The effect of variable remuneration on the executive board's risk-taking within banks and the effect of government policy within this field.

Final version Master Thesis Tax Economics

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Date: 10 February 2021

Abstract

Employing hand-collected compensation data of 26 European banks from 12 European countries in the period 2010-2018 this thesis researches the effect of relative variable compensation on risk-taking. Risk-taking is measured with employed market-based measures, based volatility, and an accounting-based risk measure, the z_score. The main finding is that relative more compensation has a small negative effect on risk-taking, and therefore leads to risk aversion. This result holds for robustness checks and sensitivity analyses. Furthermore, the reverse causality between risk and compensation is controlled for in Granger-causality tests and instrumental variable regressions. The Granger-causality test reveal that there is no reverse causality between risk and compensation. The proposed instrument, a cap introduced in the European Union on variable-to-fixed remuneration, turned out to be reasonably adequate. Lastly, this thesis places some comments on the z_score as this measure cannot deal with negative values.

Contents

1 INTRODUCTION

After the financial crisis in 2007-2008, banks' remuneration policies got debated in public, and some even blamed the so-called excessive remuneration policies of banks for the crisis. Some empirical studies also suggested that variable compensation packages within banks may have provoked an increase in managerial risk-taking and may have been an additional cause of the financial crisis (Financial Stability Board, 2009; Bebchuk & Spamann, 2010; Uhde, 2016). The reason for this is that banks are highly leveraged, and, under limited liability, bank managers can shift risk to dispersed and unsophisticated debtholders (Uhde, 2016).

Research by Conyon et al. (2011) shows that the average bonuses CEOs received in 2006 were higher in the banking sector than in the non-banking sector. However, when comparing 2006 data with 2008 data, the decrease of bonuses was also higher in the banking sector than in the non-banking sector (Conyon et al., 2011). Several researchers have concluded that there is no robust empirical evidence for a relationship between financial institution remuneration policy and financial crises (Andres, Reig & Vallelado, 2019; Andres & Vallelado, 2011b; Edmans, 2016; Ferrarini, 2015; Murphy, 2013; Murphy & Jensen, 2011). However, the remuneration of banking executives still got blamed by politicians and the media. Following the financial crisis, the European Parliament and the European Union council published a directive on the 26th of June 2013 (Directive 2013/36/EU). The directive states that the remuneration's variable component may not exceed the amount (100%) of fixed remuneration. Variable remuneration that is twice the amount (200%) of fixed remuneration is only acceptable on stringent conditions formulated in article 94 of the directive. The European Member States are allowed to implement the directive in stricter national legislation, e.g., only to allow a lower variable-to-fixed remuneration ratio.

Prior academic literature showed that variable compensation has different effects on risk-taking within banks. The research of Ayadi, Arbak, and DeGroen (2011) showed that there was no significant effect of short-term performance schemes, such as annual bonuses, on risk-taking. The results on long-term performance schemes were mixed. Option plans had no significant effect on risk-taking; however, the so-called long-term performance bonus plans did significantly positively affect risk-taking. In another study, there was a significant positive effect of excess variable equity-based and cash-based compensation on risk-taking (Uhde, 2016). Some studies even found a significant negative effect of CEO cash bonuses on banks' riskiness (Vallascas and Hagendorff, 2013). These various outcomes are partly due to the different periods the studies are conducted. These studies' results were also affected by the difference in the geographical location, the different risk measures, and the various variable compensation measures used. In Section 2.2, these studies will be analyzed more thoroughly.

This research extends and complements the literature on variable compensation and its effect on risk-taking in Europe, as mentioned in the previous paragraph. The effect of the executive board's variable compensation on banks' riskiness in Europe is not yet researched for the period in and after the financial crisis. Moreover, the compensation data of the 26 banks from 12 European Countries had to be collected by hand. This makes it more time-consuming to research European banks than U.S. banks, for example, where databases can be used. Furthermore, this will be the first research to extensively describe the governmental policy in Europe on banking executives' remuneration introduced in 2013 and its effects. Another addition to the existing literature is that this policy is used to isolate some exogenous variation in variable remuneration, making it possible to estimate the causal effect. Therefore, the research question of this thesis is as follows:

What is the effect of the executive board's variable remuneration on bank riskiness within European banks from 2010 until 2018?

This thesis research contributes to the literature by analyzing the effect of variable compensation of executive board members. As a core result, it is found that an increase in the relative variable to fixed compensation decreases the riskiness of banks by a small amount. This effect is mainly caused by relative more variable equity-based compensation, as the effect of more relative variable cash-based compensation was not significant. This thesis research uses the European policy change, a cap on variable-to-fixed remuneration, to isolate some exogenous variation in variable remuneration to better estimate the compensation and risk variable's effect. The proposed instrument turned out to be all right, however not very convincing, so the results should be interpreted with care. The analysis at hand provides implications for banking regulators and politicians. As there is no evidence that variable-to-fixed remuneration increases risk-taking, as is argued by politicians and regulators. The underlying research could form a starting point for discussions on the regulation of variable compensation.

The remainder of this thesis proceeds as follows. In Section 2, the relevant literature will be discussed. In Section 3, the data sources are described, variable definitions are given, and descriptive statistics are presented. Section 4 will discuss the methodology, followed by Section 5, which will present the empirical results. Section 6 concludes with a summary and discussion.

2 THEORETICAL FRAMEWORK

2.1 RELEVANT ECONOMIC MECHANISMS: HOW DOES VARIABLE COMPENSATION AFFECT RISK-TAKING WITHIN BANKS?

The economic mechanism of a (listed) bank can be set out as follows. The bank's shareholders want both a high short- and long-term performance. Both the distributed dividends in the present and the share value, e.g. distributed dividends in the future, are essential. Bank shareholders hold an implicit contingent claim on the residual value of a bank's assets (Merton, 1973; Merton, 1974). To achieve this high performance, the bank's shareholders appoint an executive board that makes both short-term and long-term decisions. The executive board usually gets both fixed and variable compensation for their duties. The fixed compensation is in the form of salary, pension, and other benefits (such as payment-in-kind, e.g., leasing a car) and does not necessarily make an executive more risk-seeking or risk-averse. However, with variable compensation, an executive may become more risk-seeking or risk-averse, depending on the form of the variable compensation, e.g., short-term, long-term, cash-based, equity-based, or a combination of multiple forms.

If the executives' compensation package is too much focused on short-term performance, this could lead to strategic choices that are optimal for the short-term value but inefficient for the long-term value of the bank. Narayanan (1985) shows in a theoretical model that there may be augmented risk-taking if executives have private information. Private information is defined as information unavailable to the investors, such as executives' ability or the executives' decisions. In his model Narayanan (1985) showed that executives who receive short-term incentives, such as annual profit-sharing plans, augment risk which he defines as short-term gains at the expense of shareholders' welfare. However, this also held for compensation schemes with decreased short-term compensation and increased compensation based on long-term performance, as these compensation schemes do not entirely eliminate the augmented risk. Narayanan (1985) explains this since these long-term schemes are usually based on three- to five-year moving averages of some performance measure, like earnings. The optimal wage in the model was based on a measure similar to earnings, based on the average of all previous executive outputs, but still did not eliminate all short-term incentives. An important takeaway for investors is that they have to be well-informed about the executives' abilities in charge and their decisions. Investors could then intervene if they see executives choose for projects with short-term profits, only to improve their ability perceptions.

Equity-based compensation, e.g., stock options, forms a large part of total executive compensation; for the data used in this thesis, the total compensation consists of 30% equity-based compensation. Therefore, it is necessary to analyze the theoretical effects of this kind of compensation. Stock options provide a direct link between executive compensation and increases of the stock prices, since the pay-out from exercising the options increases in the stock price (Murphy, 1999). However, there is are three differences in effects of the incentive between stock options and stock ownership. The most interesting difference for this research is regarding the stock-price volatility. Since the value of stock options increase with stock-price volatility, executives with stock options have an incentive to engage in riskier projects or investments (Murphy, 1999). Empirical research of DeFusco, Johnson & Zorn (1990) shows that stock-price volatility increases after the approval of executive stock option plans. The same results are demonstrated in the studies of Agrawal and Mandelker (1987) and Hirshleifer and Suh (1992). The second difference is that stock options only reward stock-price and not total shareholder returns, including dividends, making share repurchases more interesting than distributing dividends. The third and last difference is that stock options lose incentive value when the stock price falls below the exercise price (Murphy, 1999).

Regarding cash-based variable compensation, Smith and Stulz (1985) showed in a theoretical model that as long as cash-based compensation increases linearly with the bank's performance and the payoffs linked to the bonus plan are non-convex, that it is not inherently risk-rewarding. Following this theory, bonus plan payoffs will be convex and offset the executives' risk-aversion's concavity if performance is below the earnings-based threshold for a bonus payment. Contrary to this, if the performance is above the threshold, there is no incentive for executives' to increase bank risk to secure the bonus payments. This theoretical model is confirmed in the empirical research of Kim, Nam, and Thornton (2008). It could also be argued that variable cash-based compensation reduces risk-taking. These payments can only be received by executives' if the bank is solvent; in case of bankruptcy, payment is not possible (Brander & Poitevin, 1992; John & John, 1993).

The former paragraphs all suggested that, in theory, it is presumable that variable remuneration augment risks within banks. However, long-term performance-related remuneration schemes may have little or no impact on risk-taking if they are relatively low compared to fixed salaries and annual bonuses. Going further in the other direction, executives may become risk-averse if the packages represent a significant proportion of the income, making the executives' portfolio less diversified (Smith & Stulz, 1985). Also, if long-term performance incentives are well aligned with depositors' and investors' interests, such as customer satisfaction and market access, this might lead to more risk-aversion (Ayadi, Arbak, & DeGroen, 2011).

2.2 Previous related empirical studies for Europe

The most recent research that focuses on European banks is from Uhde (2016). He showed that for the period 2000-2010, there is empirical evidence that excess variable compensation is positively related to bank risk. In this research, excess variable compensation stands for the residuals of a regression of variable compensation on bank size, country- and time-dummies. The dataset consisted of 63 listed and unlisted banks in 16 European countries, collected from annual reports. The risk measure in this research was solely the z_score, an accounting-based measure, that will be explained more thoroughly in Section 3.2. The compensation measure used was excess variable compensation, which was lagged for one-period. In this research, a panel regression with fixed effects was performed. The causality between executive compensation and bank risk is not clear if variable compensation packages' design depends on the bank's riskiness. Therefore, endogeneity problems are dealt with by lagging the compensation measure with one period, performing Granger-causality tests, and performing a two-stage least squares (2SLS) instrumental variable (IV) estimator with fixed effects, time dummies, and a robust-clustering at the bank-level. The instrumental variable used in this research was the executive's consecutive years on board (tenure) standardized by the executive's respective age. Uhde (2016) hypothesizes that the amount of excess pay is positively related to the length of tenure, as this may result in entrenchment, provoke higher firm-specific human capital and a better reputation. This, in turn, should induce an increase in executive compensation (Barro & Barro, 1990; Harjoto & Mullineaux, 2003). Furthermore, it is assumed that risk-taking from excess compensation may become less important for more experienced executives since these executives might already show an extensive track record of their value for the bank. These hypotheses are substantiated with empirical research that provides evidence that intrinsic motivation for executive risk-taking decreases with tenure due to career and reputational considerations (Berger, Kick & Schaeck, 2014).

The most important results of Uhde (2016) are the following. First, the paper provides empirical evidence that excess variable compensation, both cash-based and equity-based, is positively related to bank risk. The results hold during the Granger-causality tests and IV regressions. Other important results obtained through sensitivity analyses were the following. The significant negative impact of the compensation measures on bank soundness was larger for non-stock-listed banks than for listed banks. Therefore, this research's empirical results support the theoretical predictions that executives' risk-taking may evolve due to the alignment of shareholders' and executives' interests within compensation schemes. Furthermore, this finding may indicate that executive risk-taking stems from intrinsic risk-taking preferences of executives (within non-stock-listed banks) beyond shareholder pressure. Another important result is that the negative impact of excess variable compensation on bank risk is weaker for a subsample of banks that retrieved governmental capital assistance than the subsample that did not retrieve this kind of support. As governmental support usually comes with specific constraints, such as replacing executives' or changing their bonus policy, it suggests that these interventions are useful instruments to mitigate risk-taking incentives. This result does not support the theoretical argument of Hakenes & Schnabel (2014) that governmental guarantees or bail-outs may have led to steeper bonus schemes and therefore, increased risk-taking of executives. Another finding of the research is that the risk-increasing impact of excess variable pay describes a long term effect, supporting the view that compensation practices may have played an important role in causing the financial crisis (Bebchuk & Spamann, 2010). This conclusion was reached by panel regressing the z-score from the crisis period (2007-2010) on the compensation data in the period before the crisis (2000-2006). In contrast, the z-score data from the period of the crisis is pooled-regressed on compensation data from the last year before the crisis started (2006). More generous deposit insurance schemes may spur managerial-risk taking, whereas governmental capital assistance during the crisis may mitigate it. Lastly, greater supervisory power may substantially diminish the negative impact of compensation on bank soundness in Europe.

Other studies also showed a significant positive effect for both cash-based compensation and equity-based compensation. Variable cash-based compensation is usually in the form of cash bonuses, subject to performance-based targets derived from accounting data of the past (Murphy, 2000). It is suggested that cash bonuses invoke risk-taking of banking executives if they indeed take high risks to meet short-term performance targets. Hence, the executives' gain short term compensation at the cost of long-term productive results of a bank (Financial Stability Board, 2009; Hakenes & Schnabel, 2014; Holthausen, Larcker, & Sloan, 1995). As this might be the case in the past, it is questionable if this still holds in the present. The findings of the studies discussed in the paragraphs hereafter partly refute this theory about cash bonuses.

Equity-based compensation is usually paid in the form of stock options or restricted stocks. Usually, both types of compensation are granted in combination with a vesting period where executives cannot exercise options or sell stocks (Uhde, 2016). It is commonly suggested that granting equity-based compensation is a good incentive to align executives' with the value-maximizing objectives of shareholders. A vesting period on stock options, or restricted stocks, may incentivize executives in greater risk-taking in the long run if the stock market is efficient (Chen, Steiner, & Whyte, 2006; Coles, Daniel, & Naveen,2006; Fahlenbrach & Stulz, 2011; Hagendorff & Vallascas, 2011; Murphy, 1999). However, this risk-taking behavior may be diluted if the executive holds a significant proportion of shares in the bank the executive manages (Houston & James, 1995). Based on these studies, it is concluded that the effect of equity-based compensation is ambiguous.

An earlier study by Ayadi, Arbak, and DeGroen (2011) showed different results for 1999-2009. The sample covered 53 banks, collected by the Centre for European Policy Studies (CEPS). In this research, multiple risk measures were used, market-based measures (stock volatility) as well as accounting-based measures (z_score). The compensation measures were a dummy for long term bonuses, a dummy for formal option plans, and the ratio of annual bonuses to total annual pay. The significant results in the study were the following. First of all, the so-called 'long-term performance bonus plans' augment the likelihood of default in banking, i.e., increase the z_score. The opposite effect was noted for the presence of option plans, as it decreased the likelihood of default. The presence of option plans did increase the systematic risk. The last result was that compensation schemes that contain relatively larger annual bonuses compared to fixed salary reduce risk. These results were explained through the following two theories. First, long-term bonus plans could be more high-powered compared to option plans that tend to respond less to executive decisions and therefore increase market exposures. This probably arises due to incentives to 'beat the market' (Galai & Masulis, 1976). Second, option plans that form a significant part of the compensation package reduce risk-taking, as the executive portfolio is then less diversified (Smith & Stulz, 1985).

Another interesting research added to the academic literature is the research of Vallascas and Hagendorff (2013). This research is performed almost the same period as that of Ayadi, Arbak, and DeGroen (2011), however, they added US banks to their dataset.

Vallascas and Hagendorff (2013) researched the relation between compensation in the form of CEO cash bonuses and the risk-taking of banks. The dataset consisted of 76 US banks and 41 European banks in the period 2000-2008. The compensation measure is divided into salary, bonuses, and other compensation. In this research, the risk measure is the Merton distance to default (DD) model, which is the number of standard deviations that the market value of a banks' assets is above the default point. The results show that banks with higher CEO bonus payments have lower levels of default risk. Besides, they found that the overall riskiness of an institution determines the effectiveness of risk-taking incentives in CEO bonus contracts. Distributed CEO cash bonuses within banks that are highly risky are associated with higher bank risk-taking. Greater levels of disclosure of the terms under which CEO bonus plans are granted will be beneficial, according to Vallascas and Hagendorff (2013). Their research does not specify why it is assumed that transparency decreases the attractiveness of risk-increasing incentives in compensation schemes because regulators and shareholders have more insight into the schemes. In Regulation (EU) No. 575/2013, which will be discussed in Section 2.3, the obligation to disclose executive compensation information was implemented. This Regulation did not impact the results of Ayadi, Arbak, and DeGroen (2011) but it will affect the empirical results of this thesis.

2.3 Directive 2013/36/EU and Regulation No. 575/2013

In this paragraph, the background and the theoretical and practical effects of the Directive 2013/36/EU[1] (the Capital Requirements Directive IV or CRD IV) will be discussed. From a legal perspective, a directive does not have a direct effect on citizens and businesses of European Member States. This implies that the European Member States first have to implement a directive in national legislation before it affects the citizens and businesses of that particular state. A directive may be implemented stricter; however, it may not be implemented less strict. As Switzerland and Norway do not belong to the European Union, they do not have to implement a directive set up by the European Parliament. However, Norway still chose to implement regulations based on the CRD IV (Sjoqvist, Nilssen, & Rogstad, 2020). In Appendix A and B, a more detailed overview of the differences in implementation can be found. As discussed in the previous paragraph, it is interesting to see the differences in the implementation of European Member States. For example, Belgium chose to allow a maximum of 50% variable-to-fixed payment and

[1] Directive 2013/36/EU on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC.

the government in the Netherlands chose a maximum of 20% variable-to-fixed payment. An interesting note is that in the case that shareholders of a particular bank agree to it, the maximum variable-to-fixed remuneration ratio in the Netherlands can be raised to 200%. In Belgium this is not the case, there the maximum in all cases is 50%.

On 26 June 2013 the Regulation (EU) No. 575/2013 was also published. Contrary to a directive, a regulation has a direct effect on individuals and businesses in the European Member States. This means that they have to comply with this European legislation without implementing this regulation in the Member States. This Regulation has legislation on the provision of information of institutions. Article 450 of the Regulation states that information has to be disclosed regarding the institution's remuneration policy and practices for several categories of staff whose professional activities have a material impact on its risk profile. Among others, the amounts and forms of variable remuneration, split into cash, shares, share-linked instruments, and other types, have to be reported. Therefore, most banks in Europe now distribute more information and specification on their executives' compensation, which helped in the data collection process (Section 3.1).

Other remuneration policy measures that are implemented with CRD IV are deferring variable payments and clawback arrangements. At least 40% of any variable pay must be deferred for at least three to five years. This implies that the European Member States are free to choose if the deferral should last three years or longer. The other 60% of variable payments can be paid in the same year as the compensation is granted. Furthermore, variable pay will be subject to clawback or malus arrangements. Financial institutions will be required to set specific criteria for such arrangements.

The variable-to-fixed remuneration ratio is derived on the same manner as the European Banking Authority (EBA) determines this ratio to check if banks comply with the Directive. For more information on this and more detailed information on the Directive and Regulation is referred to Appendix H.

3 EMPIRICAL METHODOLOGY

3.1 DATA COLLECTION

The primary data used in this research is collected by hand from annual reports of banks in Europe. This is necessary as there is no database yet that adequately reports the remuneration of banking executives in Europe. In earlier studies on European banking compensation, data also had to be hand collected from annual reports (Uhde, 2016; Vallascas and Hagendorff, 2013). The advantage of using annual reports is that banking executives' remuneration can be collected more precisely than databases such as Orbis usually can. The disadvantage is that it is very time consuming, and therefore, the dataset in this research is rather small. The final dataset consists of 26 banks across multiple European countries. The geographical distribution can be found in Table 1. The collection of data on executive remuneration is done for the years 2010 until 2018, giving 234 observations. Banks were included in the dataset if the bank's annual report specified the remuneration of banking executives in variable (cash and equity) remuneration and fixed remuneration. Furthermore, only large European banks were included in the dataset, the threshold being a minimum of 15 million EUR total assets. For banks to be included, the annual reports had to contain at least three consecutive years of data. Besides data on compensation, also data on board characteristics were collected. These variables include board-size, average board age, and the average amount of years that executive board members were part of the board in a specific year.

The banks located in Denmark, United Kingdom, Switzerland, Poland have different currencies than EUR stated in their annual reports. Therefore, these amounts were transformed to EUR. The average exchange rate for each of the years 2010 to 2018 was calculated using the exchange rate table of XE (XE, 2020).

Besides collecting data by analyzing annual reports, the Orbis Bankfocus database was also used for bank-specific variables such as the amount of total assets, employees, returns on average assets, total capital ratios, operating revenues, Tier1 ratios, and equity-liability ratios.

The gross domestic product of each country in the years 2010 to 2018 was collected from Eurostat. Moreover, the national remuneration policy and the implementation of the Directive 2013/36/EU were retrieved by translating government documents.

The last data source used in this thesis is Yahoo Finance, as stock volatility is used as a risk measure. Yahoo Finance provides the day-to-day stock performances of all listed banks, government bonds' performances, and the index trackers of European banks.

In Table 2, a list of all the variables that are used in this research is given, as well as a description and the source of every variable used in this thesis.

Table 1
Geographical distribution of banks

Country	Bank name	Country	Bank name
Austria	● Erste Group Bank AG	**Netherlands**	● ABN Amro Group N.V. (relisted as of 2016)
			● Cooperatieve Rabobank U.A.
Belgium	● Belfius Banque SA/NV (missing data of 2010 & 2011)		● ING Bank Nv
	● KBC Groep NV / KBC Groupe SA		● NIBC Holding Nv
Denmark	● Danske Bank A/S	**Poland**	● Mbank SA
	● Jyske Bank A/S (Group)		
	● Nykredit Realkredit A/S	**Spain**	● Banco Bilbao Vizcaya Argentaria SA
	● Sydbank A/S		● Banco Santander SA
Finland	● Nordea Bank Abp	**Switzerland**	● Credit Suisse Group AG
France	● Credit Agricole S.A.	**United Kingdom**	● Barclays Plc (missing data of 2012)
	● Societe Generale		● Lloyds Banking Group Plc
			● Royal Bank Of Scotland Group Plc (The)
Germany	● Commerzbank AG		
	● Deutsche Bank AG		
Ireland	● Allied Irish Banks Plc		
	● Bank of Ireland Group Plc		
	● Permanent TSB Group Holdings Plc (missing data of 2010-2012)		

3.2 Risk measures

3.2.1 Stock volatility measures

In this thesis, the risk measure of Ayadi, Arbak, and DeGroen (2011) is used, which is based on the banks' stock performance. The risk measure of Ayadi et al. (2011) is based on the risk measure used in the studies of Flannery and James (1984) and Chen and Chan (1989). The simplest market-based measure is the total stock volatility, which is calculated through the standard deviation of each bank's daily returns each year. This is referred to as the total risk. However, this risk measure also incorporates the risks beyond bank-specific risks, such as the market conditions and the economic environment. Therefore, the total risk is decomposed into three risk measures. The first measure constructed is the exposure to the volatility of the banking sector as a whole, also known as systematic risk. The second measure is the exposure to interest rate yields called interest risk. The third and last measure is the residual term variation, which is obtained once total variation is decomposed into the systematic risk and interest risk, called idiosyncratic risk. This last measure provides an estimate of the volatility that is the bank's own doing.

Table 2

Description of variables and data sources

Variable name	Description	Datasource
z_score	Natural log of the ratio of the sum of equity capital to total assets and the return on average assets before taxes (ROAA) to the standard deviation of ROAA. The standard deviation of ROAA is calculated employing a three-year rolling window. The z_score is a measurement for distance to insolvency.	Orbis Bankfocus, own calculation
Total risk	The total stock volatility, or the standard deviation of the daily returns, calculated for each bank and for each year seperately.	Yahoo Finance, own calculations
Market risk	The banking sector volatility. As an indicator for this volatility the STOXX Europe 600 Banking index tracker is used, traded on the German stock exchange (Xetra).	Yahoo Finance, own calculations
Interest risk	Exposure to interest rate yields. As an indicator for this exposure the daily one-year Germand bond yield is used.	Investing.com
Idiosyncratic risk	The residual term, which is obtained once total variation is decomposed into the market and interest-rate exposure components, defines the final market-based measure. It provides an estimate of the volatility that is the bank's own doing.	
Total direct compensation	Sum of executives' salary (excluding pension, payment in the form of a car, and other non-kind compensation) and total variable compensation.	Orbis Bankfocus
Salary (fixed compensation)	Sum of executive total salary compensation	Orbis Bankfocus
Total variable compensation	Sum of executive total variable compensation in million EUR per bank and year. If indicated by bank, sum of cash-based and equity-based (non-cash) performance-related compensation.	Orbis Bankfocus
Variable compensation in cash	Sum of executive variable compensation in cash in million EUR per bank and year.	Orbis Bankfocus
Variable compensation in equity	Sum of executive variable compensation in equity (shares) in million EUR per bank and year.	Orbis Bankfocus
Variable-to-fixed remuneration ratio	The total variable compensation divided by the the fixed compensation (salary).	Own calculation
Average variable compensation	The sum of total variable compensation divided by the number of executives in charge per bank and year in million EUR	Own calculation
Boardsize	The amount of board members on the executive board	Annual reports
Average active board years	Sum of executives' consecutive number of years on a bank board divided by the amount of executives	Annual reports, own calculation
Average board age	Sum of the executive boards' age divided by the amount of executives	Annual reports, own calculation
Variable name	**Description**	**Datasource**
Return on average assets	The return on average assets per bank and year.	Orbis Bankfocus
Total assets	The total amount of assets at closing date per bank and year.	Orbis Bankfocus
Profit before taxes	The profit before taxes per bank and year.	Orbis Bankfocus
Operating revenue	The operating revenue per bank and year.	Orbis Bankfocus
Total capital ratio	The ratio of the banks' total capital (Tier 1 and Tier 2 capital) to standardized total risk-weighted assets. Capital ratios measure the amount of a bank's capital in relation to the amount of risk it is taking.	Orbis Bankfocus
Variable name	**Description**	**Datasource**
Gross domestic product (GDP)	The gross domestic product (GDP) per country and year.	Eurostat
Maximum allowed variable-to-fixed remuneration	The national policy on the maximal variable remuneration that may be given to executive board members of financial institutions.	Directive 2013/36/EU and government websites
Maximum allowed variable-to-fixed remuneration with shareholders' approval	The national policy on the maximal variable remuneration that may be given to executive board members of financial institutions after shareholders' approval.	Directive 2013/36/EU and government websites
Directive 2013/36/EU	Dummy that takes on the value of 1 for all observations in the years 2014 to 2018, as the Directive was active from that moment.	Directive 2013/36/EU

The market-based risk measures described above are calculated with a two-index model (Ayadi, Arbak, & DeGroen, 2011):

$$R_{jd} = \alpha + \beta_{mj} R_m + \beta_{ij} \mathrm{I}_d + \mathrm{u}_j \qquad (1)$$

where R_{jd} is the return on the stock of bank j on day d, R_m is the daily market return on the STOXX Europe 600 Banking index, and I_d is the daily one-year German bond yield. The STOXX banking index consists of the largest European banks, of which a large part is represented in the dataset. Therefore, it is a good measure of market risk. Germany is one of the most stable economies of the European Union, and in the financial crisis, Germany seems to have gained a safe-haven status in international financial markets (Bernoth, von Hagen & Schuknecht, 2012). Therefore, the one-year German bond yield will be used as a proxy for the European interest risk.

The four measures are then obtained as follows. The total risk is equal to the standard deviation of the daily returns per bank and year. The systematic risk is equal to the coefficient estimate β_{mj} and the interest risk is equal to the coefficient estimate β_{ij}, which is obtained by performing a regression analysis. Since any exposure, whether positively or negatively correlated with the market rates, is considered risky, the absolute value of the coefficient estimate β_{ij} is used (Ayadi, Arbak, & DeGroen, 2011). The idiosyncratic risk is then equal to the standard deviation of the error term.

The dataset consists out of 21 banks that are listed on a stock exchange in Europe, for which pricing data are collected. The other banks are unlisted. The adjusted closing price was used to calculate the daily stock performances of the listed banks. This is the price that is amended to reflect the stock's value after accounting for any corporate actions, such as stock splits, dividends, and rights offerings. For the five non-stock-listed banks, only an accounting-based risk measure was derived, which is explained in Section 3.2.2 hereafter.

3.2.2 ACCOUNTING-BASED RISK MEASURE

In this research, a bank's risk will also be proxied by the z_score, a measure based on accounting values. The measure's general form is derived from previous studies (Boyd & Graham, 1986; Hannan & Hanweck, 1988; Boyd, Graham & Hewitt, 1993). Furthermore, the z_score is widely used in other studies (Boyd & De Nicoló, 2006; Demirgüc-Kunt & Huizinga, 2010; Foos, Norden & Weber, 2010; Uhde & Heimeshoff, 2009; Uhde, 2016). Using annual balance sheet data from the Orbis Bankfocus database, the z_score per bank i in year t is defined as:

$$z\_score_{i,t} \equiv \frac{ROAA_{i,t} + CAR_{i,t}}{SD(ROAA)_{i,t}} \qquad (2)$$

where ROAA is the bank's return on average assets, which is the net income divided by the average total assets (assets at the beginning of the year + assets at the end of the year divided by two) per year. CAR is the bank's capital ratio defined as equity capital to total assets, and SD(ROAA) is calculated as a 3-year rolling window standard deviation of ROAA.[2] The z_score is a measure of bank stability and indicates a bank's distance to insolvency by combining profitability (ROAA), leverage (CAR), and volatility (SD(ROAA)). A bank is declared insolvent if ROAA + CAR is equal or below zero, as the capital is then insufficient to offset the losses. Therefore, the z_score indicates the number of standard deviations a bank's asset return has to drop below its expected value before the bank's capital is depleted and it becomes insolvent. The observations with relatively higher z_scores are considered less risky and, therefore, more stable banks.

Lepetit & Strobel (2015) analyzed the z_score and proposed a refined probabilistic interpretation based on mathematical analysis. As mentioned earlier, bank insolvency is a state where CAR + ROAA ≤ 0. As suggested by Hannan & Hanweck (1988) and Boyd et al. (1993), the ROAA is a random variable with a finite mean μ_{roa} and variance σ_{roa}^2, where the Chebyshev inequality allows one to state an upper bound of the probability of insolvency as[3]:

$$p(ROAA \leq -CAR) \leq Z^{-2} \qquad (3)$$

where the z_score is defined as $Z \equiv \frac{CAR + \mu_{roa}}{\sigma_{roa}} > 0$; Lepetit & Strobel (2015) refer to the measure Z^{-2}as the traditional probability bound.

Then, Lepetit & Strobel (2015) prove that if the ROAA is a random variable with finite mean μ_{roa} and variance σ_{roa}^2, an improved upper bound of the bank's probability of insolvency p is given by

$$p(ROAA \leq -CAR) \leq \frac{1}{1+Z^2} \leq 1 \qquad (4)$$

where the Z-score Z is still defined as $Z \equiv \frac{CAR + \mu_{roa}}{\sigma_{roa}} > 0$. The measure derived in Equation (4) is referred to as $(1 + Z^2)^{-1}$, the improved insolvency probability bound. This bound is consistently tighter and naturally bounded below one (See Appendix E). Therefore Lepetit & Strobel (2015) showed that the z_score might suffer from being upwardly

---

[2] The 2010 value is the average standard deviation for the years 2009 and 2010. The 2011 value is the average standard deviation for the years 2009, 2010, and 2011. The 2012 value is the standard deviation for the years 2010, 2011, and 2012, and so on. This standard deviation is calculated with the formula for the sample standard deviation: $s = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2}$.

[3] As similarly implemented by (Roy, 1952), this is an application of the (two-sided) Chebyshev inequality (Ross, 1997): it states that for a random variable X with finite mean μ and variance σ^2, it holds for any k > 0 that $P\{|X - \mu| \geq k\} \leq \sigma^2/k^2$ (Lepetit & Strobel, 2015).

biased, i.e., the probability of a bank becoming insolvent may be overestimated for lower z_score ratios. As the z_score may be described as a too conservative measure, this research will correct for these outliers by including the natural log of the z_score, similar to earlier research (Houston, Lin, Lin & Ma, 2010; Laeven & Levine, 2009).

In the underlying dataset approximately 30 observations have negative z_scores, before taking the logarithm. These observations are banks' where ROAA + CAR < 0, which is mainly caused because the ROAA is lower than zero. The z_score cannot handle negative values for two reasons. First of all, it is not possible to take the logarithm of a negative value. This could be avoided by not taking the logarithm. However, this would lead to the bias as described in the previous paragraph. Another solution would be to add a constant to all observations so that no observation has a negative z_score anymore. This solution would be suitable for the logarithm issue, however it does not solve the problem described in the next paragraph, which is considered to be a more fundamental problem of the z_score. Also, this problem is not discussed in previous research.

The second problem for the z_score with observations where ROAA + CAR < 0 is the following. If ROAA + CAR < 0, and the standard deviation of ROAA increases, this would lead to a higher z_score (tending more to zero). This suggests that an increase in the standard deviation of the ROAA leads to a less stable bank, which is not true. Therefore, negative z_scores have to be excluded, it must be noted, however, that this is a suboptimal solution as these observations may contain valuable information.

3.3 Compensation measures

In this thesis, the variable-to-fixed remuneration ratio will be used as the compensation measure. As discussed in Section 2.2, previous studies showed different effects of cash-based compensation and equity-based compensation on executive board members' risk-taking behavior. Therefore, the baseline regressions ratio will be divided into (relative) cash and equity compensation.

Although from 2013, regulation is in place on the information disclosure of compensation, most annual reports do not provide clear information on the deferral period and if the clawback provision has come into effect (as discussed in Section 2.3). Banks may choose if they defer the executive compensation for a period of three to six years. This implies that actual payments of the compensation are spread over multiple years. Furthermore, a clawback provision implies that awarded compensation can be withdrawn in the following years if (long-term) goals are eventually not realized.

However, as this information is not clearly stated in the annual reports, the awarded compensation per year is taken into account, which might not be the exact paid compensation. However, this does follow the approaches of previous studies on compensation and risk-taking.

3.4 INSTRUMENTAL VARIABLE

The instrumental variable used in this thesis is the cap on variable-to-fixed remuneration. This ratio is the awarded variable remuneration divided by the fixed remuneration of the executives. In Appendix A and B the cap is reported per country and year.

3.5 CONTROL VARIABLES

In the analysis, multiple control variables are used. Control variables are added to the regression model to prevent that the relationship between risk and compensation can be explained by other, omitted factors. Hence, to correctly measure the relationship between the independent and dependent variable, the control variables are added. These control variables consist of macroeconomic, bank-specific, and institutional variables.

3.5.1 BANK SIZE

The variable bank size will be measured by taking the natural logarithm of the banks' assets' total value. First of all, this variable controls for the size differences of banks in the dataset. Ayadi, Arbak & DeGroen (2011) state three theoretical effects that size could have on risk-taking. Size might have a negative impact on riskiness if large banks can diversify their risks. On the contrary, larger-sized banks may also evoke risk if they take on activities that expose them to various risk components. Furthermore, larger banks may be able to withstand elevated risks due to the market's belief that they will be saved by governments ("too-big-too-fail"). Other, empirical, studies show a noticeable positive impact of size on risk-taking (Bhagat, Bolton & Lu, 2015; Laeven, Ratnovski & Tong, 2014; Barrell et al., 2010). Therefore, both a negative and positive effect can be substantiated from the theory.

3.5.2 BANK SOUNDNESS AND CAPITAL STRUCTURE

In this research, the total capital ratio will be used as a proxy for a bank's capital structure, in the regressions with the market-based risk measures, following Uhde's

(2016) approach.[4] The total capital ratio variable is the Tier 1 and Tier 2 capital[5], standardized to the total risk-weighted assets. There are several theories on the expected effect of capital structure on risk-taking (Bitar, Pukthuanthong, & Walker, 2018). One theory is that capital structure is negatively correlated with risk since research indicates that capital creates additional space of absorption in the event of an adverse shock (Anginer & Demirgüç-Kunt, 2014; Ayadi, Arbak, & DeGroen, 2011). There is also a theory that suggests the opposite. If it is too costly for a bank to increase its capital level to meet capital in the future, then, the only solution for the bank in the present is to increase the portfolio risk (Blum, 1999). Lastly, more recent studies show no association between risk-based capital ratios and bank risk (Haldane, 2012; Cathcart, El-Jahel, & Jabbour, 2015). Blum (2008) found that if banks can determine risk exposure themselves, they will be incentivized to understate their risk to avoid higher capital requirements. These deceptive assessments could lead to higher investments in risky activities. Therefore, it is interesting to analyze the effect of the total capital ratio on risk-taking in this research.

3.5.3 Macroeconomic influence

The last control variable included is the natural logarithm of the real gross domestic product per country and year. This variable will control for differences in countries regarding their economic development. It is expected that an increase in real GDP negatively impacts bank risk, which is consistent with loans turning riskier when the economy is weaker (De Nicolò, Dell'Ariccia, Laeven, & Valencia, 2010).

3.6 Descriptive statistics

In Table 3, the descriptive statistics can be found for the variables used in this research. The average total compensation per bank per year is equal to €9.604.139, of which €4.535.514 is variable compensation (cash and equity). Suppose we specify these amounts to an average per executive per bank per year. In that case, we see that an executive board member earns an average of €821.716 variable compensation and €988.427 of fixed compensation. The relatively low mean means that the data on compensation is highly skewed to the right. This can be explained as the number of banks that grant €0 total variable compensation amounts to almost 40% of the data. This implies that a relatively small group of executive board members received a rather large amount of variable compensation. For example, the executive board of Credit Suisse in

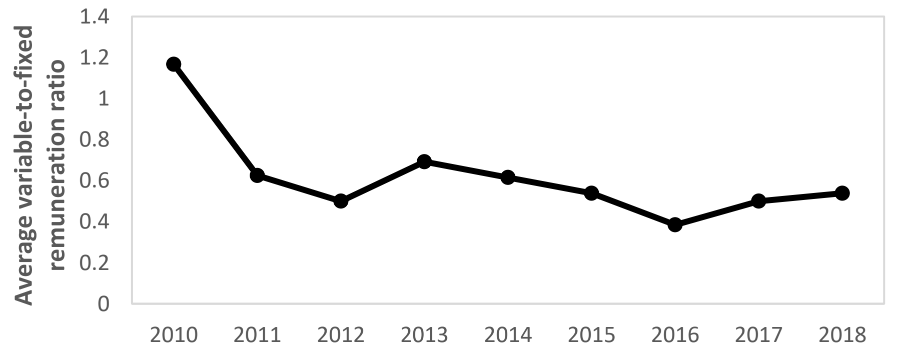
[4] The capital-assets ratio is part of the z_score measure, however as the correlation between the total capital ratio and the z_score measure is low, it is also justified to use the total capital ratio in these regression models.
[5] Tier 1 capital is the equity capital and disclosed reserves, and Tier 2 capital is Tier 2 is the second layer of a bank's capital and consists out of revaluation reserves, hybrid instruments, and subordinated term debt.

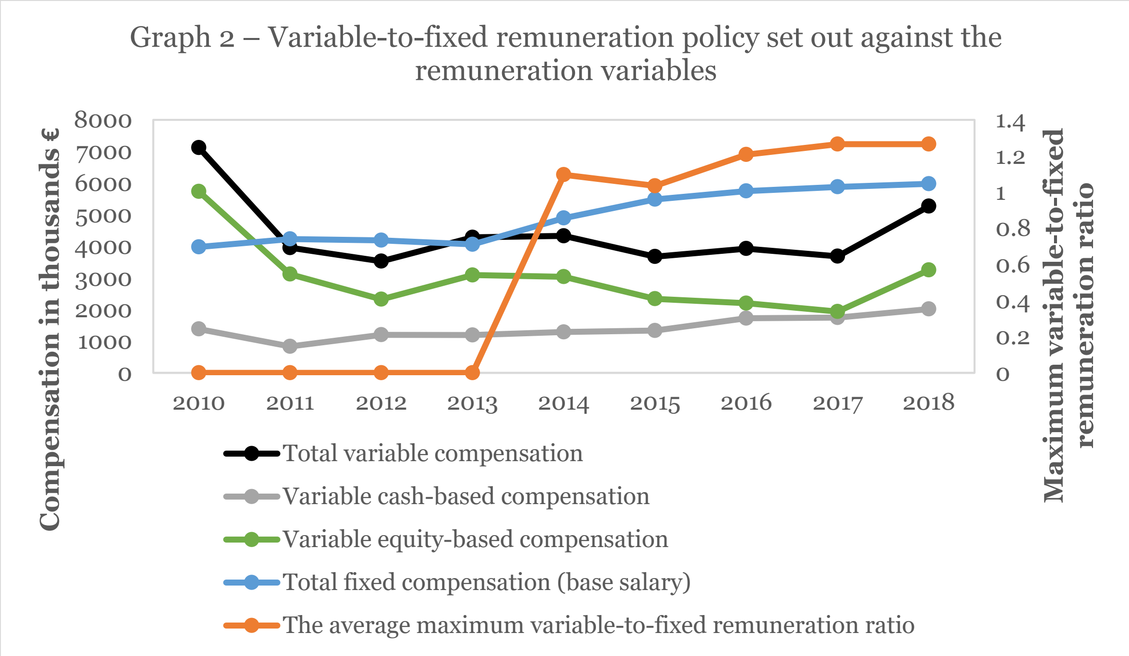
2010 was granted a total of €93.900.000 variable compensation. The fixed remuneration is also skewed to the right, but significantly less than the variable remuneration. This is a logical result, as every executive board member gets paid a fixed salary independent of the bank's circumstances. As a result of this, the lowest fixed compensation paid lies above zero.

The variable remuneration variable can be further specified in variable cash-based and equity-based compensation. Logically following from the analysis on total variable compensation, both these variables are highly skewed to the right. In the data collected, 45% of the banks grant no variable equity-based compensation, and 50% grant no variable cash-based compensation. However, the average variable-to-fixed remuneration ratio of all banks per year is still relatively high, as shown in Graph 1. The ratio stays under one after 2014, which corresponds with the regulation set out in the Directive 2013/36/EU. As these remuneration variables are so skewed and a large part is equal to zero, the natural logarithm of these variables will not help the analysis. Therefore, this research will make use of the variable-to-fixed remuneration ratio. This variable is still skewed to the right, but there is no gap in the data. Also, as this is a percentage, this variable is easier interpretable.

In Graph 2, the trend of the remuneration variables over the years and the average (of all countries) variable-to-fixed remuneration policy can be found. As can be seen, the policy is being implemented in 2014 and increases in the years following, as some countries were later with the implementation of the Directive.

Graph 1 – Average variable-to-fixed remuneration ratio





Furthermore, in Table 3, we see the descriptive statistics of the risk measures used in this research. The systematic risk mean is equal to 0,795. This implies that the European banking index is less volatile than the market, as its beta is always equal to 1. If the market has a 1% move up or down, the European banking index will move up or down with 0,795%. The mean of the total risk is equal to 0,023. The means of the interest risk and idiosyncratic risk are both equal to 0,020. Lastly, the normal z_score has a mean of 2,919, and the logarithm of the z_score has a mean of 0,816. Since the distribution of the log of the z_score is more skewed for the sample of banks compared to the distribution of the traditional z_score, the log of the z_score may be more ideally interpreted as a risk measure that is negatively proportional to a bank's log odds of insolvency. Therefore, it has a more meaningful interpretation when using the z_score as a dependent variable in standard regression analyses (Uhde, 2016).

The maximum variable-to-fixed ratio is 100 percent from 2014 onwards, however as shown in Appendix A and B, some European Member States implemented the Directive in a later year (Poland and United Kingdom), and some implemented it stricter than the Directive (Belgium, Denmark, and The Netherlands). Switzerland is not part of the European Union and therefore not obligated to implement. Switzerland did also not choose to implement a similar cap on variable remuneration on their own.

Table 3
Descriptive statistics

Variable	N	Mean	SD	Min	Max
Risk variables					
z_score	216	7.683	17.598	-11.335	178.106
(Logarithm of the) z_score	186	1.379	1.271	-2.110	5.182
Total risk	183	0.024	0.019	0.009	0.205
Systematic risk	183	0.795	0.400	-0.223	1.669
Interest risk	183	0.020	0.031	0.000	0.143
Idiosyncratic risk	183	0.020	0.019	0.006	0.206
Compensation variables					
Total direct compensation (in '000s)	228	9,604.139	13,900.000	605.000	109,000.000
Salary (fixed compensation) (in '000s)	228	5,068.625	4,814.813	605.000	29,900.000
Total variable compensation (in '000s)	228	4,535.514	10,400.000	0.000	93,900.000
Variable cash-based compensation (in '000s)	228	1,452.324	3,376.461	0.000	25,900.000
Variable equity-based compensation (in '000s)	228	3,083.194	8,432.205	0.000	90,800.000
Variable compensation per executive (in '000s)	228	821.716	1,333.674	0.000	7,221.361
Fixed compensation per executive (in '000s)	228	988.427	575.154	187.889	3,323.457
Relative variable cash-based to fixed compensation	228	0.100	0.131	0.000	0.611
Relative variable equity-based to fixed compensation	228	0.162	0.205	0.000	0.833
Variable-to-fixed remuneration ratio	228	0.630	0.937	0.000	6.925
Bank and board characteristics					
Boardsize	228	5.123	2.607	1.000	13.000
Average active board years	203	5.462	3.920	1.000	24.600
Average board age	188	52.460	3.619	44.500	64.800

4 METHODOLOGY

In this thesis, the following model will be used to determine if the amount of variable remuneration of a bank's executive board affects the riskiness of the bank. Therefore, the following baseline regression is performed:

$$risk_{it} = \alpha + \beta remuneration\_variable_{i(t-1)} + \gamma_i + \theta_t + \varphi X_{it} + \psi Z_{ct} + \epsilon_{ict} \qquad (5)$$

where $risk_{it}$ measures the risk of bank i at time t. This research's risk measures are market-based (volatility) measures and the z_score, as discussed in Section 3.2.1 and 3.2.2. Furthermore, $remuneration\_variable_{it}$ measures the variable remuneration, divided into cash-based and equity-based remuneration, of the banks' executive board and is lagged for one period. In this model γ_i denotes bank fixed effects, θ_t denotes time dummies and X_{it} and Z_{ct} are vectors of bank-level and country-level control variables. Bank fixed effects absorb all cross-sectional variation, so the risk measures are identified solely by changes in the independent variable. In essence, this research is testing whether banks that changed their executives' compensation also changed their risk relative to other banks experiencing similar changes in bank-level and country-level controls.

The compensation measures are lagged for one period, following the approach of Uhde (2016). Firstly, this basically addresses the possible reverse causality problem from the two-way relationship between compensation and risk-taking.[6] Secondly, this lag creates a time-gap to allow for potential risk-taking incentives inherent in variable compensation schemes. Lastly, lagging the compensation variable diminishes simultaneity and collinearity regarding unlagged (bank-specific) control variables.[7]

A bank-specific fixed effects model will be used, including time dummies to control for time-specific effects, such as trends in banking regulation, shocks in the European banking market, and a change in supply or demand for executive board members. Previous research performed by Graham, Li & Qiu (2011) showed that unobserved bank-specific and executive-specific characteristics might affect the compensation measure, so that employing a fixed-effects model is more suitable than a random-effects model (Woolridge, 2015). Furthermore, it is possible to estimate a fixed-effect model as there is a high within-bank variation of the compensation measure observed for the European banks in the dataset. As this thesis includes clustered robust standard errors at the bank-level due to heteroskedasticity, Hausman's (1978) test is not suitable. Therefore, it is assumed that the fixed effects model is appropriate.

The levels and frequency of variable equity-based and cash-based compensation granted to an executive board differs a lot across banks in the dataset. Therefore, heterogeneity is addressed by clustering standard errors at the bank-level. Additionally, a Modified Wald test for groupwise heteroskedasticity in a fixed-effects regression model is performed. The null hypothesis of homoscedasticity is rejected at $p < 0.000$, suggesting that the use of robust standard errors is appropriate for this model.

The causality between variable remuneration and bank volatility is not clear if the allocation of variable remuneration to banking executives depends on its overall risk exposure. Uhde (2016) provided two possible theories in his research. The first theory entails that if it is assumed that financially stronger banks pay higher variable remuneration and set stronger risk-taking incentives than financially weaker banks, this implies reverse causality. The second theory is that financially weaker banks pay higher variable remuneration to banking executives if they use “gambling for resurrection” strategies (Uhde, 2016).

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[6] Endogeneity is caused by (1) simultaneity, (2) omitted variables, and (3) measurement error (Woolridge, 2015). The simultaneity bias is basically addressed through lagging the compensation, but also a two-stage least squares regression will be performed, which is the standard way to deal with simultaneity. The omitted variable bias is addressed to a large extent through adding control variables. There is no expected measurement error.

[7] Simultaneity between the independent variable and control variables occur if these variables are correlated, which does not lead to a bias, however, it does lead to less precise estimators (Woolridge, 2015).

A two-staged least squares (2SLS) instrumental variable (IV) regression with fixed effects and time dummies will also be performed as reverse causality might occur. Uhde (2016) proposed the executive's consecutive years on board (tenure) standardized by the executive's respective age as an instrumental variable for excess compensation. An instrumental variable is usually hard to find, and it is also hard to validate if the model is appropriate. One important assumption is that the instrumental variable should not have a partial effect on the dependent variable. In the research of Uhde (2016), it is questionable if this is the case, as studies have shown that executives' age and tenure impact the risk-taking behaviors of these executives. For example, research of Chen and Zheng (2014) shows that CEO tenure has a positive significant, and direct effect on risk-taking. Furthermore, Serfling (2014) found a negative relation between CEO age and stock return volatility. Another research into the executive board composition and bank risk-taking within German banks showed that younger executive teams increase the portfolio risk (Berger, Kick & Schaeck, 2014). Although the z-score and the instrumental variable in Uhde's (2016) research were uncorrelated, this does not necessarily have to be the case, as shown by the other studies mentioned in this paragraph. Therefore, it might be interesting to study another, and potentially better, instrumental variable. As several policy changes occurred in the European banking sector, it is proposed to use the cap on variable-to-fixed remuneration ratio as an instrumental variable.

According to the instrumental variable literature, an instrumental variable needs to satisfy several assumptions (Woolridge, 2015). First, the cap on variable-to-fixed remuneration ratio (the instrumental variable IV) should not have a partial effect on the bank's risk (the dependent variable y). Second, the cap on variable-to-fixed remuneration ratio (IV) should not be correlated with confounding variables, e.g., variables that are not added to the model, which affect both the dependent and independent variable. Lastly, the cap on variable-to-fixed remuneration ratio (IV) must be related to the variable remuneration (the independent variable x).

Furthermore, the instrumental variables should satisfy two statistical assumptions, as can be seen in (6) and (7), and it has to be arguable why the instrumental variable only affects the bank's risk through the remuneration of banking executives:

$$Cov(\mathrm{IV}, u) = 0 \qquad (6)$$

$$Cov(\mathrm{IV}, x) \neq 0 \qquad (7)$$

The cap directly affects variable remuneration if the bank's remuneration is above the threshold, as it prohibits variable-to-fixed remuneration ratios that are higher than the policy prescribes. For the dataset, the covariation between the cap and the remuneration variable is non-zero (see Appendix D). Also, the covariation between the cap and the market-based risk variables are tending to zero.[8] If the cap is directly related to bank risk, e.g., if a country with a risky banking sector wants to reign the banks in with stricter bonus regulation, the instrument would not be valid. However, this theory presumably does not hold for several reasons. First of all, the countries with a more strict cap do not show more risk-taking than other countries, as shown in Appendix E and F. This furthermore reflects in that the cap and risk variables are uncorrelated for the dataset. Also, there is no empirical evidence found that countries with increased risk-taking set stricter variable compensation regulations. Therefore, it is assumed that the IV does not impact risk-taking directly. Furthermore, it is assumed that the instrumental variable will also not be affected by variables that are not added to the model (uncorrelated with the error term), i.e., the instrument is assumed to be exogenous.

The corresponding formula of the first stage regression in the 2SLS regression model is the following:

$$remuneration\_variable_{i(t-1)} = \alpha + \beta remuneration\_cap_{i(t-1)} + \gamma_{Control_i} + \epsilon_{ict} \quad (8)$$

The second-stage regression will use the fitted values of the variable remuneration of model (8), represented by the hat. The second stage is shown in model (9):

$$risk_{it} = \alpha + \beta \widehat{remuneration\_variable}_{i(t-1)} + \gamma_{Control_i} + \epsilon_{ict} \quad (9)$$

The first-stage regression (8) estimates a coefficient β for $remuneration\_variable_{it}$ that is exogenous and independent of the error term. For this reason, we can perform the second-stage regression (9) with the fitted values of variable $remuneration\_variable_{lt}$, based on the first-stage regression. This alternative model should increase the statistical credibility of the results and give a better insight into the impact of the variable remuneration on the banks' risk.

The strength of the first stage of the instrumental variable (F-test > 10) which implies that it satisfies the Staiger and Stock (1997) rule of thumb that the F-statistic should at least be 10. Therefore, the null hypothesis of a weak correlation between the instrument and the endogenous regressor can be rejected. Furthermore, the Durbin-Watson test

[8] The covaration between the cap and the z_score is not tending to zero, which will be discussed in the results section in more detail.

showed that there is no autocorrelation in the residuals. Moreover, the Sargan-Hansen test, also Sargan's J test, was used to check for over-identifying restrictions in the model. The null hypothesis of this test is that the instruments are exogenous. As the p-value is larger than 0.05, the null hypothesis can be accepted, which implies that the instrument is valid.

5 RESULTS

Hereafter, the results of the regressions will be discussed. First, the relations between relative cash-based incentive compensation, relative equity-based compensation, and the five risk measures are analyzed (Section 5.1). Second, the reverse causality problem is addressed (Section 5.2) with a Granger causality test (Section 5.2.1). Thirdly, we will examine the effect of the European policy on variable remuneration in the regressions by adding this policy as an instrumental variable (Section 5.2.2). Then, several robustness checks are performed (Section 5.3). To finalize the results section, sensitivity analyses will be performed (Section 5.4).

5.1 BASELINE REGRESSIONS

The baseline regression is a fixed effects regression to measure the effect of relative variable cash-based and equity-based to fixed compensation ratio on risk. The regression analysis's coefficients analyzing the effect of cash-based and equity-based compensation relative to total compensation on the risk measures are reported in Table 4. The compensation variables are lagged for one period. Also, dummy variables for all years are included to control for annual volatility in the risk measures (Ayadi, Arbak, & DeGroen, 2011).

The estimates of the baseline regressions in Table 4 show that all interactions between the compensation variables and the market-based risk measures are very small and negative for the dataset used in this thesis. The coefficients of relative equity-based compensation on total risk and idiosyncratic risk are significant, respectively, at the 10% and the 1% confidence level. Without time fixed effects, the effect is no longer significant, which could imply that excluding fixed effects induces a bias.

An increase in relative variable equity-based compensation compared to fixed compensation decreases the total and idiosyncratic risk of banks. However, the effect is minimal; an increase of 1% in relative equity-based compensation decreases the risk with only approximately 1/16 standard deviations.[9] The effect of a percentage increase in relative equity-based compensation on the total risk is also very, as it decreases the risk with approximately 1/18 standard deviations. Therefore, the economic effect is considered very small, which makes it difficult to make any substantial implications.

There could be several reasons for little to no decrease in risk-taking after increasing the relative equity-based compensation. It supports the theory of Ayadi, Arbak & DeGroen (2011) that long-term performance incentives are well aligned with depositors' and investors' interests, which therefore does not lead to increased risk-taking. Furthermore, the total compensation packages consist of average out of 26% variable compensation (cash and equity). If variable compensation packages represent a significant proportion of the income, executives become more risk-averse (Smith & Stulz, 1985). Therefore, it could be that the executives' in this dataset receive an amount of equity-based compensation, with belonging performance conditions, that does not encourage risk-seeking and risk-averse behavior of executives.

Table 4 further shows that the interactions between the compensation variables and the z_score are positive (note that the z_score is inversely related to the probability of insolvency, e.g., a higher z_score means more bank stability). The relative variable equity-based compensation is with fixed effects more significant than without, i.e., 5% significance level compared to 10% significance level.

The impact of the compensation measure on the z_score is larger than the impact on the market-based measures. An increase of one percent relative equity-based compensation compared to fixed compensation increases the z_score by 0.238 percent. To illustrate, this is approximately 1/5 standard deviations of the z_score. This implies that a five percent relative increase in relative equity-based compensation increases the z_score with a whole standard deviation.

This result is contrary to Uhde's (2016) findings that excess variable to fixed compensation[10], both equity and cash, are negatively related to the z_score, and therefore, more risk-inducing. The findings in Table 4 suggest that the executive board becomes more risk-averse if the relative equity-based compensation is increased. An important difference between this research and that of Uhde (2016), besides the period,

[9] This is calculated through taking the coefficient and divide this by the standard deviation of idiosyncratic risk $\frac{1}{\frac{0.0012}{0.019}} \approx 16$.

[10] The residuals of a regression of the ratio of variable to fixed compensation on bank size, country- and time-dummies (Uhde, 2016).

is that he used excess variable compensation measures, which are the residuals of a regression of variable compensation on bank size, country- and time-dummies. In this thesis research, the variable-to-fixed compensation ratio of the executive board is used. This thesis also gets contradictory results because the underlying dataset already has a reasonably lower amount of variable-to-fixed compensation ratio. The mean of the dataset of Uhde (2016) is equal to 1.46, with a maximum of 17.9, and the mean for the dataset in this thesis is equal to 0.63 with a maximum of 6.93. Fortin, Goldberg & Roth (2010) also find a considerably lower variable-to-fixed remuneration. They found that for their dataset with US banks that executives with high base salaries take less risk, while banks that grant an executive more in stock options or pay higher bonuses take more risk. Executives seek to maintain a high base salary by taking on less risky activities but are encouraged to take on more risk when they are paid more in stock options or cash bonuses (Fortin, Goldberg, & Roth, 2010). Moreover, this thesis's time period is after the financial crisis, during which a lot of state aid was given to banks. As governmental capital assistance usually comes along with certain restrictions, such as the replacement of executives or the suspension of executives' (variable) compensation, the results found in this thesis suggest that these capital aid interventions are effective instruments to mitigate risk-taking incentives (Uhde, 2016). A last explanation for the findings is based on the theory of Narayanan (1985). It is essential for investors to be well-informed about the executives' decisions and their corresponding compensation, as investors then could intervene if they see executives choosing for projects with short-term profits. As of 2013, Regulation (EU) No. 575/2013 is in place, which obligates banks to inform the investors and others on additional aspects, such as executives' compensation schemes and which performance measures are connected to the (variable) compensation. Therefore, results suggest that this policy is an effective measure for reducing the information gap between investors and executives, and therefore, reducing risk.

The effect of cash-based compensation is in all regressions that include year fixed effects, statistically insignificant. This result is contrary to some of the earlier research on compensation and risk-taking as cash-based bonuses are often thought to contribute to more myopic risk-taking as they do not depend on long-term performances (Ayadi, Arbak, & DeGroen, 2011). However, the results are in line with the empirical findings of Vallascas and Hagendorff (2013). The reason that variable cash-based compensation does not affect risk-taking might be that it linearly increases with the banks' performances, and the payoffs linked to the bonus plans are non-convex (Smith & Stulz, 1985). Another explanation is that investors are better informed about the executives and their decisions, now that Regulation (EU) No. 575/2013 is in place. As private information plays less of a role, this could imply that executives' are less seduced to risk-seeking activities (Narayanan, 1985).

There are some remarkable results concerning the control variables. The total capital ratio is positively correlated to total risk and idiosyncratic risk, and significant at the 10% level. This result is in line with other studies that found that capital ratios are associated with higher bank risk (Blum, 1999; Koehn & Santomero, 1980). A possible explanation for this is that banks finance the increased capital level in the future with riskier investments (Blum, 1999). Furthermore, GDP's effect on total risk and idiosyncratic risk is negative and significant at the 5% level. This implies that banks located in countries with more developed economies bear less total and idiosyncratic risk. A possible explanation for this is that more developed countries have more resources to financially support banks in trouble, such as during a financial crisis (De Nicolò, Dell'Ariccia, Laeven, & Valencia, 2010).

As these results differ from earlier research, it is interesting to explain why this is the case. First of all, the period of the underlying dataset started in 2010. This is somewhat at the end of the financial crises, which already impacted the compensation of executive board members a lot. Other studies on the effect of compensation on risk-taking created a dataset with an earlier period, ending before or during the financial crisis. In 2013 new regulation came on deferring of variable compensation (see Section 2.3). This simultaneously required more documentation on compensation packages. Therefore, executive compensation became more transparent, e.g., the performance measures linked to variable compensation are clearer now, which presumably resulted in compensation incentives that are better aligned with risks.

Moving on to the results of the regression reported in Table 5, which contain the baseline regressions including total variable-to-fixed compensation as the compensation measure. The compensation measure's effect is shown for the risk measures total risk, idiosyncratic risk, and the z_score. The total variable-to-fixed coefficients on the risk measures are significant, which is mainly caused by the relative equity-based compensation, as shown in Table 4. In the further robustness regressions and instrumental variable regression, this compensation measure will be used.

Table 4
Baseline regressions (1)

VARIABLES	(1) Total risk	(2) Idiosyncratic risk	(3) Interest risk	(4) Market risk	(5) z_score	(6) Total risk	(7) Idiosyncratic risk	(8) Interest risk	(9) Market risk	(10) z_score
Relative variable cash-based to fixed compensation$_{(t-1)}$	-0.0111	-0.0100	-0.00836	-0.101	0.117	-0.00716	-0.00839	-0.0186*	-0.0107	-0.130
	(0.00705)	(0.00612)	(0.00634)	(0.0925)	(0.272)	(0.00754)	(0.00655)	(0.00999)	(0.0900)	(0.405)
Relative variable equity-based to fixed compensation$_{(t-1)}$	-0.00103**	-0.00120***	-0.00149	-0.0254	0.238**	-0.000285	-0.000799	-0.00255	-0.0182	0.176*
	(0.000434)	(0.000341)	(0.00141)	(0.0199)	(0.102)	(0.000391)	(0.000498)	(0.00186)	(0.0252)	(0.0973)
Total Capital Ratio	0.0834*	0.0708*	-0.0419	0.984	-4.896	0.0929	0.139*	0.456***	-3.932***	2.18e-05
	(0.0410)	(0.0400)	(0.116)	(1.037)	(4.232)	(0.0861)	(0.0805)	(0.156)	(1.215)	(3.470)
Total Assets	0.0112	0.00947	-0.00316	0.0402	-0.128	0.0141	0.0136	0.00599	-0.124	0.0400
	(0.00774)	(0.00775)	(0.00885)	(0.141)	(0.726)	(0.00913)	(0.00854)	(0.00770)	(0.126)	(0.532)
GDP	-0.0349**	-0.0395**	0.0256	-0.367	4.058	-0.0535***	-0.0419***	0.0919**	-0.986**	6.444***
	(0.0152)	(0.0153)	(0.0187)	(0.284)	(2.946)	(0.0108)	(0.00922)	(0.0340)	(0.357)	(1.751)
Year dummies	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No
Observations	153	154	154	154	167	154	154	154	154	167
Adjusted R-squared	0.256	0.236	0.721	0.734	0.300	0.094	0.068	0.291	0.275	0.235
Number of Company_ID	21	21	21	21	26	21	21	21	21	26

The fixed effects panel model estimated risk measures is $Risk_{(i = bank,\, t = time)} = \alpha + \beta_1\, Compensation_{i,(t-1)} + \beta_2\, Total\ Capital\ Ratio_{i,t} + \beta_3 \ln(Total\ Assets)_{i,t} + \beta_4 \ln(GDP)_{i,t} + \mu_t + \epsilon_{i,t}$. The relative variable cash-based and equity-based to fixed compensation ratios are lagged for one period and regressed against all risk measures. The regressions (1)-(5) contain year dummies, while the regressions (6)-(10) do not contain year dummies.

Robust standard errors in parentheses. The constant term is included but not reported.

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

Table 5
Baseline regressions (2)

VARIABLES	(1) Total risk	(2) Idiosyncratic risk	(3) z_score
Relative total variable to fixed compensation(t-1)	-0.00116**	-0.00132***	0.236**
	(0.000459)	(0.000411)	(0.102)
Total Capital Ratio	0.0582	0.0488	-5.036
	(0.0374)	(0.0372)	(4.166)
Total Assets	0.0123	0.0104	-0.0963
	(0.00955)	(0.00929)	(0.712)
GDP	-0.0355**	-0.0400**	4.043
	(0.0150)	(0.0151)	(2.948)
Year dummies	Yes	Yes	Yes
Observations	154	154	167
R-squared	0.245	0.226	0.299
Number of Company_ID	21	21	26

The fixed effects panel model estimated risk measures is $Risk_{(i = bank, t = time)} = \alpha + \beta 1\ Compensation_{i,(t-1)} + \beta 2\ Total\ Capital\ Ratio_{i,t} + \beta 3\ \ln(Total\ Assets)_{i,t} + \beta 4\ \ln(GDP)_{i,t} + \mu_t + \epsilon_{i,t}$. The relative variable cash-based and equity-based to fixed compensation ratios are lagged for one period and regressed against all risk measures. All three regressions contain year dummies.

Robust standard errors in parentheses. The constant term is included but not reported.
*** p<0.01, ** p<0.05, * p<0.1

5.2 REVERSE CAUSALITY

The causality between executive compensation and bank risk is not clear if variable compensation packages' design depends on the bank's overall risk exposure. In this research, one-period lagged compensation measures are employed. These compensation measures are the same as performed in the regressions in Section 5.1. This approach generally addresses possible endogeneity problems; however, it is possible to control for reverse causality in a more sophisticated way. Hereafter, Granger-causality tests and instrumental variable regressions will be performed.

5.2.1 GRANGER CAUSALITY

To explore the causal directions between the bank risk measures and the compensation measures, a simple Granger model (Granger, 1969) will be used, which is a standard econometric procedure. This test can only be performed on the condition that the time series of the z_score and excess variable compensation measures are covariance stationary[11]. Therefore, a few tests are performed in advance to test for stationarity (see Appendix C). The Augmented Dickey-Fuller unit root test and the Phillips-Peron unit root test are performed to test if the series has a unit root, which is a stochastic trend.

[11] A stationary process is a stochastic process whose joint probability distribution does not change when shifted in time (Woolridge, 2015). This means that the statistical properties, e.g. the mean, variance and autocovariance, have to be constant over time. A variable is covariance stationary if the following is true: (1) the expected value $E(X_t)$ is constant for all t, (2) the variance $E(\sigma^2)$ is a finite constant for all t, and (3) the correlation coefficient between X_t and X_{t-n} is equal for all t. In addition, the covariance of the time series with itself must be constant and finite for all fixed numbers of past or future periods (De Fusco, 2015).

Also known as a random walk with drift that gives unpredictable patterns (Woolridge, 2015). These tests can handle panel data, which is not completely balanced, making them suitable for this dataset. In Appendix C, the null hypothesis shows that the tested variable has a unit root. For all of the risk measures and the compensation measures, the null hypothesis can be rejected. The test results give no reason to believe that the variables are non-stationary, and therefore, it is assumed that performing a Granger causality test is valid.

Following the research of Granger (1969), a two-variable model is used. The proposed simple causal model, where Compensation and Risk are stationary, is:

$$Compensation = \sum_{j=1}^{8} a_j Compensation_{t-j} + \sum_{j=1}^{8} b_j Risk_{t-j} + \varepsilon_t \tag{10}$$

$$Risk = \sum_{j=1}^{8} c_j Compensation_{t-1} + \sum_{j=1}^{8} d_j Risk_{t-1} + \eta_t \tag{11}$$

where it is assumed that the residuals, ε_t and η_t, are two uncorrelated white-noise series, e.g., serially uncorrelated random variables (Granger, 1969). In equation (10), causality occurs if Risk is causing Compensation provided that b_j is not zero and significant. This similarly holds for equation (11), Compensation causes Risk if c_j is not zero and significant. If both events occur, there is said to be a feedback relationship, or reverse causality, between Compensation and Risk.

In Table 6, the results of the Granger causality regressions are shown for the risk variables that were significant in the baseline regressions. The causality between two variables, risk and compensation, will be checked through the Granger causality regressions. Therefore, the variable-to-fixed ratios, split into cash and equity, are not suitable, and the total variable-to-fixed compensation ratio will be used. Regressions (1), (3), and (5) show that the total variable-to-fixed remuneration ratio has a significant impact on total risk, idiosyncratic risk, and the z_score, and therefore Granger causes risk-taking. Furthermore, regressions (2), (4), and (6) reveal the risk measures do not Granger-cause the variable-to-fixed remuneration ratio, as there is no significant effect. Hence, the Granger test results confirm that the risk measures and the compensation measure in the baseline findings are not biased by reverse causality. The Granger causality regressions for interest risk and market risk were not significant, and as they were also insignificant in the baseline regression, the estimated coefficients are not reported.

Table 6
Granger causality tests

VARIABLES	(1) Compensation → Total risk	(2) Total risk → Compensation	(3) Compensation → Idiosyncratic risk	(4) Idiosyncratic risk → Compensation	(5) Compensation → z_score	(6) z_score → Compensation
Relative total variable to fixed compensation(t-1)	-0.000965**	0.377***	-0.00120***	0.376***	-0.0188	0.388***
	(0.000405)	(0.0772)	(0.000383)	(0.0770)	(0.0779)	(0.103)
Total risk(t-1)	0.0999***	-1,298				
	(0.0291)	(0.832)				
Idiosyncratic risk(t-1)			0.0537*	-1,680		
			(0.0284)	-1,044		
z_score(t-1)					0.321***	-0.0186
					(0.0773)	(0.0421)
GDP	-0.0336*	0.459	-0.0386**	0.440	-0.798	0.627
	(0.0165)	(0.624)	(0.0161)	(0.622)	(1.966)	(1.775)
Total Capital Ratio	0.0486	2,619	0.0439	2,646	-1.549	-0.756
	(0.0364)	-3,559	(0.0371)	-3,570	(3.578)	(1.761)
Total Assets	0.0102	-0.00295	0.00938	0.00200	0.00271	-0.0166
	(0.00839)	(0.330)	(0.00888)	(0.331)	(0.488)	(0.218)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	154	154	154	154	152	152
R-squared	0.252	0.324	0.229	0.325	0	0
Number of Company_ID	21	21	21	21	25	25

The emprical model and estimation parameters are defined in Table 4. In regression (1) total risk is regressed on a one-period lag of itself and on the one-period lagged relative total variable to fixed compensation measure. In regression (2) the compensation variable is regressed on a one-period lag of itself and on the one-period lagged total risk. In regression (3) idiosyncratic risk is regressed on a one-period lag of itself and on the one-period lagged relative total variable to fixed compensation measure. In regression (4) the compensation variable is regressed on a one-period lag of itself and on the one-period lagged Idiosyncratic risk. In regression (5) the z_score is regressed on a one-period lag of itself and on the one-period lagged relative total variable to fixed compensation measure. In regression (6) the compensation variable is regressed on a one-period lag of itself and on the one-period lagged z_score.

Robust standard errors in parentheses. The constant term is included but not reported.

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

5.2.2 INSTRUMENTAL VARIABLE REGRESSION

Table 7 shows the instrumental variable regressions that are performed. In this regression, the total variable compensation to the total fixed compensation ratio is used as the dependent variable. This is necessary as the instrument used impacts the total variable compensation to the fixed compensation ratio, not solely the cash or equity compensation. The cap, that was introduced in Directive 2013/36/EU, prohibits additional variable remuneration (both cash and equity) if the variable-to-fixed remuneration ratio of Identified Staff is above the cap. Therefore, the cap only has effect on the banks' executive boards that are above the threshold of maximum variable-to-fixed remuneration.

Hereafter, the results of the instrumental variable regressions of the market-based risk measures will be discussed, which can be found under (1)-(3) in Table 7. The instrumental variable enters the first stage regression significant at the five percent level. Furthermore, the control variables still exhibit the expected signs. However, the logarithm of GDP loses its significance in the IV regressions. The baseline findings of a positive relationship between the variable-to-fixed remuneration ratio and risk are also found during the second stage regressions. The remuneration ratio effects on total and idiosyncratic risk also stay significant at the ten percent level. The instrumental variable regressions for interest risk and market risk were not significant in the second stage. As they were also not significant in the baseline regression, these are not reported.

It should be noted that the negative coefficient of the effect of variable-to-fixed remuneration on total risk and idiosyncratic becomes approximately thirty times stronger during the IV estimation. This could imply that the results of the baseline regressions including the market-based risk measures are influenced by endogenous variables. And, that the negative effect of relative variable compensation on risk-taking becomes more evident when using an exogenous estimator. One might argue that the unobserved executives' view on risk-taking might have changed to more risk averse, after the financial crisis. Lastly, the first stage of IV regression with the market-based risk measures are significant and the relationship between risk and the compensation measure is reiterated in the second stage. Therefore the IV estimates give, in addition to the Granger causality test, no reason to assume the baseline regressions are biased by reverse causality (Uhde, 2016).

Instruments are valid if the instrument meets two requirements (Woolridge, 2015). The first requirement is that the instrument has to be exogenous, e.g., uncorrelated with the error term. This requirement can, in general, not be tested. This requirement's validation should be based on a strong theoretical argumentation, as already discussed in the methodology section (Section 4). The second requirement is that the instrument is highly correlated with the endogenous regressors even after controlling for the exogenous regressors, i.e., the instrument relevance. Instruments with a low correlation between the endogenous regressors are called weak instruments. There is empirical and theoretical evidence that IV regressions with weak instruments have poorer statistical properties and could perform worse than baseline models (Stock, Wright, & Yogo, 2002). The instrumental relevance (second requirement) can be tested through the F-test of the first stage regression. For the first-stage regression, the F-statistic is equal to 6.33. This does not satisfy the rule of thumb that the F-statistic should be at least 10 (Cragg & Donald, 1993; Staiger & Stock, 1997). However, Stock & Yogo (2005) provided a refinement and improvement on the rule of thumb, which was considered too conservative. The proposed procedure is to compare the first-stage F-statistic to a critical value.[12] The critical value is based on simulations, where under weak identification, the F-test is rejected too often. The test statistic is based on the rejection rate r (from 10% to 25%) that the researcher is willing to tolerate if the true rejection rate should be the standard 5% (Baum, Schaffer, & Stillman, 2007). The test has good power and can effectively discriminate between weak and strong instruments. The F-statistic is larger than the 25% critical value of 5.53 (Stock & Yogo, 2005).[13] This implies that based on a rejection rate of 25%, the null hypothesis that the instrument is weak can be rejected. As the F-statistic in the first stage is equal to 6.33, the null hypothesis can be rejected, based on the study of Stock & Yogo (2005). This is not a very strong rejection of the null hypothesis, so some caution is required when interpreting the results.

The instrument exogeneity (first requirement) can, in general, not be tested. However, as there is one instrumental variable, the under-identification can be tested. Therefore, an under-identification test was performed (Anderson canon. Corr. LM statistic), which returned a p-value of 0.03. Therefore, we can reject the hypothesis that the equation is under-identified. Lastly, the Anderson-Rubin Wald test and the Stock-Wright LM S statistic show that the null hypothesis that the endogenous regressors are relevant can

[12] This critical value is determined by the IV estimator that is used, the number of instruments, the number of endogenous regressors, and how much bias or size distortion is allowed.
[13] The statistic is based on an IV regression with one instrument (the cap) and one endogenous regressor (the compensation measure), as performed in this thesis. With a 20% significance interval the F-statistic should be 6.66 or higher.

be rejected. However, as said, the tests described in this paragraph are only an indication and are not leading in determining whether the instrument is valid.

Under (4) and (5) of Table 7, the first and second stage instrumental variable regressions can be found for the accounting-based risk measure, i.e., the z_score. It turns out that the proposed instrument has no significant effect on the compensation measure, and the compensation measure loses its significant effect on the z_score in the second stage. The instrumental variable regressions including the z_score does not rule out the chance that the z_score and compensation measures are biased by reverse causality. Although, the Granger causality test already showed that this is presumably not the case. The results could also imply that endogenous variables in the earlier models (section 5.1) influenced the z_score and that compensation measure is less evident when using an exogenous estimator. In response to this finding a few thing could be argued. First, the cap on variable-to-fixed remuneration is not a good instrument to measure the effect between the z_score and the compensation measure. As mentioned in the methodology section, the covariation between the z_score and the instrument is non-zero and could therefore have a partial effect on the z_score. As this is necessary to performd a good IV regressions, this forms presumably the problem. A possible explanation that this does happen for the z_score risk measure, but not for the market-based risk measures is the following. As mentioned in Section 3.2.2 the z_score cannot deal with negative values. Therefore, in the next section a robustness check of the z_score will be performed, which deals with these negative values of the z_score in another sub-optimal manner.

Table 7
Instrumental Variable regressions

VARIABLES	(1) First stage Lagged variable-to-fixed-ratio	(2) Second stage Total risk	(3) Second stage Idiosyncratic risk	(4) First stage Lagged variable-to-fixed ratio	(5) Second stage z_score
Policy measure - maximum variable-to-fixed remuneration ratio with shareholder approval$_{(t-1)}$	0.365**			0.0555	
	(0.173)			(0.152)	
Relative total variable to fixed compensation$_{(t-1)}$		-0.0406*	-0.0388*		-0.549
		(0.0217)	(0.0208)		(4.445)
Total Capital Ratio	4,535	0.230	0.212	3.491	-2.213
	-3,831	(0.199)	(0.190)	(2.632)	(16.55)
Total Assets	0.243	0.0169	0.0148	0.732*	0.471
	(0.447)	(0.0204)	(0.0195)	(0.426	(3.289)
GDP	-0.611	-0.0593	-0.0626	-2.053	2.440
	-1,124	(0.0531)	(0.0508)	(1.460)	(9.392)
Year dummies	Yes	Yes	Yes	Yes	Yes
Observations	153	153	153	167	167
R-squared	0.162			0.174	
Number of Company_ID	21	21	21	26	26
Craig-Donald Wald F statistic (weak identification test)	6.33				
Anderson canon. corr. LM statistic (underidentification test)	4.67 (0.031)				
Anderson-Rubin Wald test	18.98 (0.000)				
Stock-Wright LM S statistic	16.59 (0.000)				

Regressions are estimated by means of 2SLS instrumental variable regressions. The relative total variable to fixed compensation measure, which is lagged for one period, is instrumented against the one period lag of the policy measure. The 2SLS regressions are performed for two seperate datasets, regressions (1)-(3) are only listed banks as these only have market-based risk calculations, regressions (4)-(5) are both listed and unlisted banks. Results from the 1st stage regression are shown in specification (1) and (4), while results from the baseline regressions for the instrumented compensation measure, also the second stage, are shown in specifications (2), (3), and (5).
Standard errors in parentheses. The constant term is included but not reported.
*** p<0.01, ** p<0.05, * p<0.1

5.3 ROBUSTNESS CHECKS

In the following two sections, the robustness of both the compensation measures will be checked by including and excluding control variables. Furthermore, the z_score will be analyzed more thoroughly, as it cannot deal with the observations that have a negative return on average assets.

5.3.1 ROBUSTNESS OF THE COMPENSATION MEASURE

Next, the performed robustness checks of the compensation measure are discussed. In models (1a)-(1c), reported in Table 8, regressions with the nominal values of variable cash-based compensation and variable equity-based compensation can be found. For interpretability reason, the compensation measures are measured per 100,000 euros. The significance and sign of the nominal compensation measures are similar to the relative compensation measures used in this thesis. This implies that the effect of the compensation measure on risk used in this thesis is reasonably robust.

Table 8
Robustness check of the compensation measure

VARIABLES	(1a) Total risk	(1b) Idiosyncratic risk	(1c) z_score	(2a) Total risk	(2b) Idiosyncratic risk	(2c) z_score
Total cash compensation(t-1)	-3.31e-05	-3.52e-05	-0.00185			
	(2.56e-05)	(2.12e-05)	(0.00363)			
Total equity compensation(t-1)	-1.11e-05**	-1.22e-05**	0.00190			
	(5.21e-06)	(5.02e-06)	(0.00125)			
Total variable compensation(t-1)				-1.15e-05*	-1.26e-05*	0.00194*
				(6.33e-06)	(6.32e-06)	(0.00103)
GDP	-0.0349**	-0.0394**	3.541	-0.0348**	-0.0392**	3.549
	(0.0148)	(0.0149)	(2.880)	(0.0147)	(0.0148)	(2.915)
Total Capital Ratio	0.0608	0.0511	-4.231	0.0557	0.0458	-4.565
	(0.0397)	(0.0396)	(4.092)	(0.0375)	(0.0377)	(4.123)
TotalAssets	0.0122	0.0103	0.0223	0.0121	0.0102	0.0415
	(0.00968)	(0.00942)	(0.729)	(0.00957)	(0.00932)	(0.731)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	154	154	167	154	154	167
R-squared	0.245	0.226	0.293	0.244	0.225	0.289
Number of Company_ID	21	21	26	21	21	26

The empirical model and estimation parameters are defined in Table 4. In regressions (1a)-(1c) the compensation measures are substituted by the total variable cash-based compensation and total variable equity-based compensation, per 100,000 euros and lagged for one period. In regressions (2a)-(2c) the compensation measure is the total variable compensation per 100,000 euros and lagged for one period.

Robust standard errors in parentheses. The constant term is included but not reported.

5.3.2 ROBUSTNESS OF THE Z_SCORE MEASURE

As mentioned in Section 3.2.2, the z_score cannot deal with negative values. As discussed, these negative observations are not added in the baseline regressions, which is a sub-optimal solution. Those observations are presumably most risky. Hereafter, the baseline regression is performed again, however, with a newly developed z_score. To all observations, a constant of 11.35 is added so that the lowest z_score value is non-negative and equal to 0.01. This data transformation method is used more often to deal with the negative values before taking the logarithm (Osborne, 2002). In regression (1) of Table 9, the regression results are shown, in which the observations that used to have negative z_scores, that are considered most risky are now also taken into account. This is also the reason why the amount of observations is higher than in the baseline regressions. The sign and significance of the effect of the remuneration variable on risk-taking do not change. The size of the coefficient, however, becomes approximately three times smaller. This decreased effect corresponds more with the baseline regressions of the market-based risk measures. Therefore, it is presumable that the effect of the compensation measure on the z_score in the baseline regressions is overestimated, by not taking into account observations that are considered most risky. However, also this result should be interpreted with much care, as the the relationship of the nominator and denominator in the z_score changes if ROAA + CAR < 0 (see section 3.2.2).

Table 9
Robustness check of the z_score

	(1)
VARIABLES	z_score
Relative total variable to fixed compensation(t-1)	0.0690**
	(0.0273)
Total Capital Ratio	-1.295
	(1.151)
Total Assets	0.0914
	(0.205)
GDP	0.542
	(0.502)
Year dummies	Yes
Observations	193
R-squared	0.222
Number of Company_ID	26

The empirical model and estimation parameters are defined in Table 4. In regression (1) the negative z_score measure is changed before taking the logarithm. A constant is added to each z_score so that there are no more negative values. The lowest z_score value (before the logarithm is taken) is -11.33529, therefore 11.3452909 is added to each z_score. The new lowest z_score is 0.01.

Robust standard errors in parentheses. The constant term is included but not reported.
*** p<0.01, ** p<0.05, * p<0.1

5.4 Sensitivity analyses

In this paragraph, the sensitivity of the effect of the compensation measure on the risk measures will be analyzed. In regressions (1a)-(1c) of Table 8, all control variables are excluded from the baseline regressions. As shown, the significance of the effect on total risk and idiosyncratic risk disappears, and the effect on the z_score stays significant. Also, the effects on total risk and idiosyncratic risk become smaller, while the effect on the z_score remains quite similar. This could suggest that there is an omitted variable bias in regressions (1a), (1b), (2a), and (2b), which is gone after adding the control variables as performed in the baseline regressions.

In regressions (3a)-(3c), the board characteristics are added as control variables. The added variables are board size, average board age, and board tenure.[14] Some studies argue that smaller boards act more consistently with the shareholders' interests, and provide empirical evidence for a negative relationship between board size and riskiness (Hermalin & Weisbach, 2003; Pathan, 2009). Other studies showed that group decision making increases versatile thinking and lead to compromises, which in discussions lead to rejection of (too) risky projects and less risk-taking on balance (Sah & Stiglitz, 1984; Sah & Stiglitz, 1991). Regarding the age of executives, conventional wisdom and empirical evidence show that risk-taking decreases with an individual's age (Berger, Kick, & Schaeck, 2014). For example, Campbell (2001) shows that increased age has a negative effect on participation in equity investments. The theory behind these empirical findings states that risk tolerance declines with age and that older people have a higher knowledge of risk and risky situations compared to people that are younger (Bucciol & Miniaci, 2011; Grable, McGill, & Britt, 2009; Agarwal, Driscoll, Gabaix, & Laibson, 2009). Lastly, the previous empirical evidence on tenure and risk-taking is very mixed, although tenure was used as a control variable in most researches. Chen and Zheng (2014), however, did research the relationship between tenure and risk-taking directly. Their results show an overall positive effect of tenure on risk-taking, which is inconsistent with viewing tenure primarily as an indicator of human capital investment. This relationship mainly depends on the information asymmetry of executives' ability.

As reported in Table 8, regression (3a) and (3b) show that all of the board-specific control variables have no significant effects on bank risk. At the same time, the risk-increasing impact of the compensation measure is still significant. This result suggests that the possibility of omitted variable bias is reduced in the baseline regressions. Furthermore, this outcome is in line with the more recent performed research of Uhde (2016) regarding the board size.

[14] The average board age is the ages of the board added to each other and divided by the number of executive board members. And, the average board tenure is the amount of years each executive board member is working in the board in the relevant year, added to each other and divided through the number of executive board members.

Table 10
Sensitivity analyses

	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
VARIABLES	Total risk	Idiosyncratic risk	z-score	Total risk	Idiosyncratic risk	z-score	Total risk	Idiosyncratic risk	z-score
Relative total variable to fixed compensation$_{(t-1)}$	-0.000775	-0.000952	0.190*	-0.000917	-0.00111**	0.216**	-0.00119*	-0.00138**	0.246**
	(0.000755)	(0.000631)	(0.0980)	(0.000571)	(0.000472)	(0.0981)	(0.000637)	(0.000568)	(0.0949)
GDP				-0.0406**	-0.0443**	3.824	-0.0346**	-0.0386**	3.506
				(0.0193)	(0.0190)	(2.897)	(0.0150)	(0.0153)	(2.506)
Total Capital Ratio							0.0576	0.0487	-2.614
							(0.0413)	(0.0416)	(3.508)
Total Assets							0.0128	0.0109	0.0501
							(0.0108)	(0.0105)	(0.652)
Average board age							0.00121	0.00301	3.371
							(0.0309)	(0.0313)	(3.807)
Average board tenure							0.000910	0.00125	0.421
							(0.00514)	(0.00489)	(0.319)
Board size							0.00226	0.00196	-0.735
							(0.00259)	(0.00211)	(0.767)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	158	158	167	158	158	167	154	154	158
R-squared	0.216	0.195	0.271	0.236	0.219	0.29	0.245	0.227	0.364
Number of Company_ID	21	21	26	21	21	26	21	21	25

The empirical model and estimation parameters are defined in Table 4. In regressions (1a)-(1c) the compensation measures is regressed on the risk variables without control variables. Regressions (2a)-(2c) contain regressions without bank-specific control variables, only including the GDP variable. In regressions (3a)-(3c) three additional bank-specific control variables are added to the baseline model, i.e. the natural logarithm of the average board age, the natural logarithm of the average board tenure, and the natural logarithm of the board size.

Robust standard errors in parentheses. The constant term is included but not reported.

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

6 DISCUSSION AND CONCLUSION

6.1 SUMMARY AND CONCLUSION

In this research, a small dataset on European banks' executive compensation divided into cash- and equity compensation has been built. In addition to the compensation variables, other bank-specific variables and country-specific variables were collected. The main compensation measure that was researched in this thesis was the variable to fixed compensation ratio of the whole executive board. Moreover, market-based risk measures, as well as an accounting-based risk measure, was developed. The market-based risk measures consist of idiosyncratic volatility, exposure to market risk, and interest-rates. These measures combined are referred to as the total risk or total stock volatility. The accounting-based risk measure is the z_score, which measures the bank failure likelihood. The European policy and national implementations of the maximum variable-to-fixed remuneration ratio were added to finalize the dataset.

The analyses performed led to the following results. The effect of relative more cash-based compensation on risk-taking was not significant, which is in line with recent previous studies. The theoretical substantiation for this effect is (1) that cash-based compensation linearly increases with the banks' performances, and the payoffs linked to the bonus plans are non-convex, and (2) the implementation of Regulation (EU) No. 575/2013 ensured that executives' have less private information (regarding the investors) and are therefore less seduced to risk-seeking activities.

The variable equity-based to fixed compensation ratio has a small negative and significant effect on total risk and idiosyncratic risk and a positive effect on the z_score. This implies that paying the executive board relatively more equity-based compensation compared to fixed compensation decreases a banks' riskiness a bit. Over the past ten years, relative variable equity-based compensation has decreased. This is mainly due to the introduced variable-to-fixed compensation cap of Directive 2013/36/EU. Therefore, it could be that the compensation packages currently consist of the right proportion of equity compensation, as it does not increase or decrease risk (Smith & Stulz, 1985).

The whole variable-to-fixed remuneration ratio, including both cash and equity compensation, was found to have a small significant negative impact on risk-taking in the baseline regressions. This is logical as equity-based compensation forms the largest part of the total variable compensation granted to executives. Taking this empirical finding into account, it would be interesting for policy makers to evaluate the new policies on variable remuneration more thoroughly. Policymakers often state that increased variable remuneration increases risk-taking within banks, and therefore, they chose to cap the variable-to-fixed pay from 2014 and onwards. However, in the dataset, a slight decrease in risk-taking is observed if the variable-to-fixed compensation increases. This could be because the compensation schemes are already more in line with the investors' interest and therefore do not lead to (excessive) risk-taking. Furthermore, it is expected, with the introduction of Regulation (EU) No. 575/2013, that the amount of private information reduces for the executives' regarding their compensation and performance. Therefore, results could lead to the conclusion that the less drastic policy change of an information obligation is more effective than the cap on variable remuneration.

To take into account the possible bias of reverse causality between risk-taking and compensation, a Granger causality test and instrumental variable regressions were performed. The Granger causality regressions showed that the compensation variable Granger-causes the risk variables, and not vice versa. This test's result does not give reason to believe that the baseline regression is biased by reverse causality.

Furthermore, three instrumental variable regressions were performed. For the market-based risk measures, the first-stage regression is significant. European policy has a significant and positive effect on the variable-to-fixed remuneration ratio, which is a logical outcome. The second stage regressions are significant as well. Thus, the 2SLS regression gives, together with the Granger causality test outcome, no reason to assume that there is reverse causality between the compensation and market-based risk measures. In the IV estimates the effect of relative more variable compensation was stronger than in the baseline regressions. This could suggest that the risk-aversion resulting from relative more variable compensation on risk-taking becomes more evident when using an exogenous estimator. However, these results need to be interpreted with care as the F-test was only significant at the 25% level. It became apparent that the proposed instrument was not suitable for the z_score risk measure.

The robustness and sensitivity analyses show that the baseline regressions with the market-based risk measures are reasonably robust. Furthermore, the z_score was re-evaluated as this risk measure cannot handle negative observations, i.e., observations that have a negative return on average assets. It became apparent that the effect on the z_score becomes smaller, when including the negative z_scores. Although, these results should be interpreted with care as well. Lastly, the relationship between the compensation and risk measures are reasonably stable as both adding control variables and leaving control variables out does not affect the results of the baseline regressions much.

6.2 Limitations

There are some limitations to this research. As this research is a master thesis, there is a limited time span. This limited time span, combined with the compensation data had to be collected by hand out of annual reports, resulted in a relatively small dataset. Therefore, it is questionable if these findings can be extrapolated to the whole banking sector of Europe.

This thesis dealt with potential endogeneity issues in several ways. Among those, a new instrumental variable was developed, which turned out to be all right, however not very convincing. The results should, therefore, be interpreted with care. It is also necessary to evaluate the instrument, i.e., the cap on variable-to-fixed remuneration, again in further research. Also, the instrumental variable regressions, including the z_score, were not significant, so reverse causality could not be ruled out for that risk measure. There was no reason to believe that there is reverse causality between the market-based risk measures and the compensation measure.

Furthermore, only the awarding of equity-linked remuneration was taken into account and not if the shares were issued. As there are clawback arrangements in deferred variable equity-based and cash-based compensation, granted compensation does not imply that the compensation is actually paid. This information is not reported in most of the annual reports , or it is unclear if the payments are actually performed. This could be something that the European Banking Authority could make compulsory in the future as additional information disclosure. It would improve the quality of research on compensation schemes, as the effect of direct payments and conditional granting of compensation could differ.

6.3 Further research

The findings of this research are interesting when they are put into perspective of banks' European compensation policy. Furthermore, qualitative research into which performance indicators are connected to cash- or equity compensation would be interesting. It could then be analyzed if and which short- or long-term performance indicators in compensation packages would increase or decrease risk-taking. Also, research into deferral and clawback provisions could be interesting; however, as mentioned in the limitation section, first, this should be better documented in the annual reports. Lastly, more research could be done into the z_score, as earlier studies did not mention that the z_score cannot deal with observations that have a negative return on average assets. Lastly, one of the limitations partly forms the recommendation for further research, as a suggestion would be to use a larger sample of European banks.

APPENDICES

Appendix A

Overview of policies on the bonus cap of x% in Europe on a national level.

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Austria	0%	0%	0%	0%	100%	100%	100%	100%	100%
Belgium	0%	0%	0%	0%	50%	50%	50%	50%	50%
Denmark	0%	0%	0%	0%	50%	50%	50%	50%	50%
Finland	0%	0%	0%	0%	100%	100%	100%	100%	100%
France	0%	0%	0%	0%	100%	100%	100%	100%	100%
Germany	0%	0%	0%	0%	100%	100%	100%	100%	100%
Ireland	0%	0%	0%	0%	100%	100%	100%	100%	100%
Netherlands	0%	0%	0%	0%	100%	20%	20%	20%	20%
Poland	0%	0%	0%	0%	0%	0%	0%	100%	100%
Spain	0%	0%	0%	0%	100%	100%	100%	100%	100%
Switzerland	0%	0%	0%	0%	0%	0%	0%	0%	0%
United Kingdom	0%	0%	0%	0%	0%	0%	100%	100%	100%

Appendix B

Overview of countries that allow banks' shareholders to approve a higher maximum variable-to-fixed remuneration ratio up to x.

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Austria	0%	0%	0%	0%	200%	200%	200%	200%	200%
Belgium	0%	0%	0%	0%	50%	50%	50%	50%	50%
Denmark	0%	0%	0%	0%	200%	200%	200%	200%	200%
Finland	0%	0%	0%	0%	200%	200%	200%	200%	200%
France	0%	0%	0%	0%	200%	200%	200%	200%	200%
Germany	0%	0%	0%	0%	200%	200%	200%	200%	200%
Ireland	0%	0%	0%	0%	200%	200%	200%	200%	200%
Netherlands	0%	0%	0%	0%	200%	200%	200%	200%	200%
Poland	0%	0%	0%	0%	0%	0%	0%	200%	200%
Spain	0%	0%	0%	0%	200%	200%	200%	200%	200%
Switzerland	0%	0%	0%	0%	0%	0%	0%	0%	0%
United Kingdom	0%	0%	0%	0%	0%	0%	200%	200%	200%

Appendix C

Tests for unit roots and stationarity

Total risk		**Z-score**	
Fisher-type unit root test		Fisher-type unit root test	
ADF (inverse X^2, p-value)	55.7156 (0.0019)	ADF (inverse X^2, p-value)	134.296 (0.0000)
Phillips-Perron (inverse X^2, p-value)	122.378 (0.0000)	Phillips-Perron (inverse X^2, p-value)	83.482 (0.0006)
Idiosyncratic risk		**Lagged variable-to-fixed ratio**	
Fisher-type unit root test		Fisher-type unit root test	
ADF (inverse X^2, p-value)	77.866 (0.0001)	ADF (inverse X^2, p-value)	405.478 (0.0000)
Phillips-Perron (inverse X^2, p-value)	122.910 (0.0000)	Phillips-Perron (inverse X^2, p-value)	71.480 (0.0094)

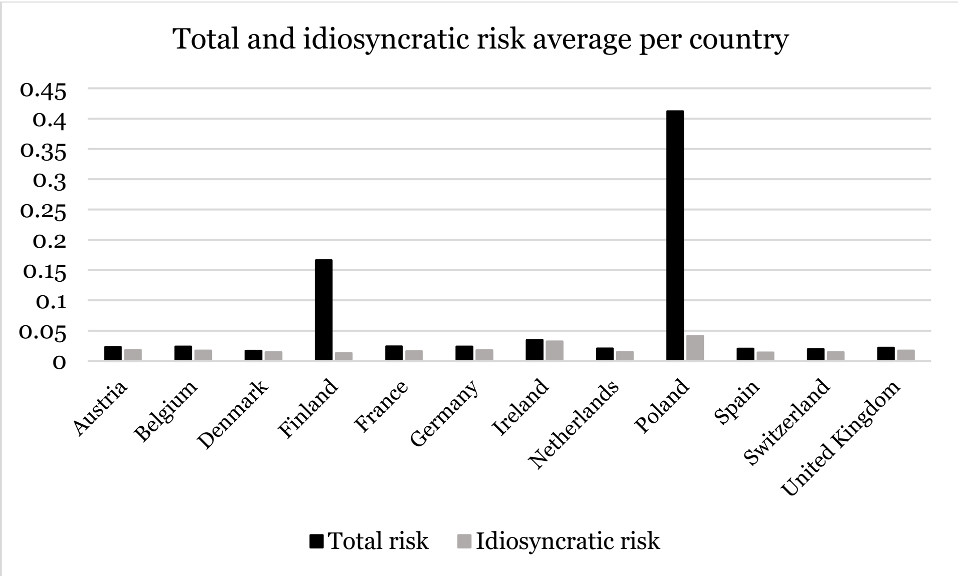
For the Fisher-type unit root test the null hypothesis is that panels contain unit roots and the alternative hypothesis is that at least one panel is stationary.

Appendix D

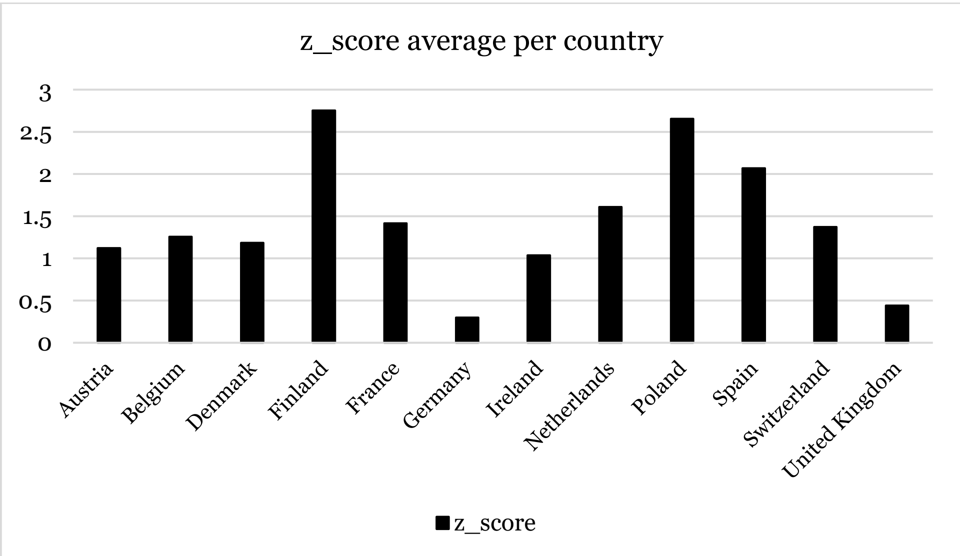
Covariation matrix

	Total risk	Idiosyncratic risk	z_score	Total variable-to-fixed remuneration ratio lagged one year
Maximum bonus policy lagged one year	-0.0036	-0.0015	0.1141	-0.1468

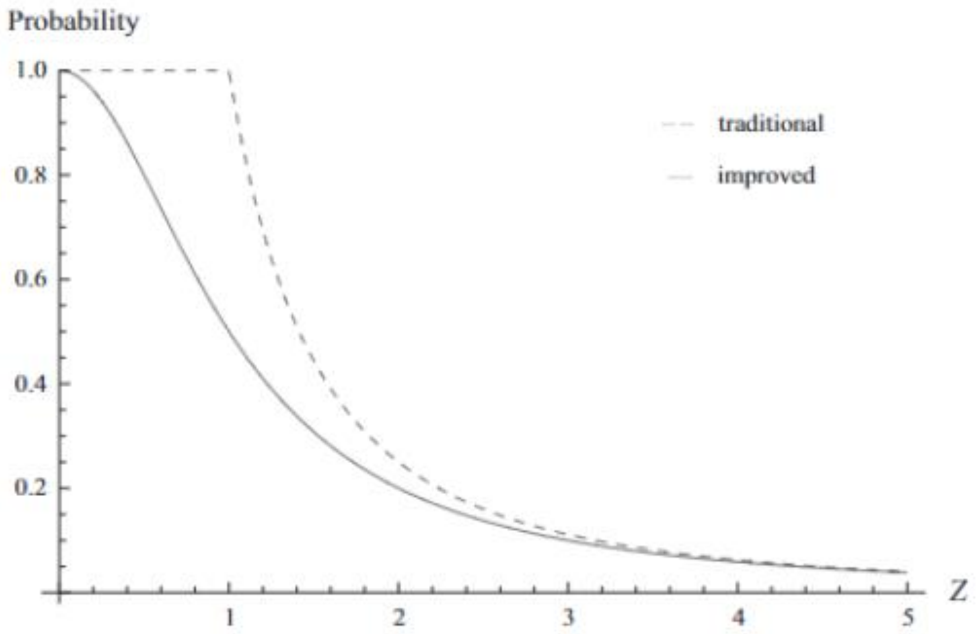
Appendix E



Appendix F



Appendix G



Source: (Lepetit & Strobel, 2015)

Appendix H

The businesses that fall under the Directive and Regulation are stated in article 4 of the Regulation (EU) No. 575/2013, and are described hereafter. First of all, credit institutions, a business that entails taking deposits or other repayable funds from the public, grant credits for its account. Secondly, investment firms: any legal person whose regular occupation or business is the provision of one or more investment services to third parties, or the performance of one or more investment activities on a professional basis. The data collected for this research only consists of banks, which all fall under the Directive and Regulation.

Based on article 94(2) CRD IV, the European Banking Authority (EBA) is authorized to establish technical, regulatory standards (Regulatory Technical Standards, or RTS). One of these standards is on which bank employees the directive, and therefore the maximum variable-to-fixed remuneration, applies. To fall under the directive ("Identified Staff"), it is necessary for a category of employees within banks to substantially affect the institution's risk profile. Supervisory board members, executive board members, and the senior management are assumed to influence the risk as they are responsible for the risk management functions, compliance functions, or internal control functions. As the compensation of executive board members will be analyzed, it is clear that they fall under the Identified Staff, as they are specifically mentioned.

The compensation policy has to be applied on a consolidated basis, on the level of the group. This implies that parent undertakings, subsidiaries, branch offices, and subsidiaries not located in the European Union have to be considered. For this reason, only parent banks were used for this analysis.

The European Banking Authority published more guidelines on calculating the maximum variable-to-fixed remuneration ratio, e.g., which variable and fixed remuneration has to be taken into account and for which amount. The European Banking Authority states that, to calculate the bonus cap, compensation instruments are valued at their fair value following IFRS 2 at the date of the award of variable remuneration without taking into account the probability whether instruments will be granted or not if their future value changes (European Banking Authority, 2016a). Furthermore, paragraph 188 of the Guidelines on sound remuneration policies specifies that “the ratio between variable and fixed remuneration components should be set independent of any potential future ex-post risk adjustment or fluctuation in the price of instruments” (European Banking Authority, 2016b). When considering the instrument's valuation, it must not be taken into account that eventually, the variable remuneration awarded in such instruments is subject to malus or clawback or that such deferred variable remuneration might be reduced in case staff leaves. Such aspects are not relevant for the value of the instrument as such. Lastly, paragraph 125 of the Guidelines on sound remuneration policies only applies to variable remuneration that is based on future performance and states that the valuation of a fixed number of awarded instruments should only be valued to calculate the ratio between the variable and fixed component of total remuneration at the market price or fair value when the remuneration plan was granted (European Banking Authority, 2016b). The feedback table of the Guidelines explains (regarding par 120 of the consultation paper) that this valuation was implemented to "ensure that institutions can determine ex-ante" – at grant before the actual award is made – "the maximum ratio between the variable and the fixed remuneration for identified staff." Furthermore, in this situation, the general rule applies that listed institutions use the market price and non-listed institutions use the instrument's fair value. Lastly, we will consider the appropriate method for the calculation of fixed compensation. Allowances that are part of the standard employment package, such as childcare allowances, regular pension contributions on top of the mandatory regime, travel allowance, are excluded from variable compensation. These compensation parts are granted in a non-discretionary way to staff and are not performance-related and, therefore, according to the European Banking Authority, do not encourage risk-taking (European Banking Authority, 2014).

In this research, we will consider the preceding valuation method in the data collection process. This will grant the most precise calculation of the variable-to-fixed ratio, as used by governments. In Section 3.1, this will be explained more thoroughly.

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