

The analysis of our preferred model begins by discussing column 1 in table 5, with debt over equity as the dependent variable. The results show that strong statistical significant effects can be found for *Size*, *Interest Rate* and *Basel III*. These explanatory are significant at the 1 percent level, whereas *Risk*, *Asset Structure* and *Financial Shock*

are only statistically significant at the 10 percent level. These results imply that we have found some reliable determinants for banks' capital structure. However, not all determinants relevant for non-financial firms appear to be relevant for financial firms, according to our findings. Nevertheless, our model and determinants are not influenced by changes and alterations regarding the explanatory variables. We deliver evidence for this claim in the sensitivity analysis (section 6), where we run several robustness checks.

Furthermore, we analyze and compare the results for our preferred model with previous work and economic theory. *Profit* and *Growth* are not statistically significant and hence we cannot make any predictions about their signs. An earlier study by Frank and Goyal (2009) discovers that profitability was a very important determinant for capital structure in the 1980's, but has later had minor - but still statistically significant - importance. The statistical insignificance of *Profit* in our result goes in line with this argument that profitability has decreasing importance. Moreover, we cannot find any evidence that *Growth* has any impact on banks' capital structure.

The variables *Risk*, *Asset Structure* and *Financial Shock* are only significant at a 10 percent level. Nonetheless, these explanatory variables approach the borderline of strong significance. *Risk* has a negative relationship with leverage. Frank and Goyal (2009) propose that riskier firms face a higher cost of financial distress and therefore use less debt. *Asset Structure* and leverage also has a negative relationship according to our results. Lim et al. (2014) contribute a negative relationship between *Asset Structure* (intangibility) and leverage to the fact that intangible assets may be poor collateral. Prolonging the financial crash period, *Financial Shock*, increases banks' leverage, according to our findings. A positive relationship between *Financial Shock* and leverage seems intuitive. The Basel Committee (2010) stress that a gradual decrease in capital base - in levels and quality - results in an increase in banks' leverage, which was one of the central factors for the financial crisis in 2007.

The variables *Size*, *Interest Rate* and *Basel III* are statistically significant at a 1 percent level. The explanatory variable *Size* exhibits a strong and positive relationship with leverage. Ezeoha and Francis (2010) argue that large firms use relatively more debt to take advantage of the lower cost of financial distress and lower interest rates provided

by financial institutions. Moreover, they state that large firms face a relatively lower risk of default and tend to have better credit ratings, which contributes to this positive relationship. Barry et al. (2008) claim that firms issue more debt when *Interest Rates* are low, hence a negative relationship between interest rates and leverage. Surprisingly, we observe that our results are not in line with this reasoning. As Frank and Goyal (2009) suggest expansions support an increase in leverage, since firms take on more debt. This can be explained by a relatively low costs of bankruptcy during times of expansion. Moreover, an increase in *Interest Rate* is generally an indicator for a prospering and expanding economy. During the period when *Basel III* has been implemented leverage appears to have decreased. This highly statistically significant (1%) result verifies the new regulatory framework. Thus, the desired negative impact was achieved with the new regulation according to our results. We argue that the effect of the new regulation could have been even greater if our observed banks had not had an initially high level of tier 1 capital ratio, as can be seen in the table in Appendix B.

In column 2 and 3 we use alternative leverage measures. Total debt over book value of assets is used in column 2 and total debt over market value of assets is used in column 3. These two ratios are also frequently used leverage measures in previous work such as Frank and Goyal (2009). Using debt over book value of assets yields statistically significant results for *Profit* (5%), *Size* (5%) *Growth* (1%), *Interest Rate* (1%) and *Basel III* (1%). The variables *Profit*, *Size*, *Growth* and *Interest Rate* exhibit a positive relationship with leverage, whereas *Basel III* displays a negative relationship with leverage. Interestingly, neither idiosyncratic risk (*Risk*) nor market risk (*Financial Shock*) are statistically significant at any conventional level when debt over book value of assets is used. This result indicates that risk factors do not influence banks' capital structure in terms of book values.

Using debt over market value of assets only yields statistically significant results for *Size* (10%), *Growth* (5%) and *Basel III* (1%). Compared to our using debt over book value of assets the sign for the coefficient for *Growth* changes and becomes negative. Yet again the risk factors appear to have no significant effect on banks' capital structure.

Table 5: Regressions with Different Leverage Measures

	(1) Debt/Equity	(2) Debt/BV	(3) Debt/MV
Profit	**142.6**	**637.1****	**209.9**
	(103.3)	(255.5)	(193.7)
Size	**2.84*****	**5.18****	**4.22***
	(0.76)	(2.29)	(2.34)
Growth	**0.24**	**1.25*****	**-1.52****
	(0.14)	(0.36)	(0.65)
Risk	**-226.1***	**105.7**	**1,338**
	(107.5)	(248.1)	(1,019)
Asset Structure	**-68.82***	**123.0**	**-9.22**
	(38.35)	(107.6)	(129.7)
Interest Rate	**102.7*****	**107.4*****	**30.18**
	(13.7)	(32.93)	(38.01)
Financial Shock	**0.78***	**0.70**	**-0.43**
	(0.36)	(0.69)	(2.27)
Basel III	**-1.10*****	**-1.86*****	**-3.25*****
	(0.28)	(0.37)	(0.86)
Constant	**-31.83*****	**-66.29***	**-43.36**
	(10.68)	(32.54)	(32.36)
Fixed effect	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Observations	585	585	585
R-squared	0.51	0.35	0.25
Number of banks	15	15	15

Note: There are 585 observations for all three leverage regressions. All variables are winsorized at the 5% level at both tails of the distribution. Standard errors in parenthesis under the coefficients are robust to arbitrary heteroskedasticity and serial correlation (clustered at bank level).

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Overall, using debt over market value yields questionable results about the reliability of our determinants of choice. However, we find some reliable determinants of bank capital structure when debt over equity and debt over book value of assets is used. Notably, our preferred model (debt/equity) and debt over book value of assets yield quite different results regarding the reliability of determinants of bank capital structure even though they both essentially are debt over book value measures. Therefore, our results reveal that the choice of leverage measure is essential for establishing which determinants are reliably important for leverage. The choice of dependent variable may overestimate or underestimate the impact of *Basel III*, since their coefficients differ. Our preferred model appears to yield the best explanatory power and effect on leverage for the chosen determinants, which is manifested by R-squared.

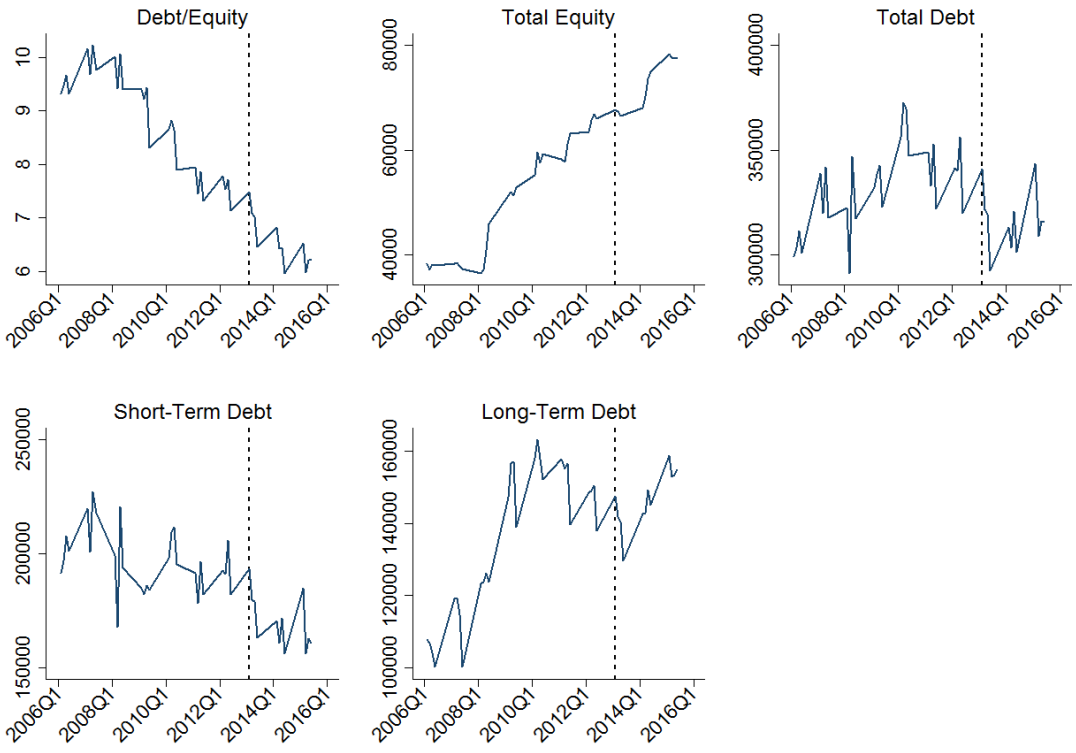
A lot of research has been conducted on some of our determinants of capital structure, such as: *Profit*, *Size*, *Growth*, *Asset Structure* and *Interest Rate*. The extensive research on these particular variables combined with the global economic state emphasizes the interest for the variables *Financial Shock* and *Basel III*.

Risk is also of interest when analyzing *Financial Shock* since these two variables yield both idiosyncratic and systematic risk. As already mentioned *Financial Shock* exhibits a positive relationship with leverage, whereas *Risk* displays a negative relationship. Modern theory of well-functioning capital markets claims that idiosyncratic risk should not matter regarding investment decisions if firm owners are diversified; hence only systematic risk yields higher expected returns. However, Panousi and Papanikolaou (2011) discover that there is in fact a negative relationship between investments and idiosyncratic risk. Furthermore, they argue that executives all over the world hold large amount shares in their firms, thus they might not be diversified well enough. Panousi and Papanikolaou reveal that risk averse managers tend to make rather defensive investment decisions (underinvest) when idiosyncratic uncertainty increases. During times of financial distress - which it was during most of our sample period - idiosyncratic uncertainty may increase greatly. Banks may issue equity rather than increasing their debt level in order to undertake investments, since riskier firms face higher cost of financial distress, according to Frank and Goyal (2009).

It is compelling that both types of risk appear to affect leverage differently. The

positive effect of the *Financial Shock* variable suggests that the leverage of banks increases in times of financial distress. However, we cannot determine if it is the lower level of equity or the higher level of debt that is the driving factor. Both effects are reasonable since equity is argued to decline in recessions, because people may be reluctant to invest money in times of financial uncertainty. Hence, it may be relatively easier for firms to use debt instead of equity. Total equity underwent a small decline during the financial crash in 2008. Thereafter, equity has had an increasing trend continuing throughout 2015. Total debt however, has had a less clear trend. It fluctuates a lot with an increasing trend prior to 2011 followed by a decreasing trend thereafter. Visually, this can be observed in figure 4.

Figure 4: Trends for Debt over Equity and its components



Note: The dotted lines depict the implementation of Basel III. All variables are winsorized at the 5% level at both tails of the distribution.

Moreover, determining the impact of regulation on leverage is central for this paper and also in general for policy makers. The relative cost of taking on more debt has increased, due to the significant rise in the bank industry's capital requirements and should therefore decrease the amount of debt relative to equity. Furthermore, a Net Stable Funding Ratio (NSFR) is introduced within the regulatory framework by the Basel Committee (2010), which is expected to promote more medium and long-term funding. Figure 4 indicates that this has been the case, since we detect a negative trend in short-term debt, whereas long-term debt tends to increase during the last years. This is all in line with the intended shift by the Basel Committee towards relatively more long-term funding induced by the NSFR within the new regulation. Overall, finding a negative sign for *Basel III* implies that the implementation of the new regulations has had the desired impact.

5.3 Testing for regional trends

Finally, we investigate if there are noticeable regional patterns. La Porta et al. (1997) argue that different legal environments should influence firms' financing decisions. Therefore, the determinants of bank capital structure may differ between regions. In order to investigate this proposition we split up the sample into Europe, USA and Nordic (Sweden, Norway and Denmark). Yet, our sample for each region is rather small and therefore the results may be relatively weak. The results for this model specification are displayed in the table 6. Column 1 is our preferred model, which includes all regions. Column 2 shows the baseline regression only for the 10 European banks. Column 3 displays the baseline regression for the 5 American banks. Finally, column 4 discloses the baseline regression for the 6 Nordic banks.

Profit yields statistically insignificant coefficients when we split up our preferred model into regions. These findings support the argument that *Profit* is of minor importance. The factor *Size* appears to be significant for the European banks (5%) overall and Nordic banks (1%), but not for the American banks. The signs for the statistically significant coefficients remain positive. Furthermore, we find that *Growth* is only significant for the American banks, but neither for the European and Nordic banks nor for our preferred model. It appears that the American banks capital structure is

affected by *Growth* (growth opportunities) rather than *Size* (assets in place) whereas we observe the opposite for the European banks. *Risk* is not statistically significant when we split up our preferred model into regions. *Asset Structure* is statistical significance for our preferred model and the European banks by themselves, but only at a 10 percent level. The coefficients for *Interest Rate* are statistically significant at a 1 percent level for our preferred model, the European banks and the Nordic banks. *Interest Rate* is only significant at a 10 percent level for the American banks. The proxy for market risk, *Financial Shock*, differs in significance when we split up our baseline regression by regions. *Financial Shock* is positively correlated with leverage for our preferred model, the European banks and Nordic banks. We cannot find proof for a positive or negative relationship between leverage and *Financial Shock* for the American banks. Lastly, we find the most interesting results for the variable *Basel III*. Our results suggest that European and Nordic banks' leverage is affected substantially more (negatively) than American banks' leverage. We find an explanation for these outcomes in the initial mean values of leverage for the different regions. The American banks have considerably less leverage (mean value = 3.38) than their European (10.55) and Nordic (11.06) counterparts, which helps to explain the large difference in coefficients for *Basel III*. Furthermore, the problem of full harmonization of capital standards between different jurisdictions may also contribute to this variation. The capital standards within the new regulation have no legal force and the members of the Basel Committee implement them independently as the Basel Committee (2010) emphasizes. Thus, minimum capital requirements may be enforced more or less strict across regions.

Concluding the regional trend discussion, the initial proposition that the determinants of bank capital structure may differ between regions is confirmed. The signs of the coefficients follow the same pattern for the statistically significant coefficients regardless of region. Furthermore, the factors' importance differs considerably between regions in terms of statistical significance. Accounting standards between Europe and USA may contribute to this difference. Yet again, possible effects of different accounting standards are beyond the scope of this paper. Notably, the effect of *Basel III* differs considerably across regions. Overall, we find proof in our results that regions should

be considered when determining reliable factors of bank capital structure.

Table 6: Baseline regression split up by regions

	(1) Debt/Equity (All regions)	(2) Debt/Equity (Europe)	(3) Debt/Equity (USA)	(4) Debt/Equity (Nordic)
Profit	**142.6**	**240.8**	**-34.26**	**-295.1**
	(103.3)	(240.9)	(36.32)	(285.4)
Size	**2.84*** **	**3.31** **	**1.94**	**5.41*** **
	(0.763)	(1.46)	(1.30)	(0.90)
Growth	**0.24**	**0.16**	**0.23*** **	**0.93**
	(0.14)	(0.24)	(0.03)	(0.48)
Risk	**-226.1***	**-236.3**	**-265.2**	**150.9**
	(107.5)	(129.0)	(171.5)	(194.9)
Asset Structure	**-68.82***	**-203.0***	**-34.57**	**-148.1**
	(38.35)	(110.6)	(21.71)	(80.88)
Interest Rate	**102.7*** **	**101.1*** **	**101.2***	**88.73*** **
	(13.69)	(11.86)	(41.45)	(19.91)
Financial Shock	**0.78***	**1.02***	**0.16**	**1.38***
	(0.36)	(0.46)	(0.19)	(0.63)
Basel III	**-1.10*** **	**-1.42*** **	**-0.45***	**-1.64** **
	(0.28)	(0.37)	(0.16)	(0.60)
Constant	**-31.83*** **	**-34.75**	**24.79**	**-59.03*** **
	(10.68)	(20.05)	(18.43)	(11.96)
Fixed effect	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
Observations	585	390	195	234
R-squared	0.51	0.50	0.73	0.51
Number of banks	15	10	5	6

Note: There are 585 observations for all regions combined. All variables are winsorized at the 5% level at both tails of the distribution. Standard errors in parenthesis under the coefficients are robust to arbitrary heteroskedasticity and serial correlation (clustered at bank level).
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

6 Sensitivity analysis

This section provides a sensitivity analysis when we alter the measures for *Profit*, *Size* and *Growth* and control for additional variables in our baseline specification. Moreover, we test our model's robustness when we use other econometric models. We investigate the robustness of our preferred model regarding *Basel III* and also *Financial Shock*. We argue that the *Basel III* variable is the most interesting determinant, since its effect on leverage is of utmost importance in this study. *Financial Shock* is also included since it is relatively unique within this research topic.

The econometric strategy we use controls for unobserved time-invariant effects. It is however possible, that there are other time varying differences that drive the results. We show how a sample of different and additional variables affects our model. The results are summarized in table 7. All cells report the coefficient and standard error for the *Basel III* variable and for the *Financial Shock* variable from separate regressions.

Return on assets is a frequently used proxy-ratio for *Profit*. When including return on assets instead of profitability in our baseline regression we notice that the coefficient for *Basel III* and *Financial Shock* remain robust to this change (row 2). In row 3 we use log of employees instead of log of assets as the *Size* determinant. The results indicate that our model is robust to this alternative specification regarding *Basel III*. *Financial Shock* however looses in statistical significance when log of employees is used. Moreover, we use delta log of assets instead of the market to book ratio as the *Growth* factor. The results in row 4 display that our *Basel III* estimate is robust to this change and *Financial Shock* improves in statistical significance (5%). The final alteration we test is using an aggregated GDP growth for our bank sample's countries, instead of *Interest Rate* (row 5). Our preferred model is not robust to this change regarding *Basel III*, whereas *Financial Shock* remains robust to this change. Using GDP growth instead of *Interest Rate* as the macroeconomic condition yields a R-squared of 0.355, which is substantially smaller than the R-squared of our preferred model of 0.512. It is worth mentioning, that using return on assets instead of profitability and delta log of assets instead of market to book, do not improve the statistical significance for *Profit* and *Growth* respectively. Furthermore, using log of employees as *Size* and GDP growth

instead of *Interest Rate*, yield statistically insignificant results. Both *Size* and *Interest Rate* in our baseline regression are statistically significant at a 1 percent level in our preferred model.

Table 7: Sensitivity Analysis (Reports Coefficients on Basel III and Financial Shock)

	Total Debt/Equity	
Robustness Test	Basel III	Financial Shock
1. Baseline	**-1.10*** **	**0.78***
	(0.28)	(0.36)
2.Using return on assets instead of profitability	**-1.05*** **	**0.68***
	(0.27)	(0.36)
3. Using log of employees instead of log of	**-0.91*** **	**0.62**
assets	(0.33)	(0.36)
4. Using delta log of assets instead of market to	**-1.06*** **	**0.76****
book ratio	(0.29)	(0.35)
5. Using GDP growth instead of interest rate	**-2.36*** **	**0.85***
	(0.40)	(0.44)
6. Controlling for financial strength	**-1.02*** **	**0.64***
	(0.27)	(0.32)
7. Controlling for cash	**-1.13*** **	**0.82****
	(0.28)	(0.37)
8. Controlling for dividend	**-1.08*** **	**0.68***
	(0.25)	(0.33)
9. Controlling for all additional variables	**-1.06*** **	**0.59***
(financial strength, cash, dividend)	(0.24)	(0.29)
10. Using Pooled OLS	**-0.64**	**0.54**
	(0.38)	(0.77)
11. Using Random Effect	**-1.08*** **	**0.74****
	(0.28)	(0.36)

Note: There are 585 observations for each robustness regression. All new and additional variables are lagged one period. We use tier 1 capital ratio as a proxy for financial strength. All variables are winsorized at the 5% level at both tails of the distribution. Standard errors in parenthesis under the coefficients are robust to arbitrary heteroscedasticity and serial correlation (clustered at bank level).

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

In rows 6 to 9 we add the variables financial strength, cash and dividend. Notably, controlling for cash improves the statistical significance of the *Financial Shock* coefficient. As our results in rows 6 to 9 imply, our *Basel III* and *Financial Shock* estimates are generally robust to these additional controls.

The importance of choosing the correct econometric model has been addressed in previous sections of this paper. We have shown that the fixed effect regression is the most suitable model for our data set. In rows 10 and 11 we run a pooled OLS regression and a random effect regression with our preferred variables, i.e. the baseline regression but as a pooled OLS model and random effect model. In row 10 we observe that the *Basel III* and *Financial Shock* estimates are not robust if we use a pooled OLS model instead of a fixed effect model. Using a random effect model in row 11 yields a robust coefficient for *Basel III* and at the same time a stronger statistically significant coefficient for *Financial Shock*. That our model is not robust when using a pooled OLS model is in line with econometric theory.

Concluding, the change in macroeconomic conditions yields a non-robust estimate for *Basel III*. Additionally, the change in *Size* generates a non-robust coefficient for *Financial Shock*. Using a pooled OLS model provides non-robust estimates for both determinants. Overall the coefficients for *Basel III* and *Financial Shock* remain quite robust regarding statistical significance for most alterations and changes.

7 Conclusion

In this paper we study the effect of several determinants of bank capital structure with a fixed effect approach. To our knowledge there are few studies regarding determinants of leverage, which focus exclusively on banks. Frank and Goyal (2009) for instance chose to exclude financial firms entirely in their study.

First, we use different Basel III time periods in order to see if there appears to be a gradual adjustment to the new regulation even before its implementation. Moreover, we discuss whether or not to extend the Basel III dummy period if there appear to be noticeable adjustments. Second, we run our preferred model in order to determine if the variables of our choice are reliable and economically significant for banks' leverage. Furthermore, previous work has focused on the factors *Profit*, *Size*, *Growth*, *Risk*, *Asset*

Structure and *Macroeconomic Conditions*. In addition we include the determinants *Financial Shock*, which is a proxy for market risk and *Basel III*, which is the new regulatory framework (implemented in 2013) for the financial sector. Moreover, we discuss idiosyncratic risk, market risk and *Basel III* at length. Third, we set out to see if there are noticeable regional trends regarding the effect of our determinants of bank capital structure.

Our results show negative statistically significant effects for the Basel III dummy variable before its implementation. However, we cannot determine if there has been a gradual adjustment towards the new regulatory framework with certainty. Thus, we refrain from including time periods before the Basel III implementation.Our results reveal that the determinants *Size* and our macroeconomic conditions proxy *Interest Rate* exhibit a strong positive relationship with leverage, whereas we find weak evidence for a positive correlation between leverage and *Financial Shock*. On the contrary we find a strong negative relationship between leverage and *Basel III* and only a weak correlation between leverage and *Risk* and *Asset Structure*. Overall, our results indicate that we have found some reliable determinants of bank capital structure. However, we find no proof for our first hypothesis that all determinants, which are reliable for non-financial firms are also reliable determinants for financial firms. The negative sign and statistically significant coefficient of *Basel III* suggests that the relatively new regulation has had its desired - leverage decreasing - effect and proves our second hypothesis. It is important to highlight that the outcome differs quite substantially when alternative leverage measures are used as the dependent variable. Furthermore, we find no clear regional patterns but it is important to note that banks' capital structure appears to be affected differently depending on the region. Reliable factors for banks' leverage may be crucial for future regulations and potential government interventions.

Finally, future research could focus on including small and medium size banks as well, since we only use some of the largest banks in their respective region. It is reasonable to assume that there may be substantial differences regarding the effect of leverage's determinants depending on banks' size. Additionally, the possible effect of different accounting standards is an interesting research topic. ■

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Appendix A

Variable definitions

Leverage	
Debt over equity	Total debt over total equity
Debt over market value of assets	Total debt over market value of assets
Debt over book value of assets	Total debt over book value of assets
Profit	
Profitability	Operating income over total assets
Return on assets	Net income over total assets
Size	
Employees	Log of number of employees
Assets	Log of total book value of assets
Growth	
Market to book	Market value of assets over book value of assets
Delta log of assets	Delta log of assets
Risk	
Variance	Quarterly stock return variance
Macro	
Interest rate	Averaged aggregated interest rate for sample countries (short term + long term interest rate divided by 2)
GDP growth	Change in quarterly Gross Domestic Product (Averaged aggregated for sample countries)
Financials	
Cash	Cash over total assets
Dividend	Quarters banks pay out dividends
Financial strength	Tier 1 capital ratio
Crash	Number of days considered as financial crash according to our IMAX approach
Crisis	Number of days considered as financial crash according to our IMAX approach
Regulation	
Basel III	Quarters considered as Basel III

Appendix B

Tier 1 capital ratio

Period	Banks	Average Tier 1 (%)	Min	Max	Minimum Required Tier 1 (Basel III)	Minimum Tier 1 Above Tier 1 requirements (%)
2010						
Quarter 1	15	11.64	9.30	14.60	-	-
Quarter 2	15	11.75	9.00	14.80	-	-
Quarter 3	15	12.37	10.00	15.7	-	-
Quarter 4	15	12.59	10.00	16.5	-	-
2011						
Quarter 1	15	13.01	10.50	17.20	-	-
Quarter 2	15	13.28	11.00	17.40	-	-
Quarter 3	15	13.01	9.30	17.40	-	-
Quarter 4	15	13.31	10.80	18.40	-	-
2012						
Quarter 1	15	13.69	10.90	20.40	-	-
Quarter 2	15	13.73	10.20	18.70	-	-
Quarter 3	15	14.11	10.60	19.80	-	-
Quarter 4	15	14.30	10.80	20.40	-	-
2013						
Quarter 1	15	14.07	10.00	20.40	4.5	5.50
Quarter 2	15	14.48	10.00	20.40	4.5	5.50
Quarter 3	15	14.63	10.40	21.50	4.5	5.90
Quarter 4	15	14.53	10.90	21.00	4.5	6.40
2014						
Quarter 1	15	14.16	11.30	21.10	5.5	5.80
Quarter 2	15	14.47	11.10	22.10	5.5	5.60
Quarter 3	15	14.77	11.30	22.30	5.5	5.80
Quarter 4	15	14.92	11.30	22.40	5.5	5.80
2015						
Quarter 1	15	15.26	11.10	24.90	6.0	5.10
Quarter 2	15	15.49	11.00	25.00	6.0	5.00
Quarter 3	15	15.75	11.10	25.70	6.0	5.10
Quarter 4	15	15.72	11.30	25.70	6.0	5.30

Note: Every quarter has 15 observations. The tier 1 capital ratio has not been winsorized.The minimum tier 1 requirements are in accordance with the Basel Committee (2010). Tier 1 capital ratio refers to tier 1 risk based capital ratio.